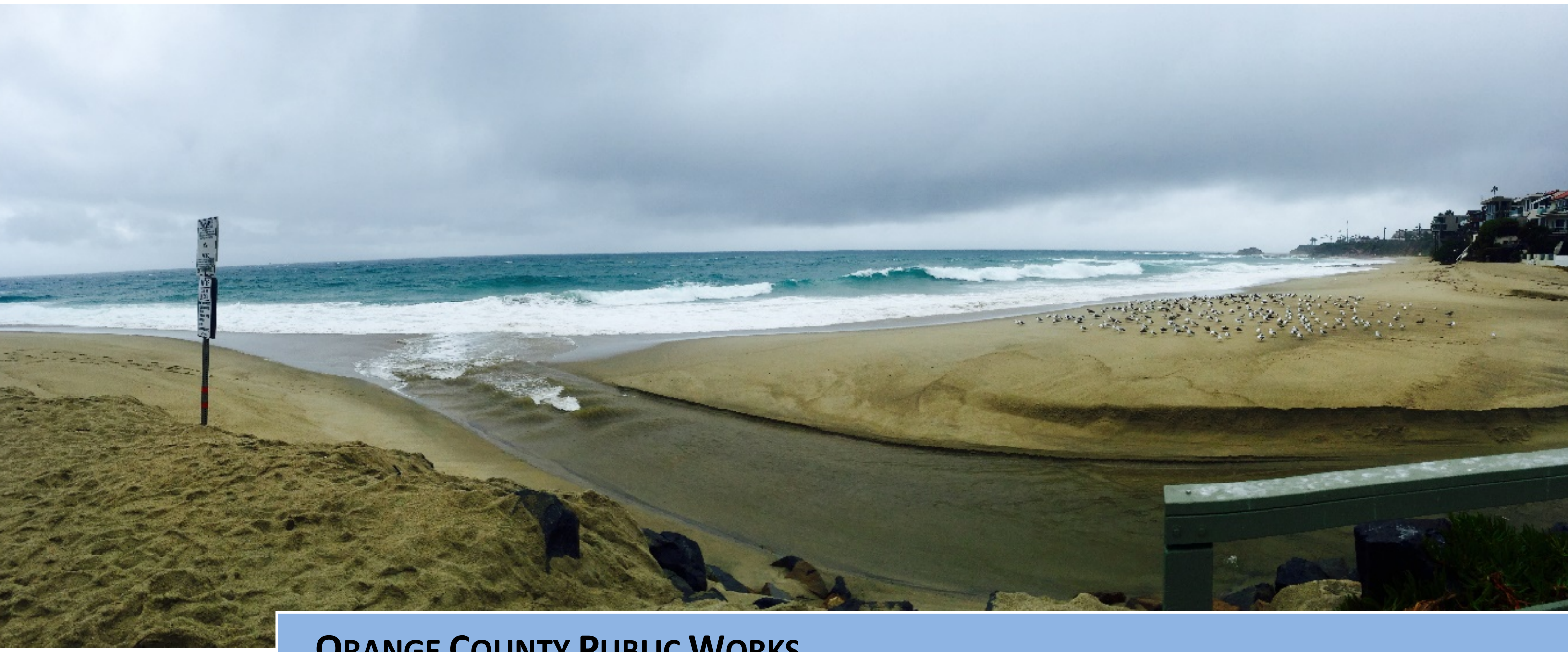
South Orange County Watershed management area 2016-17 San Diego Region Transitional Monitoring and Assessment Report



Orange County Public Works

Prepared by Orange County Public Works

For the San Diego Regional Water Quality Control Board

On Behalf of the South Orange County Watershed Management Area Permittees:

The County of Orange, Orange County Flood Control District and Cities of Aliso Viejo, Dana Point, Laguna Beach, Laguna Hills, Laguna Woods, Lake Forest, Mission Viejo, Rancho Santa Margarita, San Clemente, and San Juan Capistrano

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EXECUTIVE SUMMARY

Introduction

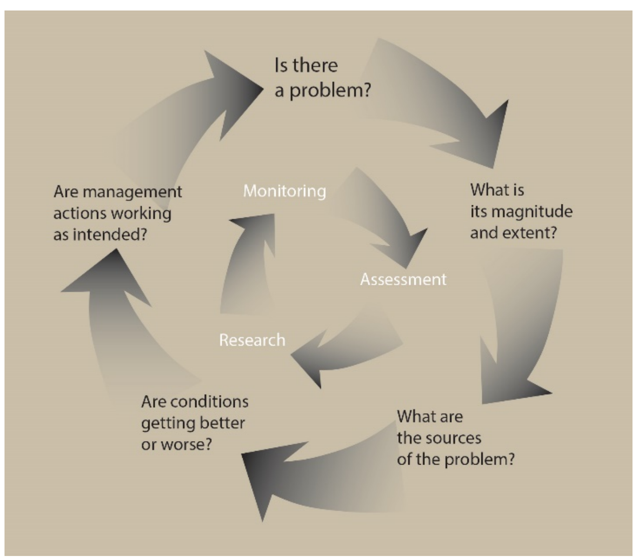
In response to the monitoring and reporting requirements of the National Pollutant Discharge Elimination System (NPDES) Fifth Term Permit (Order R9-2013-0001, as amended by Orders No. 2015-001 and R9-2015-0100, NPDES CAS0109266,) from the San Diego Regional Water Quality Control Board (RWQCB), the Permittees present this Transitional Monitoring and Assessment Report (TMAR). This report provides the data, assessment, and findings of the transitional monitoring activities conducted for the 2016-17 reporting year (October 1, 2016 through September 30, 2017). This document is submitted prior to the approval of the South Orange County Watershed Management Area (SOC WMA) (San Juan Hydrologic Unit) Water Quality Improvement Plan (WQIP). This is the second such transitional monitoring report prepared under the Fifth Term Permit.

Background

On April 1, 2017, the SOC WMA submitted a proposed WQIP for the San Juan Hydrologic Unit to fulfill the requirements of the Fifth Term Permit. The WQIP includes the following main elements that address each Permit provision:

- B.2 – Priority Water Quality Conditions
- B.3 – Water Quality Improvement Goals, Strategies and Schedules
- B.4 – Water Quality Improvement Monitoring and Assessment Program
- B.5 – Iterative Approach and Adaptive Management Process

To address these provisions, the WQIP builds upon the findings and recommendations identified in the 2014 Report of Waste Discharge (ROWD) submitted by the Permittees to the RWQCB. The figure below depicts the adaptive management process defined in the ROWD, describing five assessment questions and how priorities should shift among elements as information improves.



The ROWD also identified three key themes to help structure the assessment of environmental conditions that have been integral in the development of the WQIP. These themes drive the Permittees' assessment strategy as well as approach to developing new assessment tools and are shown below:

- Theme 1: Focus on priority areas and constituents rather than trying to monitor all constituents, potential issues, and locations.
- Theme 2: Increase the integration of data from a wider range of sources.
- Theme 3: Continue evolving from a discharge-specific approach to a risk prioritization approach.

Consistent with this approach, the proposed WQIP identifies three Highest Priority Water Quality Conditions (HPWQCs) amongst other priority water quality conditions (PWQCs), based on the review and prioritization of the following available water quality data:

- Pathogen Health Risk at Beaches
- Channel Erosion and Associated Geomorphic Impacts for Inland Waters
- Unnatural Water Balance/Flow Regime in Inland Waters

Goals, strategies and schedules to address the identified HPWQCs and PWQCs was incorporated into the WQIP, along with the Monitoring and Assessment Program (MAP) that will be implemented to assess progress in meeting proposed WQIP goals. Pending WQIP approval, the SOC WMA will initiate the implementation of the WQIP and work to further enhance water quality within the San Juan Hydrologic Unit.

1 INTRODUCTION

1.1 Monitoring Activities

During the transitional monitoring period, the Permittees have continued to implement key monitoring programs required by the Fourth Term Permit, while initiating new transitional monitoring program elements required in the Fifth Term Permit, until the WQIP is approved for implementation. A discussion of the sampling and analysis methods used is included as **Appendix A**. In accordance with the Fifth Term Permit requirements, the Permittees implemented the following key receiving waters monitoring programs that contain detailed reports as appendices:

- Long Term Mass Emissions Monitoring Program - Stormwater composite samples were collected as part of the Long Term Mass Emissions program for two storm events, the first storm of the season in November of 2016, and during a second event in February of 2017. The complete assessment for this monitoring program is included as **Appendix B**.
- Bioassessment Monitoring Program - Surveys were conducted during the spring and summer of 2017. The complete assessment for this monitoring program is included as **Appendix C**.
- Unified Beach Water Quality Monitoring Program - Bacteria samples were collected once per week, year round during dry weather conditions. **Appendix D** contains the assessments for this monitoring program.
- Beaches and Creeks Total Maximum Daily Load (TMDL) sampling activities were comprised of data from the Unified Beach Water Quality Monitoring Program, monthly sampling for the Comprehensive Load Reduction Plans (CLRPs), and additional sampling for the Aliso Creek 13225 Directive Monitoring Program. The Beaches and Creeks TMDL analysis is included as **Appendix E**.
- Monitoring for the 11 Baby Beach TMDL locations was conducted as part of the Unified Beach Monitoring Program, as well additional targeted wet weather sampling at station BDP14. The Baby Beach TMDL is included as **Appendix F**.

In addition to the receiving waters program, the transitional monitoring provisions of the Fifth Term Permit require development of a MS4 outfall inventory and dry weather outfall field screening, as well as wet weather outfall composite sampling. A new long term mass emissions monitoring station is planned to be installed on Salt Creek just downstream of where it crosses Pacific Coast Highway, with the intent to gain more information on discharge in the watershed to provide supplemental information.

The monitoring and reporting program is supported by a quality assurance/quality control (QA/QC) 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. All analytical laboratories have been certified through the Environmental Laboratory Accreditation Program (ELAP) and follow standard method procedures. The quality assurance program evaluates data for accuracy, precision, and other factors using certified reference materials (for preparing synthetic samples), laboratory control standards for common analyses, duplicate field samples for precision, and equipment/trip blanks. The complete QA/QC report is available in **Appendix G**.

1.2 Watershed Management Area

The South Orange County WMA, shown in **Figure 1.2-1**, includes the area that encompasses the San Juan Hydrologic Unit (SJHU) as defined in the Water Quality Control Plan of the San Diego Basin. The SJHU encompasses seven major watersheds; Laguna Coastal Streams, Aliso Creek, Dana Point Coastal Streams, San Juan Creek, San Clemente, San Mateo Creek, and two groundwater basins; the San Juan and San Mateo

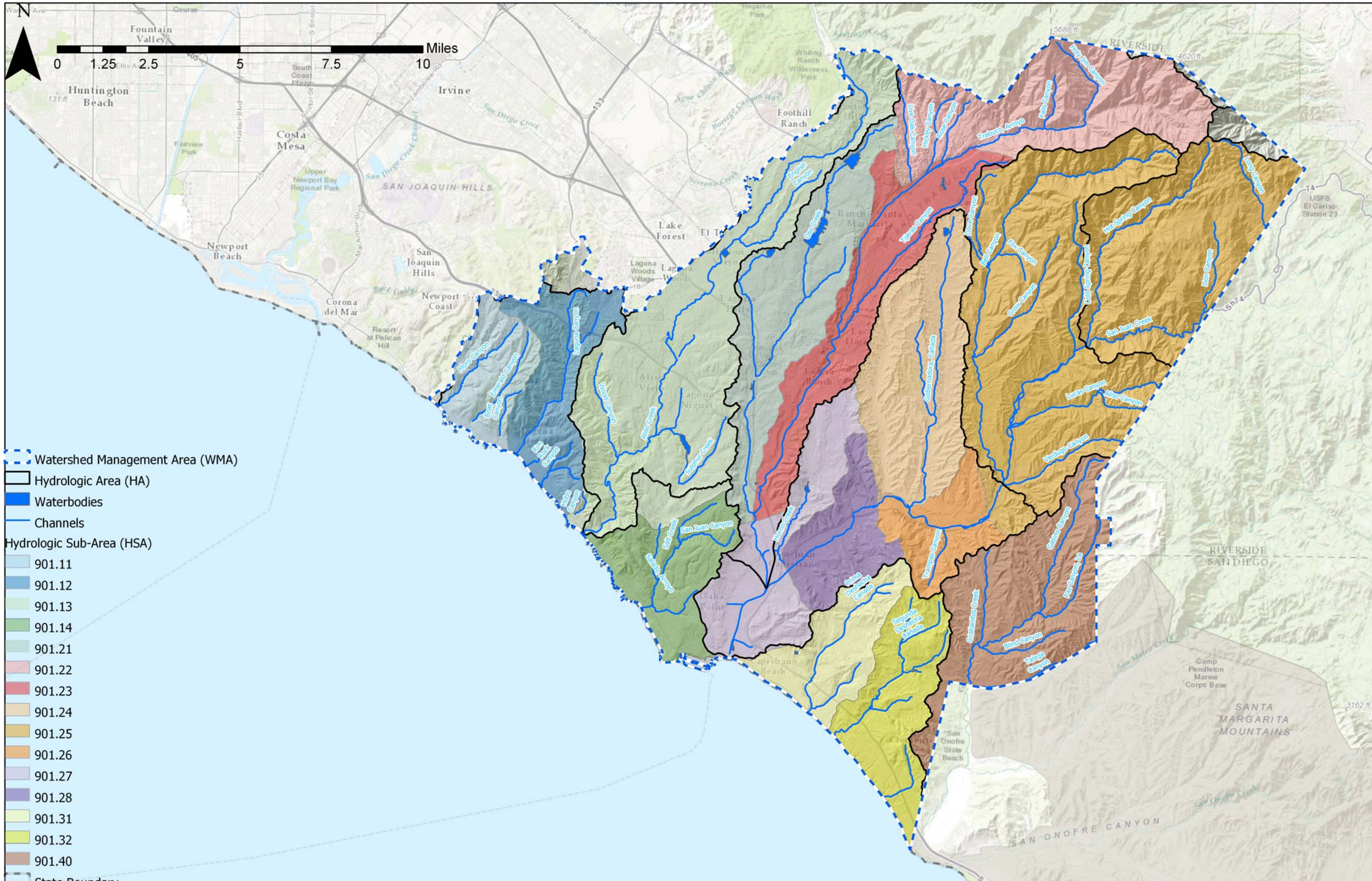
Groundwater Basins. The San Diego Region Basin Plan further subdivides the San Juan Hydrologic Unit into four Hydrologic Areas (HA), and fourteen Hydrologic Sub Areas (HSA). The area for each hydrologic feature is presented in **Table 1.2-1**.

Table 1.2-1 WMA Hydrologic Features

<table>
<tr><th>Hydrologic Unit (HU)</th><th>HU Number</th><th>Hydrologic Area (Acres*)</th><th>HA Number</th><th>Hydrologic Sub Area (Acres*)</th><th>HSA Number</th></tr>
<tr><td rowspan="15">San Juan Hydrologic Unit</td><td rowspan="15">901</td><td rowspan="4">Laguna (39,894)</td><td rowspan="4">901.1</td><td>San Joaquin Hills (4,305)</td><td>901.11</td></tr>
<tr><td>Laguna Beach (6,750)</td><td>901.12</td></tr>
<tr><td>Aliso (22,628)</td><td>901.13</td></tr>
<tr><td>Dana Point (6,210)</td><td>901.14</td></tr>
<tr><td rowspan="8">Mission Viejo (101,279)</td><td rowspan="8">901.2</td><td>Oso (11,117)</td><td>901.21</td></tr>
<tr><td>Upper Trabuco (12,532)</td><td>901.22</td></tr>
<tr><td>Middle Trabuco (10,047)</td><td>901.23</td></tr>
<tr><td>Gobernadora (11,209)</td><td>901.24</td></tr>
<tr><td>Upper San Juan (39,112)</td><td>901.25</td></tr>
<tr><td>Middle San Juan (4,301)</td><td>901.26</td></tr>
<tr><td>Lower San Juan (8,038)</td><td>901.27</td></tr>
<tr><td>Ortega (4,920)</td><td>901.28</td></tr>
<tr><td rowspan="2">San Clemente (12,597)</td><td rowspan="2">901.3</td><td>Prima Deshecha (5,407)</td><td>901.31</td></tr>
<tr><td>Segunda Deshecha (7,188)</td><td>901.32</td></tr>
<tr><td>San Mateo (11,964)</td><td>901.4</td><td>-</td><td>-</td></tr>
</table>

***Within the WMA**

Figure 1.2-1 South Orange County WMA



1.3 Rainfall Events

The southern Orange County climate is typically dry from May through October, and rainy from late October through April. The 2016-17 water year (July to June) rainfall total, recorded at the Palisades Reservoir rain gage, was 16.53 inches. This marks a break in the recent trend in the previous five years of below average precipitation amounts. 2016-17 was only the fifth year to have above average rainfall since a high of 28.7 inches in the 1997-98 water year. The historic record for the Palisades Reservoir rain gage is presented in **Figure 1.3-1.** Overall, the 2016-17 rainfall totals recorded through the County Automated Local Evaluation Real Time (ALERT) telemetry network ranged from 12.17 to 38.82 inches and is generally greater at higher elevations (**Figure 1.3-2**).

Figure 1.3-1 Historic Rainfall at Palisades Reservoir

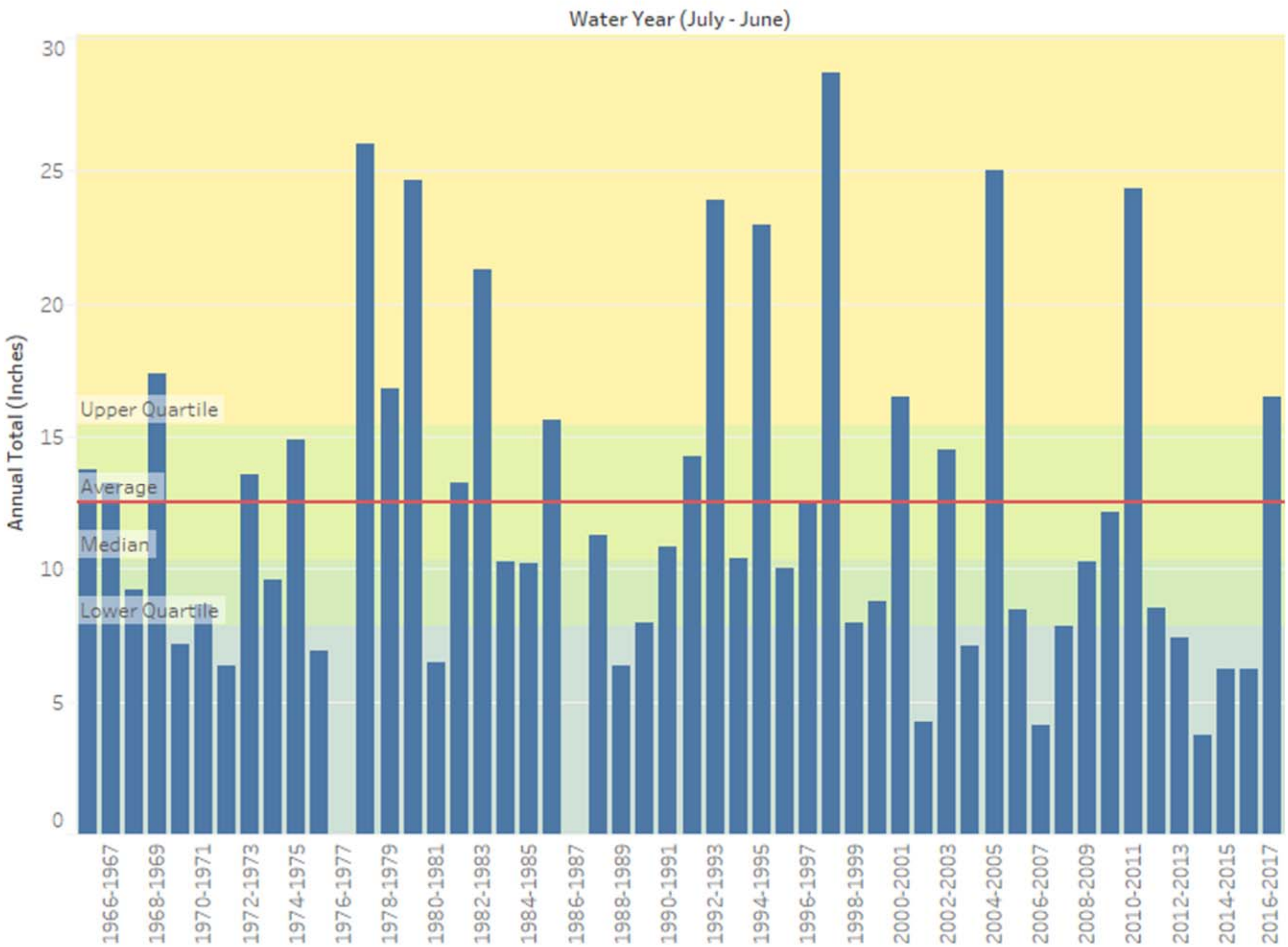
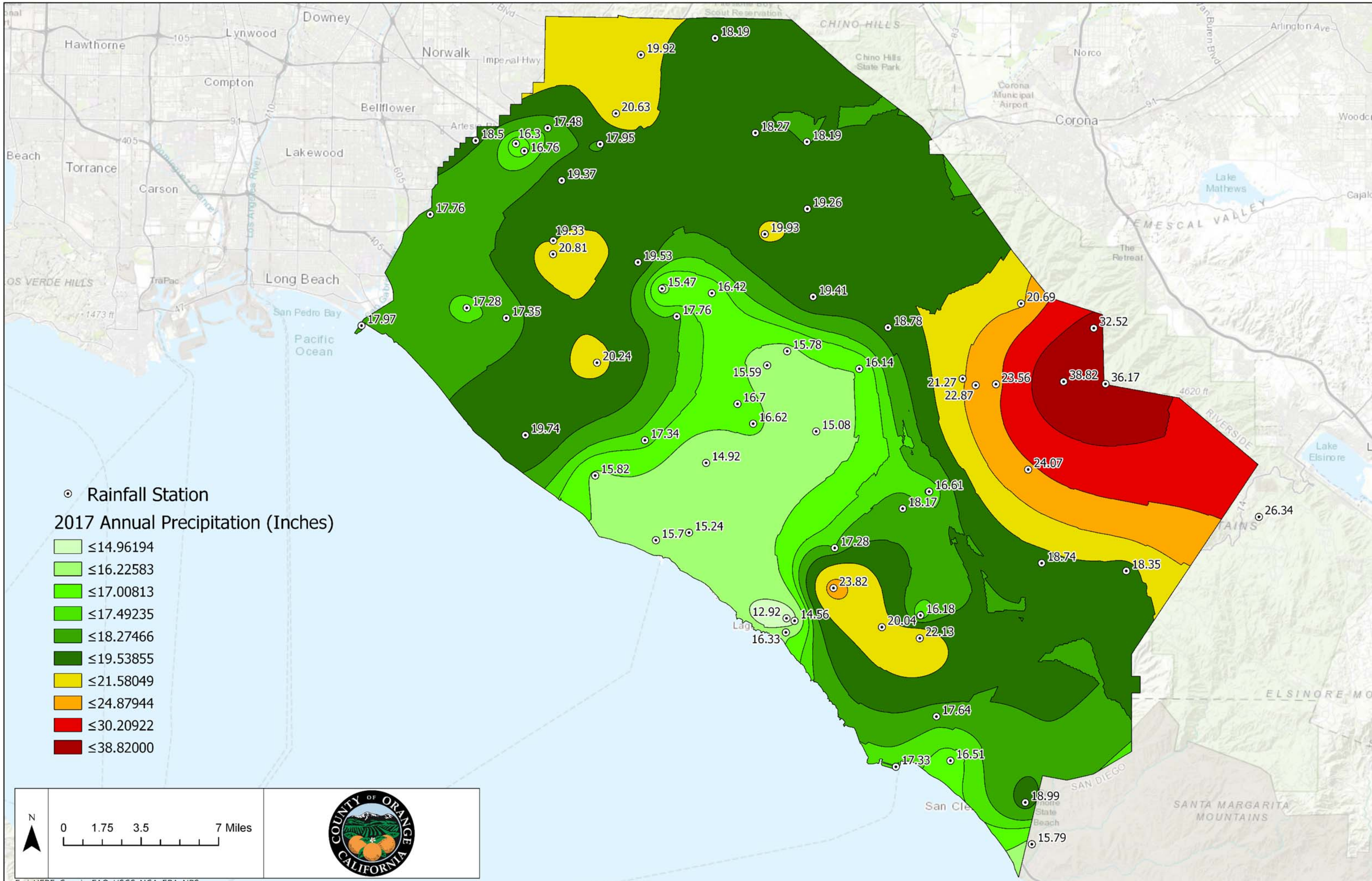


Figure 1.3-2 Annual Rainfall Total



2 RECEIVING WATER ASSESSMENTS

2.1 Long-term Monitoring

2.1.1 Dry Weather

Toxicity

Toxicity was observed in 5% of dry weather samples collected in receiving waters as part of the Long Term Mass Emissions monitoring program, occurring in the *Ceriodaphnia dubia* reproduction samples taken at Aliso Creek during the September and June monitoring events. Toxicity was not observed in any other test organisms.

Chemistry

Dry weather receiving water samples collected as part of Long Term Mass Emissions monitoring contained detections of synthetic pyrethroids and organophosphate pesticides. The most frequent pyrethroid detection was Bifenthrin (55% of samples) followed by Cyfluthrin (36% of samples). Allethrin, Cypermethrin, Deltamethrin, L-Cyhalothrin, and Prallethrin were also detected. For organophosphate pesticides, detections occurred for Chlorpyrifos (18% of samples) and Dichlorvos (9% of samples). Additionally, two locations (Prima and Segunda Deshecha) were monitored for carbamate compounds, however there were no detections.

Bioassessment

Regional bioassessment monitoring was conducted during the transitional monitoring period under the requirements of the 2007 Permit and participation in the Southern California Stormwater Monitoring Coalition (SMC) regional bioassessment monitoring program. The results covered in this report correspond to sampling events conducted during the spring and summer of 2017 by the Permittees, as well as data products related to the California Stream Condition Index (CSCI). A total of nine stations were visited in 2017: four as part of the SMC Program (901M14137, 901M14138, SMC00206, SMC00873), and five targeted monitoring locations (CC-CR, REF-FC, REF-TCAS, SJC-74, TC-DO). CSCI scores ranged from 0.33 at station TC-DO (Trabuco Creek) in an engineered flood control channel to 0.93 at station REF-TCAS located in upper Trabuco Creek in Trabuco Canyon. This station is characterized by natural flow and a complex riparian habitat.

2.1.2 Wet Weather

Toxicity

No toxicity occurred in the 31 stormwater samples collected at receiving water monitoring stations as part of the Long Term Mass Emissions program.

Chemistry

Wet weather receiving water samples collected as part of Long Term Mass Emissions monitoring contained detections of synthetic pyrethroids and organophosphate pesticides. The most frequent pyrethroid detection was Bifenthrin (96% of samples) followed by Cyfluthrin (79% of samples). Cypermethrin, Deltamethrin, and L-Cyhalothrin were also detected. For organophosphate pesticides the only detections were of Malathion. Additionally, two locations (Prima and Segunda Deshecha) were monitored for carbamate compounds, however there were no detections.

2.2 Regional Monitoring

Beginning in April of 2015, sampling for the Unified Beach Monitoring Program, approved by the San Diego Regional Board, was initiated. This monitoring program supersedes prior sampling requirements, and introduced new protocols for sampling at "point zero" locations where surface runoff meets the ocean, or would potentially meet the ocean. Sampling responsibilities are shared between three agencies: OC Public Works, Orange County Health Care Agency (OCHCA), and the South Orange County Wastewater Authority (SOCWA). Monitoring results indicate that drains with active flows to the ocean have greater exceedance rates, however only 7% of all samples had direct flows to the ocean (**Table 2.2-1** Indicator Bacteria Exceedance Frequencies).

Table 2.2-1 Indicator Bacteria Exceedance Frequencies

AB411 Season						
Sample Type	**Site Visits**	**# of Samples**	**Ent**	**FC**	**TC**	**Total**
All Samples	1928	2198	4%	2%	1%	2%
Drains Flowing to Ocean	144	414	11%	5%	4%	7%
Drains *Not* Flowing to Ocean	1784	1784	2%	1%	1%	1%

Appendix D contains the additional results for the Unified Beach Monitoring Program, as well as an analysis of supplementary data collected by the Blue Water Task Force (BWTF) program managed by the Surfrider Foundation.

Bight '18

With the conclusion of Bight '13 in 2017, the Permittees have begun participation in the development of the Southern California Bight 2018 Regional Monitoring Program (Bight '18) to assess the conditions of marine ecosystems in the Southern California Bight. County staff attended the Bight '18 kickoff meeting held on September 14th 2017. A total of six areas of interest were discussed: sediment quality, ocean acidification, harmful algal blooms, trash, microbiology, and Areas of Special Biological Significance (ASBS).

2.3 Sediment Quality

The Permittees continue to participate in the Regional Harbor Monitoring Program (RHMP) along with the Port of San Diego, city of San Diego, and city of Oceanside to address water and sediment quality in the region's harbors. The RHMP is a comprehensive effort to survey the general water and sediment quality and condition of aquatic life in the harbors and to determine whether beneficial uses are being met in Dana Point Harbor, Oceanside Harbor, Mission Bay, and San Diego Bay. The program is comprised of a core monitoring program supplemented by focused special studies. The core program was designed to answer questions regarding:

- The spatial distribution of pollutants and their impacts
- The safety of the waters for human contact
- The safety of fish for human consumption
- Capability of the water and sediment to sustain healthy biota
- Long-term trends in harbor conditions.

The core monitoring was conducted in combination with Bight '13. During the transitional reporting period the County has been actively involved in planning for the 2018 sampling program, including refining monitoring program questions, establishing a schedule for future monitoring and analysis, and meeting with Regional Board staff for their advice and consent on program adjustments.

2.4 TMDL Monitoring

Beaches and Creeks TMDL

The Fifth Term Permit requires the Permittees to conduct the following activities associated with the Beaches and Creeks TMDL; implement the monitoring programs developed as part of any implementation plans or load reduction plans (e.g. Bacteria Load Reduction Plans, Comprehensive Load Reduction Plans) for the TMDL, and submit the TMDL monitoring and assessment results as part of the TMAR per requirements in Attachment E.6 of the Fifth Term Permit. The key monitoring and assessment results are as follows:

- Dry weather: Among the 27 monitored water segments out of the 30 TMDL segments, 22 have met the final dry weather receiving water limitations (RWLs) which include all delisted segments and Poche Beach. San Clemente City Beach at Pier has limited exceedance of 3% for ENT. The 30 day geomean exceedance rate for San Juan Creek and Creek mouth is not available due limited data and intermittent flows. The water bodies that have elevated bacteria levels are: Aliso Creek (CTPJ01) and Aliso Creek mouth (ACM1). The beach water bacteria concentrations remain low but fluctuate with the creek mouth's condition due to the sand berm being intermittently open. Potential sources of bacteria include regrowth and droppings from birds that congregate at the Creek mouth.

- Wet weather: The 2016-17 storm season was much wetter than average. An average of 17 inches (compared to 6 inches during 2015-16) of rain occurred across South Orange County. There were 65 wet weather days (compared to 48 days last year) in reporting year 2016-17. Among the 27 stations, 15 stations have met the final RWLs (compared to 19 last year) which are also mostly delisted segments and Poche Beach. It is also critical to recognize that wet weather attainment is highly impacted by rainfall pattern and available sample size which vary from year to year. Therefore, the more intense storm condition this year and the limited wet weather sample size were potentially reasons for an increased water bodies that have shown exceedances during wet weather.

Baby Beach TMDL

Bacteria source investigation and control efforts have continued at Baby Beach since the initial 1996 Beach closing and eventual TMDL adoption in 2008. Data analysis for the reporting period indicates improving water quality across dry and wet weather conditions:

- Dry weather final TMDL targets have been achieved for Total Coliform and Fecal Coliform. No dry weather exceedances of the 30-day geometric mean target occurred for both indicators during the reporting period. There was no exceedance of the single sample maximum numeric target for Total Coliform and only 2% exceedance of the numeric target for Fecal Coliform. Exceedances of the *Enterococcus* numeric targets in receiving waters occurred for both the 30-day geometric mean and single sample maximum. However, with the implementation of the dry weather diversion BMP, the MS4 did not discharge to the receiving water, which demonstrates compliance.
- Wet weather interim TMDL targets have been achieved for Total Coliform, Fecal Coliform and *Enterococcus*. There were no wet weather exceedances of the Total Coliform numeric target and only 5% exceedance of the Fecal Coliform numeric target during the reporting period. The wet weather interim

TMDL compliance milestone of 31.1% load reduction was met for *Enterococcus* this reporting period, with a 44% exceedance rate reduction compared to the baseline period.

3 TRANSITIONAL MS4 OUTFALL ASSESSMENTS

As part of the requirements of the Fifth Term Permit and to support development of the WQIP, transitional MS4 outfall discharge monitoring was conducted, which included developing a comprehensive MS4 outfall inventory, dry weather field screening, and wet weather discharge monitoring.

3.1 MS4 Outfall Station Inventory

Over the reporting period the Permittees have developed and refined their inventory of MS4 outfall structures that have been cataloged in the South Orange County Watershed Management Area. The complete dataset of outfall structures can be found in **Attachment 3.1-1** at https://ocgov.box.com/v/201617-TMAR-Datasets. Additionally, the MS4 outfall dataset can be explored with an ArcGIS web map application at http://ocpw.maps.arcgis.com/apps/webappviewer/index.html?id=8ead976338c544e68fe4ac05e20f4b76, as well as an interactive dashboard: https://www.arcgis.com/apps/opsdashboard/index.html#/f754decba2e54b87bbb6109de26e607b. Currently a total of 438 outfall structures of all sizes have been identified and classified into three facility types: Box, Culvert, and Outfall (**Figure 3.1-1**). The numbers of verified outfalls, tallied by Permittees, are presented in and their locations in **Figure 3.1-3**. **Figure 3.1-2** and **Figure 3.1-3** do not capture the total monitoring effort, as some outfalls were unable to be located or accessed.

Figure 3.1-1 Outfall Inventory

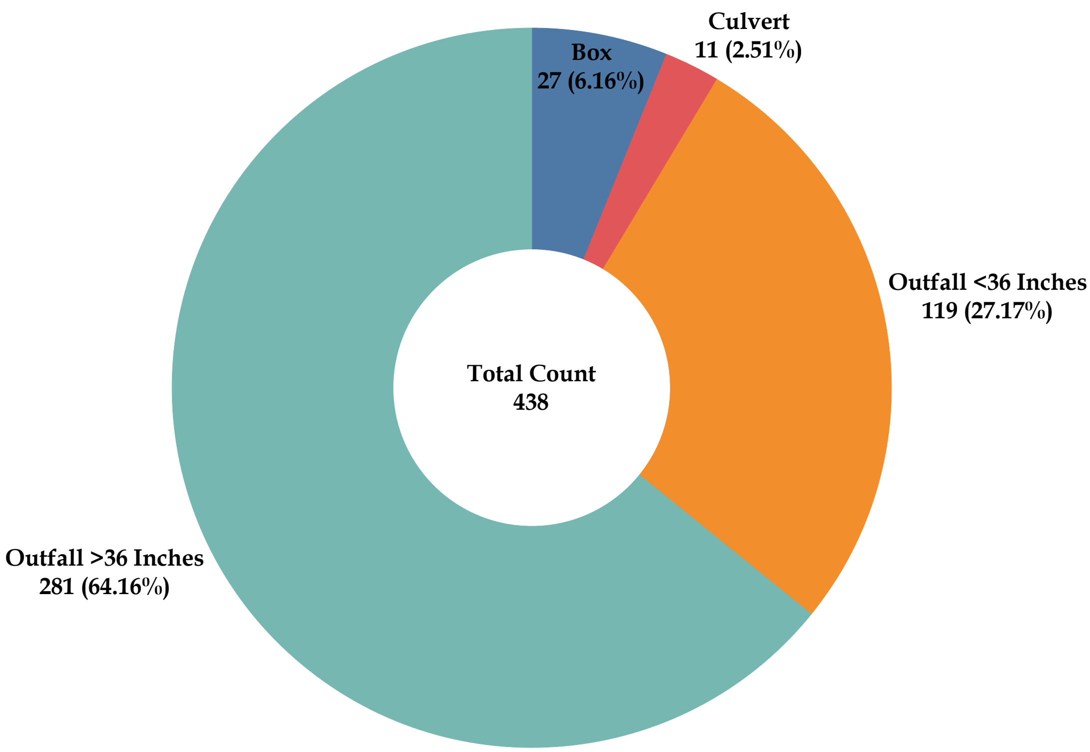


Figure 3.1-2 Number of Outfalls by Permittee

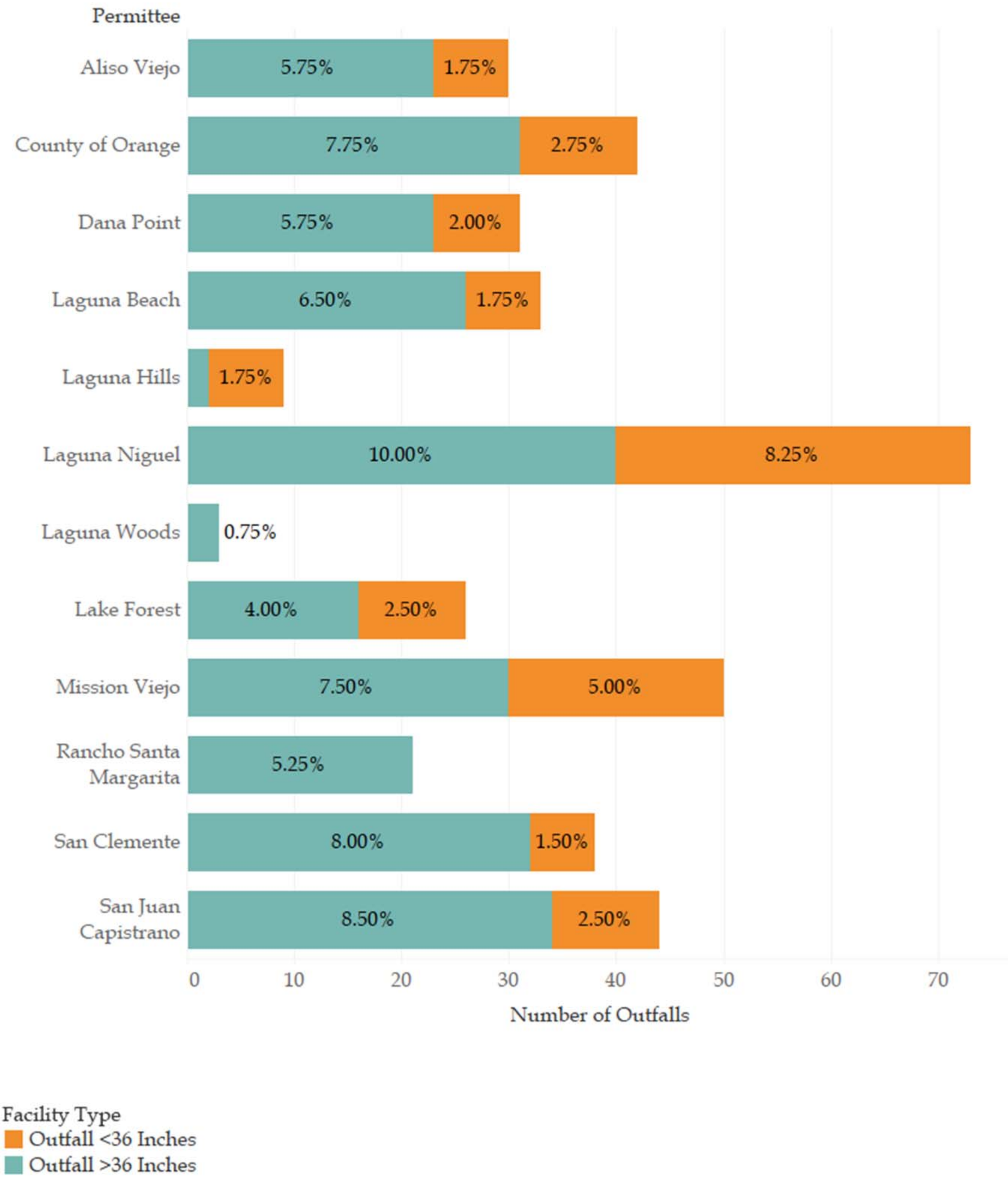
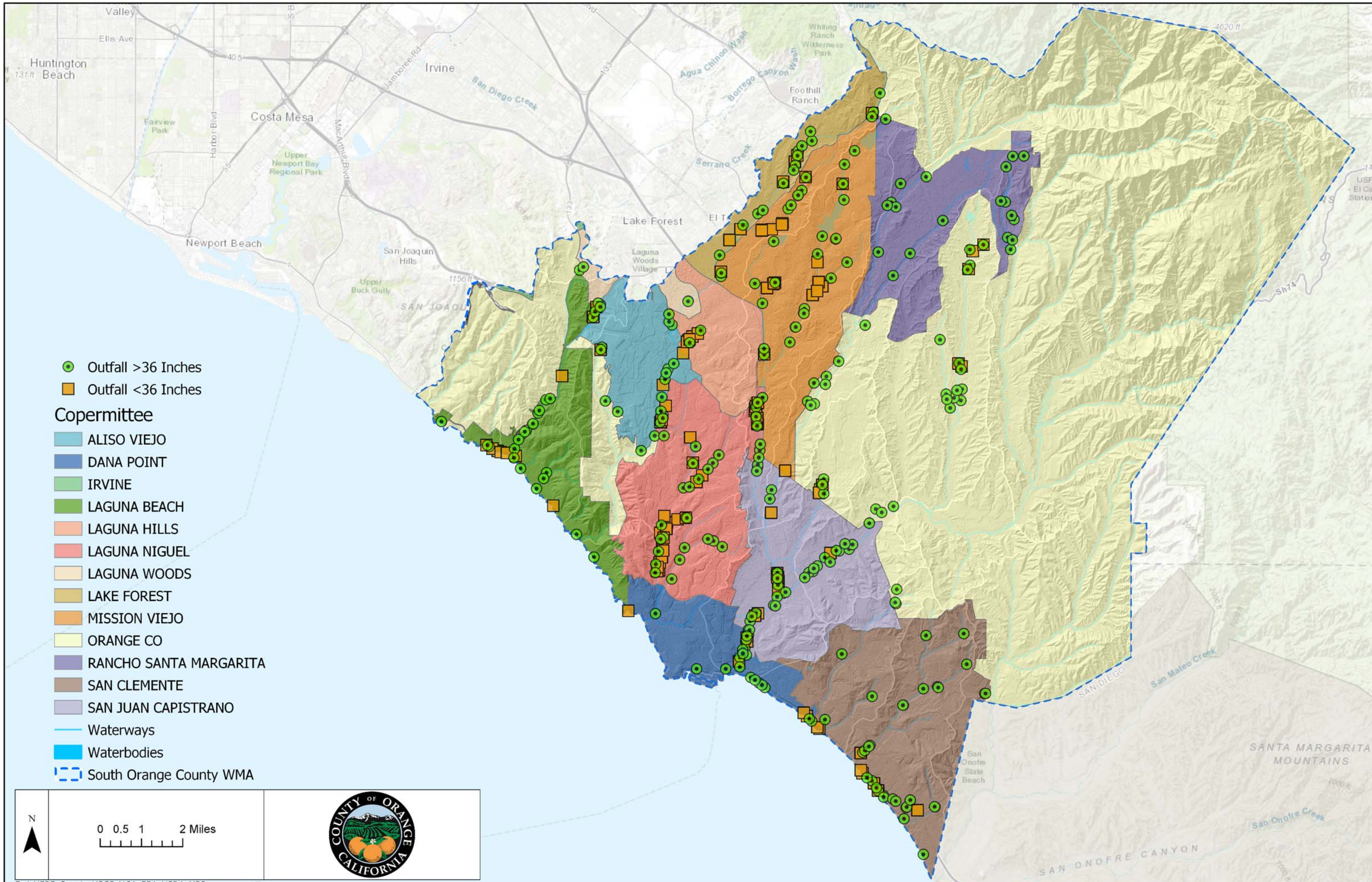


Figure 3.1-3 Outfall Locations



3.2 Dry Weather Field Screening

The Permittees conducted a visual field screening of each outfall, recording observations such as the facility ID, inspection date, accessibility, flow condition, flow estimation, trash assessment, indications of illicit connections or illegal dumping, and an estimate of the contribution to receiving water flow. The complete dataset showing all outfall inspections are available in **Attachment 3.2-1** at https://ocgov.box.com/v/201617-TMAR-Datasets. Additionally, the MS4 outfall dataset can be explored with the ArcGIS web application at http://ocpw.maps.arcgis.com/apps/webappviewer/index.html?id=8ead976338c544e68fe4ac05e20f4b76. The number of outfalls greater than 36 inches in size within each Permittees jurisdiction and the total number of outfall visits can be found in **Table 3.2-1.**

Table 3.2-1 36 Inches and Greater Outfall Inspections

Permittee	Number of Outfalls	Total Number of Outfall Visits
Aliso Viejo	23	104
County of Orange	31	125
Dana Point	23	117
Laguna Beach	26	115
Laguna Hills	2	10
Laguna Niguel	40	177
Laguna Woods	3	13
Lake Forest	16	79
Mission Viejo	30	124
Rancho Santa Margarita	21	87
San Clemente	32	129
San Juan Capistrano	34	153

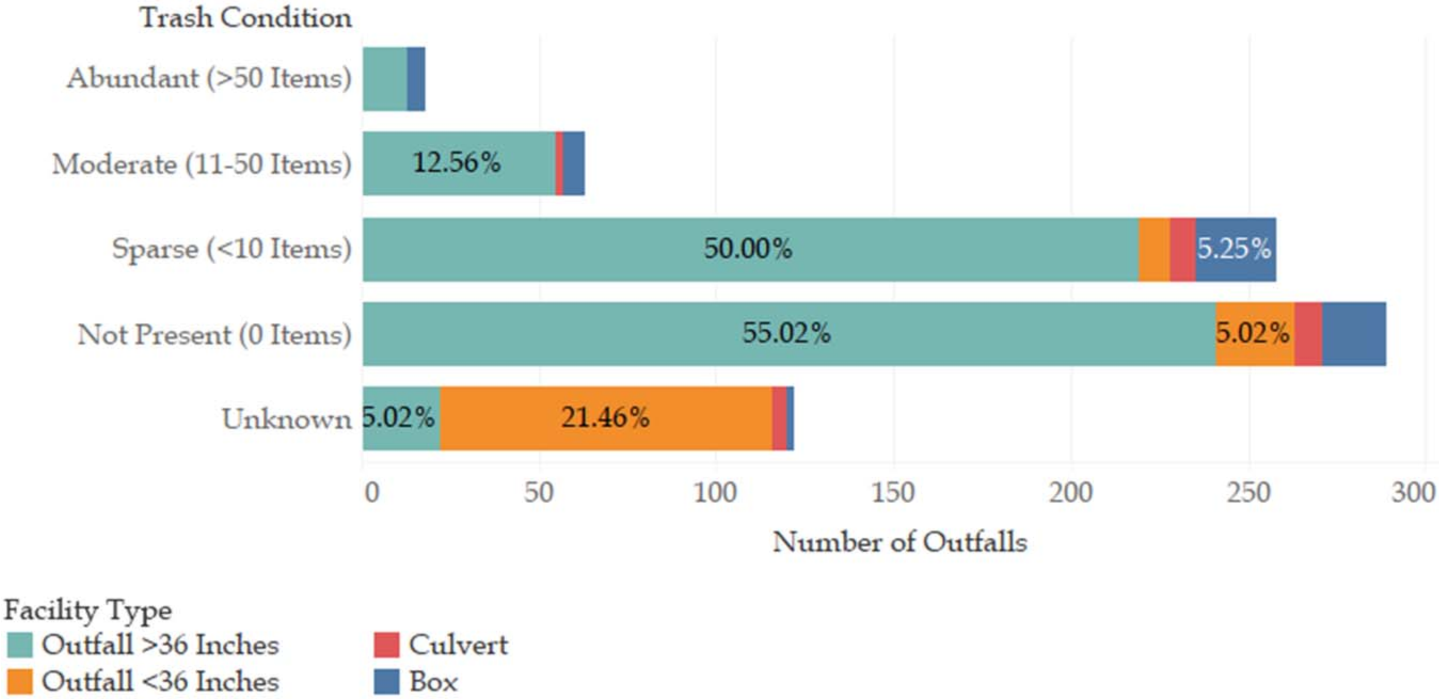
Table 3.2-2 indicates the number of 36 inches or greater outfalls in each Permittee jurisdiction that were inspected at least two times or more, and the percentage of total outfalls that have been inspected two times or more.

Table 3.2-2 36 Inches or Greater Outfalls Inspected Twice or More

Permittee	Number of Outfalls	Percent of Total Outfalls in Jurisdiction
Aliso Viejo	23	100.00%
County of Orange	30	96.77%
Dana Point	23	100.00%
Laguna Beach	26	100.00%
Laguna Hills	2	100.00%
Laguna Niguel	40	100.00%
Laguna Woods	3	100.00%
Lake Forest	16	100.00%
Mission Viejo	29	96.67%
Rancho Santa Margarita	21	100.00%
San Clemente	32	100.00%
San Juan Capistrano	34	100.00%

Overall field observations demonstrated low presence of trash during most inspections with half of all inspections having no trash present (**Figure 3.2-1**).

Figure 3.2-1 Outfall Trash Assessment



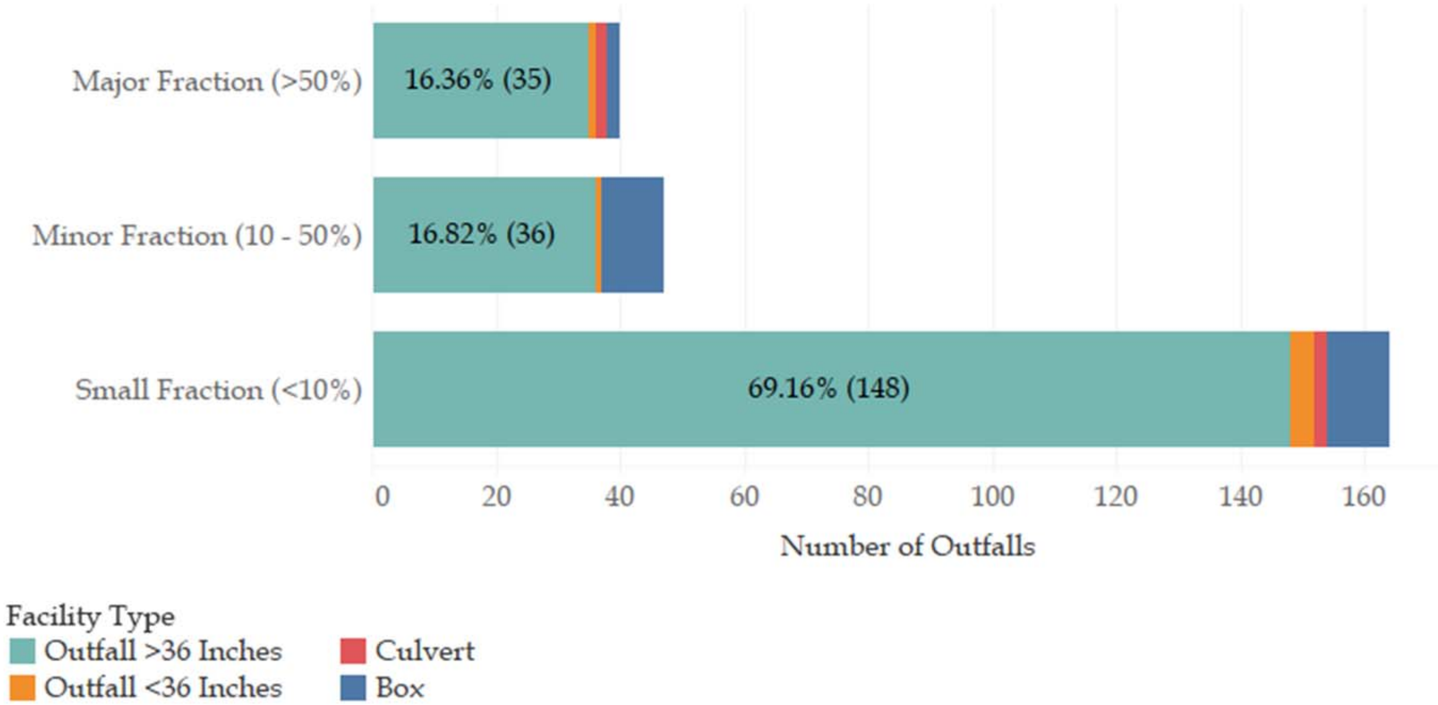
Expanded Dry Weather Field Screenings

In the Spring of 2016, the Permittees expanded the dry weather field screening observations to include the following assessments:

- Connectivity of flow to receiving waters
- Upstream and downstream flow conditions in the receiving water
- Relative contribution of the outfall discharge to in-stream flow.

The expanded dry weather field screenings were initially targeted at high priority outfalls where persistent flow was observed during multiple visits, and then later expanded to all outfall inspections. The connectivity for all inspections with expanded receiving water assessments is shown in **Figure 3.2-2** below.

Figure 3.2-2 Outfall Flow Contribution to Receiving waters



Expanded Dry Weather Flow Monitoring

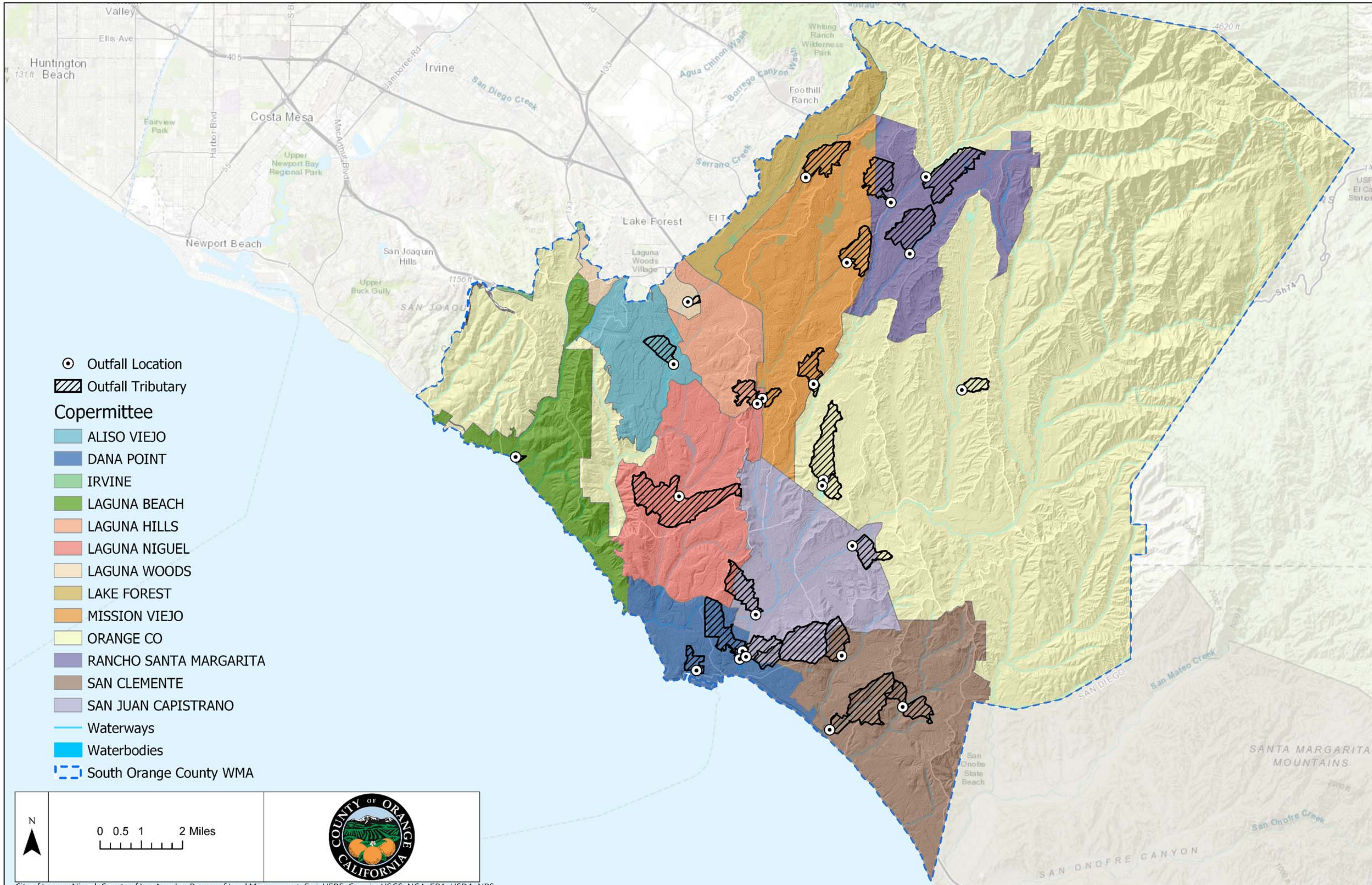
Concurrent with the expanded dry weather field screenings, the Permittees continued detailed dry weather flow monitoring studies at high priority outfalls. HACH Ultrasonic Flow meters were deployed in two week periods to measure flow at 5 minute intervals. Flow meters were installed at locations that demonstrated persistent flow with the goal of gaining a better understanding of average flow magnitude and daily flow patterns. During the 2016-17 reporting period, flow meters were deployed at 25 locations. Combined with locations monitored during the 2015-16 monitoring period, a total of 83 locations have had flow measurements taken with ultrasonic meters. **Figure 3.2-3** shows the locations where additional dry weather flow monitoring has been conducted and upstream tributary areas have been estimated.

Outfall Prioritization

Data collected from the expanded dry weather field screenings and intensive flow monitoring were used as the basis of a dry weather analysis that helped lead to a data-driven decision to identify unnatural water balance and flow regime as a HPWQC in the B.2 chapter of the WQIP. A methodology for calculating composite scores for outfalls was developed based on five weighted factors: flow contribution, flow magnitude, base flow, tributary land use, and certainty. As detailed in the B.3 chapter, this composite scoring methodology will be used to prioritize where strategies to address the unnatural water balance and flow regime HPWQC will be targeted.

Additional information on the outfall prioritization methodology can be found in WQIP, Appendix J: (https://www.waterboards.ca.gov/sandiego/water_issues/programs/stormwater/docs/wqip/south_orange_county/APRIL2017_COMPLETESOCWQIP-I_J.pdf).

Figure 3.2-3 Dry Weather Outfall Flow Monitoring Locations



3.3 Wet Weather Outfall Discharge Monitoring

Wet weather outfall monitoring was conducted at fourteen locations during the transitional reporting period for the constituents required by the permit. In addition, the Permittees also included samples for organophosphate and pyrethroid pesticides. Monitoring station locations, station codes, and corresponding MS4 outfall inventory ID can be seen in **Figure 3.3-2** below. In total, seventeen composite samples were collected across fourteen monitoring locations. Due to equipment malfunction at the Horno_OUT monitoring station for the January 19th storm, only grab sample was collected.

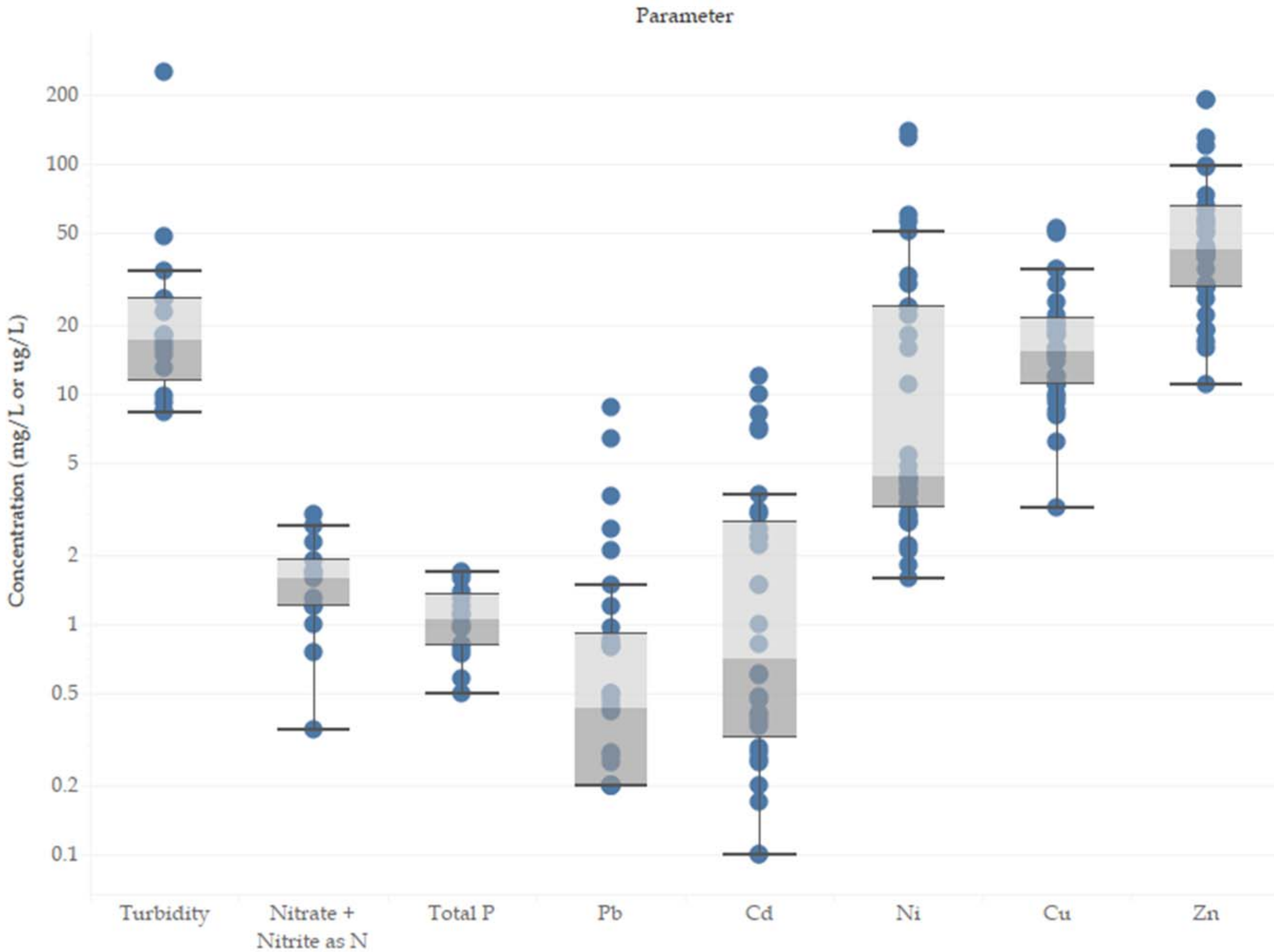
Generally speaking, all of the monitoring locations showed detectable amounts of total and dissolved metals. Bacteria data ranged from 40 to 35,000 CFU/100mL for *Enterococcus*, 9 to 11,400 CFU/100mL for fecal coliform, and 22,000 to 240,000 CFU/100mL for total coliform. Sample results showed four detections of organophosphate pesticides, all of which were Malathion. Pyrethroid pesticide detections were more frequent and are summarized in **Table 3.3-1** below.

Table 3.3-1 Outfall Pyrethroid Detections

Synthetic Pyrethroids	Samples	Detected	min	max
Allethrin	17	0	<2	<2
Bifenthrin	17	14	22.9	683.9
Cis-Permethrin	17	2	74.9	86.5
Cyfluthrin	17	13	5.8	69
Cypermethrin	17	8	3.7	21.7
Deltamethrin	17	6	2.9	43.2
L-Cyhalothrin	17	6	13.4	62.2
Prallethrin	17	0	<2	<2
Trans-Permethrin	17	2	184.9	296.1

Figure 3.3-1 below documents the current condition of wet weather MS4 discharges for Turbidity, Nitrate + Nitrite as N, Total Phosphorus, Lead, Cadmium, Nickel, Copper, and Zinc. The complete sampling chemistry results can be found in **Attachment 3.3-1** at https://ocgov.box.com/v/201617-TMAR-Datasets.

Figure 3.3-1 Outfall Chemistry Boxplots



Stormwater Assessment

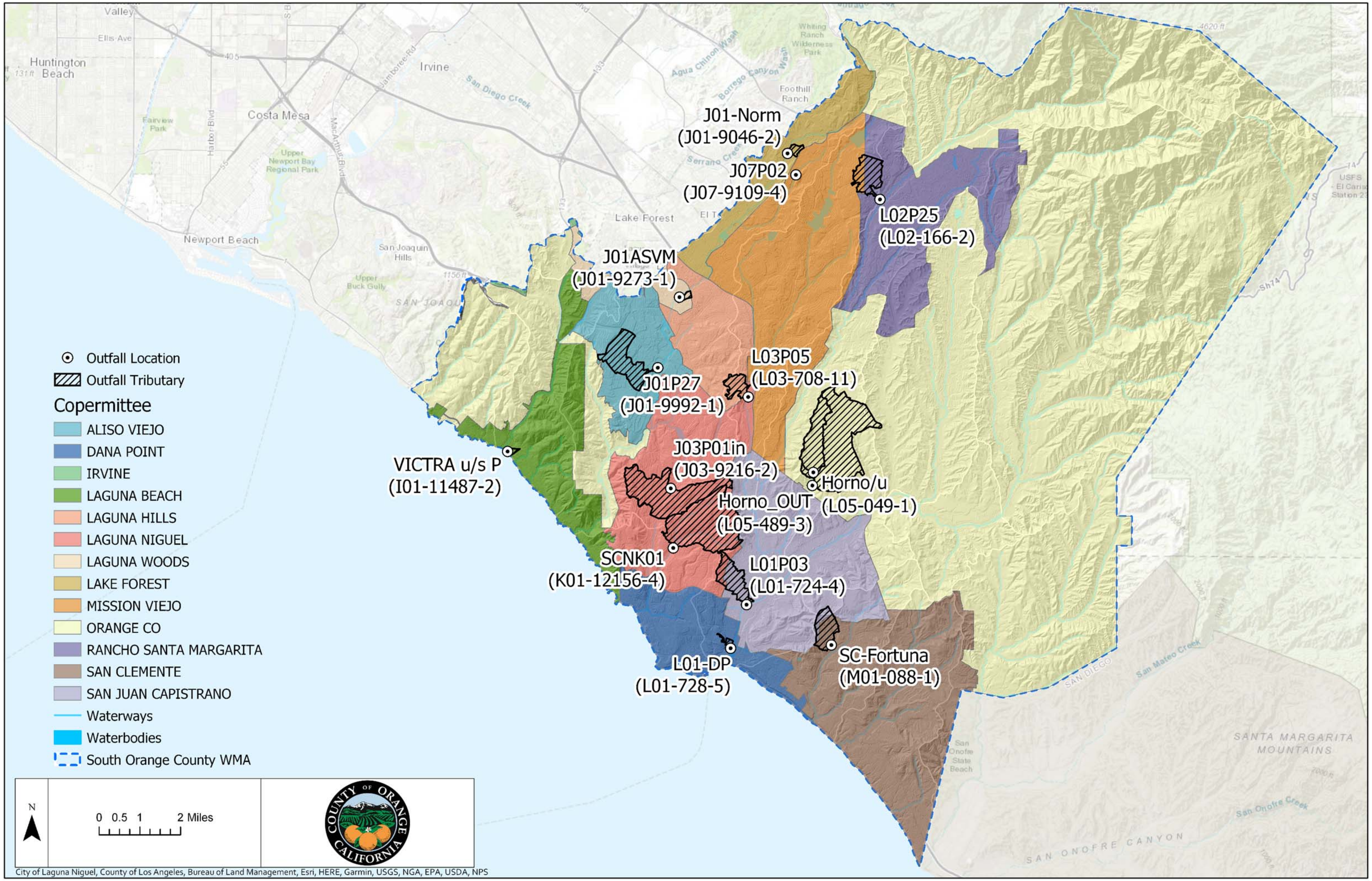
Average stormwater runoff coefficients for each land use type within the South Orange County WMA were calculated based on flow data collected at each outfall sampling event in combination with runoff coefficients developed by the Southern California Coastal Water Research Project (SCCWRP) for six land use categories: agriculture, commercial, industrial, open, residential, and other urban. Three sampling events were excluded from the analysis that did not have discharge measurements due to technical issues with flow monitoring equipment. For each storm event greater than 0.1 inch, runoff coefficients were used to estimate the total stormwater runoff and pollutant load for the reporting period. The total estimated stormwater volume discharged for each outfall is shown in **Table 3.3-2**, and the total annual pollutant load is available in **Attachment 3.3-2** at https://ocgov.box.com/v/201617-TMAR-Datasets.

Table 3.3-2 Outfall Stormwater Volumes

Station	Area (acres)	Total Rainfall (inches)	Runoff Coefficient	Total Stormwater Volume (ac-ft)
Horno/u	517.5	19.4	0.4046	338.4
J01ASVM	30.7	17.59	0.3918	17.6
J01-Norm	46.4	17.59	0.3968	27.0
J03P01in	1123.3	19.4	0.3909	709.8
J07P02	382.6	17.59	0.4341	243.4
L01-DP	103.9	15.85	0.3811	52.3
L01P03	365.0	15.85	0.3874	186.8
L02P25	368.6	23.75	0.3711	270.7
L03P05	171.7	19.4	0.3786	105.1
SC-Fortuna	304.0	15.85	0.4044	162.4
SCNK01	1399.0	19.4	0.3945	892.3
VICTRA u/s P	15.0	15.76	0.5140	10.1

To estimate the total stormwater pollutant loads from each Permittee's jurisdiction, land use runoff coefficients were used in combination with chemistry results to extrapolate results to the entire watershed management area. Available published land use event mean concentrations (EMC) values were calibrated to sampling results across eight land use categories: agriculture, commercial, education, industrial, multi-family residential, single-family residential, open space, transportation, and other urban. The pollutant load for each assessed land use category are calculated based on the total stormwater runoff volumes and calibrated EMC values for each land use category. The jurisdictional loading results are available in **Attachment 3.3-3** at https://ocgov.box.com/v/201617-TMAR-Datasets. No outfalls monitored during the reporting period contained industrial land uses and therefore were not included in the calculation of jurisdictional loadings.

Figure 3.3-2 Wet Weather Outfall Monitoring Locations



APPENDIX A
MONITORING APPROACHES AND METHODS OF ANALYSIS

TABLE OF CONTENTS

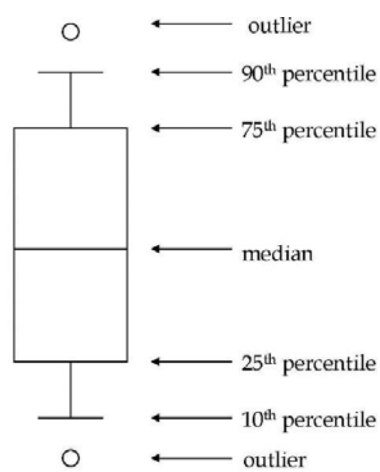
1 INTRODUCTION

This section outlines the program goals and objectives for the monitoring programs. The Fifth Term Permit transitional monitoring and assessment program contains some of the same elements of the Fourth Term Permit monitoring program as it relates to certain receiving waters programs such as Long Term Mass Emissions and Bioassessment. However, the Fifth Term Permit has also added numerous new requirements, which have been added to this appendix where appropriate.

The approach for evaluating water quality monitoring data includes comparisons to various benchmarks, including as appropriate:

- Basin Plan Objectives for Inland Waters and Enclosed Bays;
- California Toxics Rule (CTR) 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;
- The California Stream Condition Index (CSCI); and
- Reference stream thresholds from the Stormwater Monitoring Coalition's Regional Watershed Monitoring Program.

Data products in this report and its associated attachments have been included in various formats: data tables, charts, maps, and associated figures. Certain data products 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 is provided in the following diagram:



2 DESCRIPTION OF MONITORING PROCEDURES

2.1 Long Term Mass Emissions Monitoring

The Permittees conduct Mass Emissions monitoring at multiple stations in the San Diego Region Water Quality Control Board (RWQCB) jurisdiction of Orange County to evaluate dry weather and stormwater runoff relative to applicable water quality criteria and to assess trends in mass loading. The monitoring site selection criteria included the following:

- Classification of the water body as a "Water of the State";
- Suitability of the site drainage area to monitor area-wide contributions of storm water pollutant loading;
- Suitability of the site's hydrological characteristics to enable practical measurement of flow and collection of representative storm water samples;
- Maintenance of long-term data collection at appropriate existing monitoring stations;
- Safety from traffic and other hazards;
- Suitability for efficient operation of automatic sampling equipment; and
- Access for safely retrieving samples and maintaining equipment during storm conditions.

Time-composite sampling and continuously recording stream gauges are used as the primary methods of monitoring the concentrations and loads of constituents at Mass Emissions sites. The sampling is conducted with automatic samplers that consist of programmable pumps (peristaltic) that transport water from the channel to a collection reservoir in the sampler base. The collection reservoir can be a single large composite bottle or a series of up to 24 bottles. The sampler program can be modified to vary sample volumes and frequency of collection. Two automatic samplers are used at each Mass Emissions site: one sampler is used for monitoring water chemistry, and the other is used for monitoring aqueous toxicity. Each dry weather composite sample is analyzed for suites of chemical analyses and toxicity tests as specified in the Fifth Term Permit, which includes a continuation of the Fourth Term Permit elements for this program during the transitional period.

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

Storm Monitoring

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

- Storm 1 – first flush (first hour of storm);
- Storm 2 – 24-hour period beginning three hours after the initiation of the first flush sampling by the water chemistry sampler.

For dry weather discharge evaluations, the automatic samplers are programmed to collect a discrete sample once an hour for a 24-hour period. During each monitored storm the automatic sampling programs are initiated when the water level in the channel rises above a triggering device (level actuator or flow meter) connected to the respective sampler. When possible, a single triggering device is used to trigger both samplers simultaneously. For the water chemistry sampler (and the toxicity sampler during the first storm) the frequency of collection during the first hour of a storm is set at 1 sample per 12 minutes. After the sixth sample is collected at the one-hour mark, the collection frequency is decreased to once every 2 hours. The first flush of the first storm of the year is modified slightly to collect additional volume for additional chemistry analyses (1 sample per 7 minutes). The concentrations of dissolved heavy metals and selenium in each of the composite samples collected during a storm can be compared to acute and/or chronic toxicity criteria from the CTR. The concentrations of organophosphate pesticides can be compared to literature values of LC_{50}s for the pesticide-sensitive toxicity testing organisms used. Sampler maintenance is performed periodically throughout a storm to change sample bottles, icepacks, and power supplies.

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

Each stormwater-influenced composite sample is analyzed for suites of chemical analyses as specified in the Fifth Term Permit. Water chemistry samples are analyzed for pH, specific conductance, turbidity, nitrate + nitrite, ammonia, total Kjehldahl Nitrogen (TKN), total phosphate, orthophosphate, dissolved and total organic carbon, total suspended and settleable solids, volatile suspended solids, chloride, sulfate, and total recoverable and dissolved cadmium, copper, chromium, lead, nickel, selenium, silver, and zinc. Priority pollutant scans (except asbestos and Dioxin) are performed on the first flush of the first monitored storm of the year at each site. Grab samples are collected at the time of sampler servicing and submitted for bacteriological analyses.

An aliquot of each sample collected for total recoverable metals analyses are filtered with a 0.45 micron groundwater filter. The filtered and the unfiltered fractions are then preserved with ultra-pure grade nitric acid prior to submittal for analysis.

Toxicity of dry weather and stormwater runoff samples are evaluated using multiple organisms. Aliquots from each stormwater or dry weather sample are salinity-adjusted by the laboratory to the proper range for the respective testing organism. The toxicity due to dissolved metals is measured using the sea urchin (*Stronglyocentrotus purpuratus*) embryo development test. *Ceriodaphnia dubia*, *Pimephales promelas*, and *Selenastrum capricornutum*are also analyzed for toxicity, and the results are presented in **Appendix B**.

Time-weighted composite sampling is supported by the Principal Permittee's precipitation and streamgaging network which consists of recording and/or transmitting Automated Local Evaluation in Real Time (ALERT) gauges. The ALERT precipitation gauges are tipping bucket type with data loggers. Data are recorded and transmitted in digital format. The sensitivity of the ALERT transmitting gauges is 1 mm (0.04 inches) of accumulated rainfall. The recording non-transmitting gauges have a sensitivity of 0.01 inch of rainfall.

Several types of stream gauges are used to monitor changes in water level. The oldest design is the stilling well with water level float; the newer types are manometer gauges or pressure transducers. Data (water level versus time) are recorded in analog form on strip charts and/or in digital form on data loggers. The ALERT interface to these gauges consists of a connection from the recorder chart drive to an ALERT shaft encoder. ALERT information is recorded on a data logger and transmitted in digital format to the Principal Permittee's base station in Orange. Sensitivity of the transmitted and recorded ALERT record is user-variable with the greatest sensitivity being a change in water level of 0.01 feet. The sensitivity of these water level gauges however is generally set to a higher increment (e.g. 0.1 foot) to prevent excessive radio transmissions during a storm.

2.2 Bioassessment

The Permittees are currently participating in a multi-year regional bioassessment monitoring program with the Stormwater Monitoring Coalition (SMC), comprised of a group of Southern California stormwater agencies, the Regional Boards, and the Southern California Coastal Water Research Project (SCCWRP). The original 5-year study spanned 2009 through 2013 with 2014 acting as a transitional year. The second 5-year study began in 2015, which included new metrics and field protocols designed to more accurately assess the state of the biological health of streams. 2015 included a new probabilistic site draw of potential monitoring locations, including non-perennial and first order streams. Four SMC bioassessment sites were sampled in 2017. The site assessments are made using Surface Water Ambient Monitoring Program (SWAMP-2016) protocols, which were authorized for statewide use by SWAMP. These protocols can be found at: http://www.waterboards.ca.gov/water_issues/programs/swamp/. SWAMP protocols use a multiple lines of evidence (LOE) approach which includes the collection of water quality, benthic macroinvertebrates (BMIs) and algae, as well as a physical habitat (phab) assessment. SMC stations also require an additional habitat assessment using the California Rapid Assessment Method (CRAM). Protocols for CRAM methods can be found at: http://www.cramwetlands.org/.

In addition to the SMC Program, 10 historical targeted stations are required to be monitored a minimum of one event over the duration of the permit. In 2017, five targeted stations were sampled including the three remaining stations that had not been sampled under the current permit. Unlike SMC stations, CRAM is not required at targeted stations as reinforcement for habitat assessment. The list of water quality constituents mirrors that of the Long Term Mass Emissions list and includes toxicity. The aquatic toxicity at the targeted stations was evaluated using the Test for Significant Toxicity (TST) tests.

2.3 Unified Beach Monitoring Program

Effective April 1, 2015, the Permittees entered into a Unified Beach Water Quality Monitoring and Assessment Program approved by the RWQCB. Partners in this unified regional program include the Permittees, Orange County Health Care Agency, and South Orange County Wastewater Authority. The unified regional shoreline monitoring program has and continues to support multi-agency objectives, such as:

- The opportunity for partners to share knowledge about bacteriological conditions and site histories while working together to monitor beach water quality.
- The implementation of a monitoring program that assists the Regional Board in achieving the statewide goal of developing a sustainable beach water quality monitoring program for public health protection purposes.
- Consolidating monitoring programs so that sites are evaluated using comparable procedures, which provide a better contextual understanding of issues observed and ensures that site issues are appropriately prioritized by the collective workgroup.
- The opportunity for partners to more effectively leverage existing resources while expanding the collective set of technical capabilities overall to address water quality issues as needed.

As part of this consolidation, the various coastal storm drains historically monitored by the Permittees were incorporated into the regional monitoring efforts. These include seven stations in Crystal Cove state park and Laguna Beach;

Historic Station	Unified Program
ONB45	ELMORO
OLB10	EMRLD
OLB00	MAINBC
S16	VICTRA
S15	BLUBRD
S14	DUMOND
S13	BLULGN

In Dana Point OSL25 was incorporated with SCM1, and in San Clemente OSC01 was incorporated with TRFCYN. Doheny State Beach sampling locations were revised as follows:

Historic Station	Unified Program
ODB02	DSB5
ODB05	S-0
S-7	DSB1
C-1	Not Included
C-2	Not Included

The unified program also introduces two types of sampling locations: fixed and outlet. Fixed stations are located along the shoreline (either up-coast or down-coast), and outlet stations are located where surface water discharges from creeks, canyons, or storm-drains to the ocean. When the station is flowing, each outlet station is sampled at 75 feet up-coast / down-coast, and at “Point zero” where the surface flow enters the ocean. Non-flowing outlet stations are sampled at “Virtual point zero,” where surface flows would appear to enter the ocean if the station was flowing.

On June 28, 2017, the three partnering agencies submitted a letter outlining recommended updates and revisions to the Unified Program per the 2016 annual program review and assessment. The updates and revisions to the Unified Program will serve to:

- Strengthen coordination and improve efficiency between overlapping monitoring program requirements for the Unified Program and the Twenty Beaches and Creeks Bacteria Total Maximum Daily Load (Bacteria TMDL) Program;
- Reallocate monitoring efforts for sites deemed inaccessible due to private property access issues; and
- Promote technological enhancements in laboratory testing methods to improve future monitoring efforts and promote public health.

On January 18, 2018, the RWQCB approved the recommended updates and revisions to the Unified Program. Additional details on the updates and revisions to the Unified Program will be provided in the 2017-18 assessment report.

2.4 TMDL Monitoring

Beaches and Creeks TMDL

Information on the monitoring approach for the Beaches and Creeks TMDL can be found in **Appendix E**, **Section 3.0**.

Baby Beach TMDL

Information on the monitoring approach for the Baby Beach TMDL can be found in **Appendix F**, **Section 4.0**.

2.5 MS4 Outfall Inventory and Field Screening

Attributes of MS4 outfall structures and associated field observations were collected using Geographic Information System (GIS) data collection software and uploaded to an online enterprise geodatabase. The following attributes were collected to develop an updated MS4 outfall inventory:

- Facility Identifier
- Location Description
- Catchment Identifier
- Drainage Identifier
- Inspection Status – Verified, Un-verified, Not found
- Facility Type (Either outfall, box, or culvert)
- Jurisdiction
- Watershed Management Area
- Priority Status
- Flow Monitoring Status
- Flow Monitoring Deploy Date
- Flow Monitoring Return Date
- Outfall Dimensions
- Latitude
- Longitude

For outfall discharge field screening visual observations, the following attributes were collected on each field visit.

- Facility Identifier
- Collection Staff
- Inspection Date
- Site Accessibility – Easily accessible, Difficult accessibility, Unsafe accessibility, Private property, Inaccessible
- Flow Condition – Dry, Flowing, Pooled or Ponded, Other
- Flow Velocity – Seconds per six feet
- Flow Width
- Flow Depth
- Biological Condition – Not present, Sparse, Abundant
- Vegetative Condition – Not present, Moderate, Overgrown
- Trash Condition – Not present (0 items), Sparse (<10 items), Moderate (11-50 items), Abundant (>50 items)
- Structural Condition – Good, Poor
- Illegal Discharge/ Illicit Connection – None, Paint, Oil sheen, Surfactants, Trash, Biohazard, FOG, Elevated discharge, Other
- Maintenance Issues – None, Graffiti, Clogged, Sediment, Overgrown, Damaged, Other
- Photographs
- Comments

In the spring of 2016 the dry weather field screenings were expanded to include additional assessments about the impact of each discharge to the receiving water. The following fields were added to the inspection list:

- Connectivity to Receiving Water – None (Flow infiltrates), Partial (Significant distance), Direct connection, Undetermined, Unsafe to access
- Upstream Receiving Water Flow Conditions – Dry, Flowing, Pooled or Ponded, Inaccessible
- Downstream Receiving Water Flow Conditions - Dry, Flowing, Pooled or Ponded, Inaccessible
- Relative Contribution to Receiving Water Flow – Small fraction (<10%), Minor fraction (10 – 50%), Major fraction (>50%)

3 METHODS OF DATA ANALYSIS

3.1 Comparision to Water Quality Criteria

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

On March 2, 2000, the State adopted the United States Environmental Protection Agency's (USEPA) Rules establishing numeric water quality criteria for priority toxic pollutants (commonly referred to as the California Toxics Rule or CTR) for the State of California. The CTR sets criteria for dissolved heavy metals in freshwater that are based on water hardness, and separate criteria for saltwater. The SWRCB's 2005 *Policy for*

Implementation of Toxic Standard for Inland Surface Waters, Enclosed Bays, and Estuaries of California, exempts stormwater discharges from the CTR. Despite this exemption the concentrations of dissolved metals in both dry weather and stormwater discharges are compared in this report to CTR criteria, with the stormwater comparisons made for discussion purposes only.

Acute (CMC-Criteria Maximum Concentration) and chronic (CCC-Criteria Continuous Concentration) aquatic toxicity criteria from the CTR are used to evaluate dissolved metals data collected from storm channels (freshwater CTR criteria).

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

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

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

3.2 Toxicity Testing Data

Toxicity data are analyzed following the Test of Significant Toxicity (TST) approach developed by the U.S. Environmental Protection Agency (EPA). The TST was developed as a supplemental analysis for two-concentration whole effluent toxicity (WET) data comprised of in stream waste concentration (IWC) and control concentration, that is more streamlined and incorporates incentives to generate high quality data. Data analysis conducted using the TST approach is hypothesis driven and results in a clear pass/fail result indicating if the sample was toxic. The basis of the TST is the question "is the mean response in effluent less than a defined biological amount?" Effluent is considered toxic if organism response in IWC is less than or equal to a fixed fraction of organism response in the control. For chronic toxicity tests, effluent is considered toxic if there is a 25 percent or greater effect in IWC than in the control. For acute toxicity tests, effluent is considered toxic if there is a 20 percent or greater effect in IWC than in the control.

The freshwater indicator organism tests used were *Ceriodaphnia dubia* survival and reproduction, *Pimephales promelas* survival and growth, and *Selenastrum capricornutum* growth. The marine indicator organism test used was *Strongylocentrotus purpuratus* fertilization and larval development.

3.3 Mass Load Calculations

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

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

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

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

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

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

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

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

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

3.4 Unified Beach Monitoring Program Data

Coastal storm drain data include water temperature and concentrations of bacterial indicators in the discharge and in the surf zone up-coast (north) and down-coast (south) of these storm drains. Data analysis may consist of:

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

2. Listing the drains in terms of the proportion of total possible exceedances of the AB411 standards. The proportion of exceedances for each monitoring site is calculated as:

$$\frac{Number\ of\ exceedances\ of\ a\ single\ sample\ standard}{Number\ of\ samples\ \times Number\ of\ analyses\ per\ sample}$$

   The total number of AB411 exceedances is then divided by the total number of sample tests, resulting in a proportion for each drain between 0 and 1.0.

3. Heal the Bay's Beach Report Card grading system which uses an evaluation process that includes:

   - Indicator bacteria thresholds (namely the total-to-fecal ratio) developed by the Santa Monica Bay Restoration Commission in the 1996 health effects studies of Santa Monica Bay beachgoers.
   - Standard deviations for each indicator bacteria threshold which was developed by the Southern California Coastal Water Research Project and Orange County Sanitation Districts during the 1998 Southern California Bight Study.
   - Use of rolling 30-day geometric mean for bacterial indicators and greater weight for the Enterococcus single sample standard relative to total coliform and fecal coliform.
   - A firm zero-to-100 point scale for a standard A through F grading system based on the following formula:

$$\%\ Grade = \frac{Total\ Points\ Available - Total\ Points\ Lost}{Total\ Points\ Available}$$

Letter Grade	%
A	100% – 90%
B	89% – 80%
C	79% – 70%
D	69% – 60%
F	<60%

4. Depicting percentages of sampled days in which at least one indicator bacteria concentration exceeded the AB411 concentration in the surf zone. Each day of surf zone sampling is evaluated with respect to the AB411 standards for the three indicators. For each drain, the percentage of sampled days in which at least one standard was exceeded in the surf zone (upcoast or downcoast) is calculated. These percentages are calculated for the entire year and the AB411 season (April 1-October 31). This method

of analysis provides a better assessment of the health risk (compared to analysis #2) associated with water contact in the surf zone near the discharges from the drains.

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

3.5 Bioassessment and the California Stream Condition Index (CSCI)

The Permittees have participated in the regional Stormwater Monitoring Coalition (SMC) bioassessment program since 2009. The stations in this program are evaluated in terms of a series of metrics, which are then scored to provide a basis for determining the overall California Stream Condition Index (CSCI) scores for each site. Historically, the Southern California Index of Biotic Integrity (SoCal IBI) was used as the scoring metric, and was based on data from the southern California region, from southern Monterey County to the Mexican border. However, the CSCI was created using a more robust dataset of reference sites from a wide variety of streams across multiple climate zones throughout California. The CSCI has become the standard index for scoring biotic integrity, and is the tool used to analyze the complex biological data in this report.

3.5.1 CSCI Methods

The CSCI is a new statewide biological scoring tool that translates complex data about benthic macroinvertebrates (BMIs) found living in a stream into an overall measure of stream health. The CSCI was finalized in 2015 and represents the latest generation of biological indicators for assessing stream health in California. The CSCI combines two separate types of indices, each of which provides unique information about the biological condition at a stream: a multi-metric index (MMI) that measures ecological structure and function, and an observed-to-expected (O/E) index that measures taxonomic completeness. Unlike previous MMI or O/E indices that were applicable only on a regional basis or under-represented large portions of the state (SoCal IBI), the CSCI was built with a statewide dataset that represents the broad range of environmental conditions across California. The CSCI provides consistency and accuracy in the interpretation of biological data collected by both statewide and regional monitoring programs and will be the basis of the new statewide Biological Integrity Plan. CSCI results are included in **Appendix C**. Full details of CSCI development can be found in the following references for calculation method, index development, and index development summary, respectively:

3.5.2 Application of CSCI to Additional Lines of Evidence

Historical CSCI scores from 2009 through 2016 were compared against several other lines of evidence that are collected in the bioassessment program. Chief among them are measures of instream habitat such as physical habitat (phab) and the California Rapid Assessment Method (CRAM). Further analysis uses the Southern California Algal Index of Biotic Integrity (SoCA Algal IBI) and the hybrid sub-index H20 for soft algae and diatoms. Thresholds have been established for each of these metrics, which allow for spatial and temporal analysis. Correlations to aquatic chemistry and toxicity are difficult to definitively correlate, although stream reaches with elevated dissolved solids consistently have lower CSCI scores. Further summaries and graphics regarding the water quality component are discussed in **Appendix C**.

Further analysis was conducted for spatial and temporal patterns in the benthic macroinvertebrate community from 2009 through 2016: dendrogram cluster analysis and two-way coincidence tables.

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

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

   The species data from all surveys were clustered to identify groupings of sites that were similar in terms of their community composition. The cluster analysis dendrogram of all historical sites (2009 – 2016) and the two-way coincidence table of the relative distribution of species in each site are included in the bioassessment analysis. On the two-way coincidence table, horizontal and vertical lines identify major groupings of species and sites, respectively. Sites are identified by their site number and year they were sampled. Relative species abundances are shown as symbols. Smaller symbols represent a lesser proportion of maximum abundance and larger symbols a greater proportion. The abundance of each species was standardized in terms of its maximum at each site over all surveys.

The specific steps are as follows:

- Preliminary biotic data transformation, using a square root transformation and standardization by species mean of values >0 (Smith, 1976; Smith et al., 1988)
- Calculation of a Dissimilarity Index for cluster analysis of stations, using the Bray-Curtis Index, step-across procedure for dissimilarity >0.8 (Bradfield and Kenkel, 1987; Clifford and Stephenson, 1975; Smith, 1984; Williamson, 1978)
- Calculation of similarities for cluster analysis of species, using flexible clustering (β=-0.25) (Clifford and Stephenson, 1975; Lance and Williams, 1967; Smith, 1982)
- Creation of the two-way coincidence table (Kikkawa, 1968; Smith, 1976)

Results from the Biological Cluster Analysis are included[1] in **Appendix C**.

3.6 MS4 Outfall Stormwater Assessment

3.6.1 Land Use Categorization

Geographic information system (GIS) software was used to quantify various land use types within the Watershed Management Area (WMA), City boundaries, and MS4 outfall drainage areas. Land uses were grouped into one set of categories for runoff coefficient calculations, and a second set for event mean concentration (EMC) calculations. Areas falling into federal jurisdictional boundaries were excluded from this analysis.

3.6.2 Watershed Management Area Runoff Coefficients

A runoff coefficient is defined as the fraction of rainfall that runs off of the surface. Stormwater runoff volumes were calculated by calibrating published runoff coefficients for various land use type categories with actual runoff coefficients for each sampling event. Typical runoff coefficients were used for the following land use categories (Ackerman & Schiff, 2003).

Land Use Category (LUC)	Runoff Coefficient ($C_{R\ SCCWRP}$)
Residential	0.1
Commercial	0.61
Open	0.64
Industrial	0.06
Other Urban	0.39
Agriculture	0.41

The actual measured outfall runoff coefficients for each outfall were calculated using the following formula:

$$C_{R\ Outfall} = \frac{Monitored\ Stormwater\ Volume}{Outfall\ Area\ \times Rainfall\ Total}$$

Calculated runoff coefficients were created for each outfall by area weighting published runoff coefficients ($C_{R\ SCCWRP}$) for each land use category area within the outfalls tributary using the following formula:

$$C_{R\ Calculated} = \frac{\sum(\ Area_{Outfall\ LUC}\ \times\ C_{R\ SCCWRP})}{\sum Area_{Outfall\ LUC}}$$

The calculated runoff coefficients ($C_{R\ Calculated}$) were adjusted with outfall runoff coefficients ($C_{R\ Outfall}$) by creating a correction factor using the following formula:

$$Correction\ Factor = \frac{C_{R\ Outfall}}{C_{R\ Calculated}}$$

The correction factor was applied to the published runoff coefficients for each monitored outfall land use category using the formula below:

$$C_{R\ Outfall\ LUC} = Correction\ Factor\ \times\ C_{R\ SCCWRP}$$

Overall WMA land use category runoff coefficients were calculated by area weighting the adjusted outfall land use category runoff coefficients:

$$C_{R\,WMA\,LUC} = \frac{\sum(\,Area_{Outfall\,LUC}\,\times\,C_{R\,Outfall\,LUC})}{\sum Area_{Outfall\,LUC}}$$

3.6.3 Outfall Stormwater Runoff Volume and Pollutant Loads

Annual stormwater runoff volumes and pollutant loads for each monitored MS4 outfall were calculated for all storm events with greater than 0.1 inches of rainfall. Rainfall totals for each station were taken from the nearest 0.01 inch recording gage located to each station.

The total stormwater volume discharged for each outfall over the reporting period was calculated with the following formula:

$$Stormwater\ Volume = \left(C_{R\,Outfall}\ \times Outfall\ Area\right) \times \sum Rainfall\ Events$$

Total pollutant load for the reporting period ($PL_{Outfall}$) was calculated by multiplying the stormwater volume and chemistry results.

$$PL_{Outfall} = (Stormwater\ Volume \times Pollutant\ Concentration)$$

Chemistry results were compared to available published EMC values for the following land use categories (Geosyntec Consultants, 2008):

Constituent / Land Use Category	FC	AmmoniaN	Nitrate as N	TKN	Total Phosphorus	TSS	Cu	Pb	Zn	Cu	Zn
Fraction							Total	Total	Total	Dissolved	Dissolved
Units	CFU/100 mL	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Agriculture	60300	1.65	34.4	7.32	3.34	999	0.1001	0.0302	0.2748	0.0225	0.0401
Commercial	51600	1.21	0.55	3.44	0.4	67	0.0314	0.0124	0.2371	0.0123	0.1534
Education	51600	0.4	0.61	1.71	0.3	99.6	0.0199	0.0036	0.1176	0.0122	0.0754
Industrial	37600	0.6	0.87	2.87	0.39	219	0.0345	0.0164	0.5376	0.0152	0.4221
MF Residential	11800	0.5	1.51	1.8	0.23	39.9	0.0121	0.0045	0.1251	0.0074	0.0775
Open Space	6310	0.11	1.17	0.96	0.12	216.6	0.0106	0.003	0.0263	0.0006	0.0281
SF Residential	31100	0.49	0.78	2.96	0.4	124.2	0.0187	0.0113	0.0719	0.0094	0.0275
Transportation	16800	0.37	0.74	1.84	0.68	77.8	0.0522	0.0092	0.2929	0.0324	0.222
Other Urban	31700	0.855	1.03	2.62	0.315	53.45	0.02175	0.00845	0.1811	0.00985	0.11545

The EMC for each outfall is calculated by area weighting each land use category EMC in each outfall tributary by the equation below:

$$EMC_{Outfall\,Calculated} = \frac{\sum(Area_{Outfall\,LUC} \times C_{R\,Outfall\,LUC} \times EMC_{SBPAT})}{\sum(Area_{Outfall\,LUC}\ \times\ C_{R\,Outfall\,LUC})}$$

The calculated EMC ($EMC_{Outfall\ Calculated}$) were adjusted with outfall EMC values ($C_{R\ Outfall}$) by creating a correction factor using the following formula:

$$Correction\ Factor = \frac{EMC_{Outfall}}{EMC_{Outfall\ Calculated}}$$

The correction factor was applied to the published event mean concentrations for each monitored outfall land use category using the formula below:

$$EMC_{Outfall\ LUC} = Correction\ Factor \times EMC_{SBPAT}$$

Overall WMA land use category EMC values for each parameter were calculated by area weighting the adjusted EMC values ($EMC_{Outfall\ LUC}$) using the equation below:

$$EMC_{WMA\ LUC} = \frac{\sum(Area_{Outfall\ LUC} \times C_{R\ Outfall\ LUC} \times EMC_{Outfall\ LUC})}{\sum(Area_{Outfall\ LUC} \times C_{R\ Outfall\ LUC})}$$

4 REFERENCES

Ackerman, D., & Schiff, K. (2003). Modeling Storm Water Mass Emissions to the Southern California Bight. *Journal of Environmental Engineering*.

Bradfield, G. E., & Kenkel, N. C. (1987). Nonlinear ordination using shortest path adjustment of ecological distances. *Ecology, 68*(3), 750-753.

Clifford, H. T., & Stephenson, W. (1975). *An Introduction to Numerical Classification.* New York: Academic Press.

Geosyntec Consultants. (2008). *A User's Guide for the Structural BMP Prioritization and Analysis Tool (SBPAT) Technical Appendices.*

Kikkawa, J. (1968). Ecological association of bird species and habitats in Eastern Australia; similarity analysis. *Journal of Animal Science, 37*, 143-165.

Lance, G. N., & Williams, W. T. (1967). A general theory of classificatory sorting strategies. I. Hierarchical systems. *Computer Journal, 9*, 373-380.

Mazor, R. D., Ode, P. R., Rehn, A. C., Engeln, M., Schiff, K. A., Stein, E., . . . Hawkins, C. P. (2015). Bioassessment in complex einvironments: designing an index for consisten meaning in different settings. *Freshwater Science*, 249-271.

Mazor, R. D., Ode, P. R., Rehn, A. C., Engeln, T., Boyle, E., Fintel, S., . . . Yang, C. (2015). *The California Stream Condition Index (CSCI): Interim instructions for calculating scores using GIS and R.* SCCWRP Technical Report #883. SWAMP-SOP-2015-0004.

Rehn, A. C., Mazor, R. D., & Ode, P. R. (20145). *The California Stream Condition Index (CSCI): A New Statewide Biological Scoring Tool for Assessing hte Health of Freshwater Streams.* . Swamp Technical Memorandum SWAMP-TM-2015-0002.

Smith, R. (1976). Numerical Analysis of Ecological Survey Data (Doctoral dissertation).

Smith, R. W. (1982). Analysis of ecological survey data with SAS and EAP. *7th Annual SAS Users' Group International (SUGI)* (pp. 610-615). SAS Institute Inc. P.O. Box 8000, Cary, NC 27511.

Smith, R. W. (1984). *The re-estimation of ecological distance values using the step-across procedure.* EAP Technical Report No. 2.

Smith, R., Bernstein, B. B., & Cimberg, R. (1988). *Community-Environmental Relationships in the Benthos: Applications of Multivariate Analytical Techniques In Marine Organisms as Indicators.* (G. S. Kleppel, & D. F. Soule, Eds.) New York: Springer-Verlag.

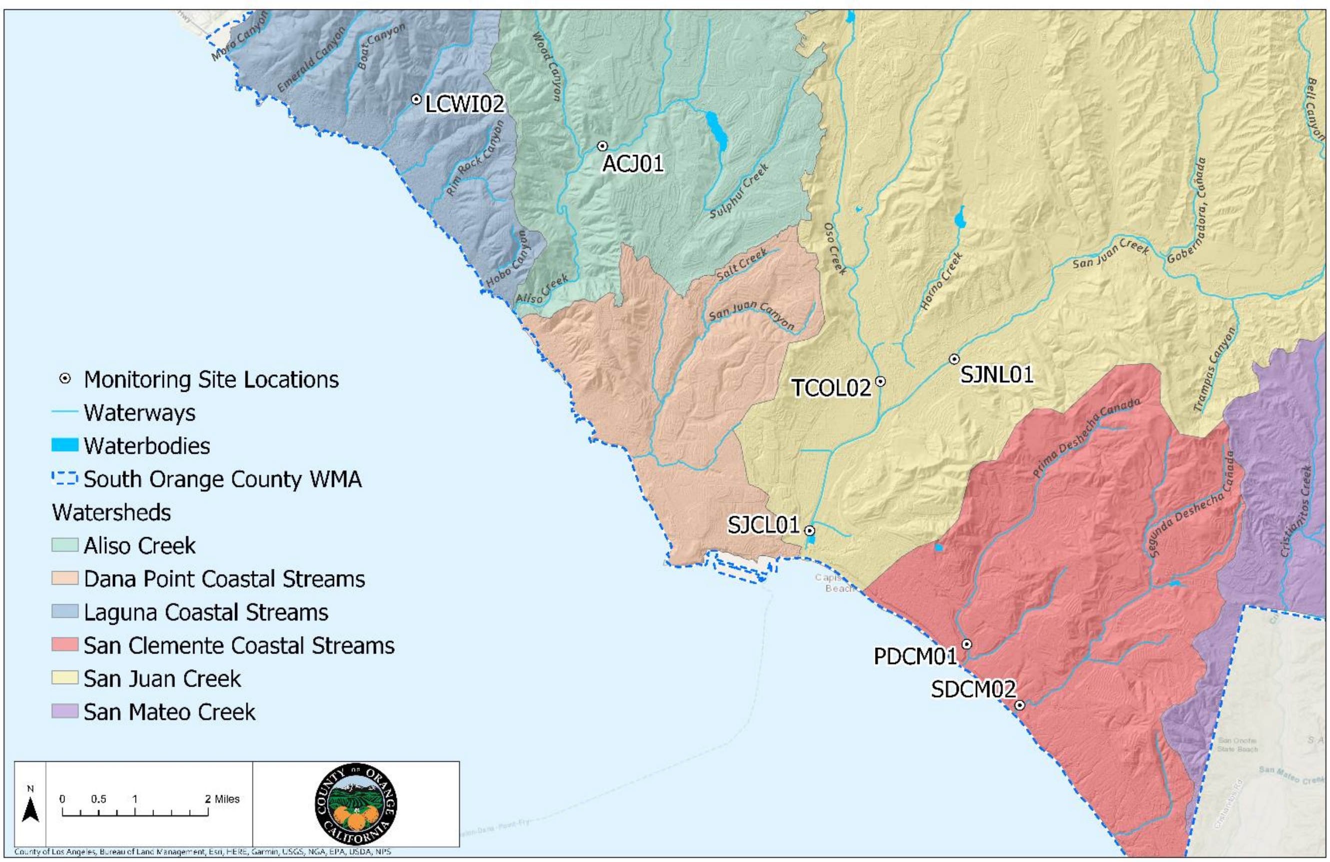
Wiliamson, M. H. (1978). The ordination of incidence data. *Journal of Ecology, 66*, 911-920.

APPENDIX B
LONG TERM MASS EMISSIONS MONITORING

1 CORE MONITORING PROGRAM

Mass Emissions monitoring is conducted primarily to estimate the total annual load (or amount by weight) of a wide range of constituents which are transported by flood control drainage channels to receiving waters during both dry weather and wet weather runoff conditions. A secondary goal is to assess the toxicity of these samples through direct aquatic toxicity testing and by comparison of chemistry constituent data to California Toxics Rule (CTR) criteria as a potential source of toxicity. Water chemistry and channel discharge rates are measured to compute loads for dry weather conditions and wet weather events each year. Under ideal conditions, the total annual load of a selected constituent from a channel is 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. Monitoring is therefore conducted at representative times in both dry weather and stormwater conditions and the information gathered is used to estimate aquatic chemistry conditions throughout the year. Monitoring locations are depicted in the **Figure 1.1**.

Figure 1.1: Receiving Water Locations for Mass Emissions Monitoring Program, 2016-17
A total of 6 sites are monitored when flowing as part of this monitoring program.



The intent of the core monitoring program is to annually monitor each site during two periods influenced by stormwater runoff and two periods of representative dry weather. The annual rainfall summary is shown below in **Table 1.1.** The 2016-17 total rainfall at Laguna Niguel (16.37 inches) and San Clemente (16.53 inches) exceed the prior three sampling years as well as the historical average. The increased rainfall totals led to greater flow conditions in the regional channels, allowing for sampling at all mass emissions stations. Storm monitoring activities were conducted at five regional monitoring stations for the first flush storm event in November 2016 and one additional storm in February 2017. An additional sample was collected in May 2017 for SJCL01. The volumes sampled for each station are shown below as **Table 1.2.**

Table 1.1: Annual Rainfall Summary, 2016-17
Rain totals in Laguna Niguel and San Clemente exceeded both prior years and the historical average.

	2016-17	2015-16	2014-15	2013-14	Average
			in		
Santiago Peak	34.93	23.42	13.69	14.11	32.83
Laguna Niguel	16.37	7.79	6.01	5.71	14
San Clemente	16.53	8.73	5.47	1.92	12.81

Table 1.2: Sample Event Summary, 2016-17
The total volume sampled for each stormwater monitoring activity based on the composite sample times.

	ACJ01	LCWI02	PDCM01	SDCM02	SJCL01	TCOL02
			acre-feet			
November 2016	252.312	0.396	0.579	514.764*		165.779
February 2017	308.425	0.535	2.722	168.44	59.506	326.248
May 2017					105.585	

*SDCM02 calculated with best available data pending rating curve re-evaluation

The November 2016 sampling was the first storm of the season and focus was on the first flush. Only the first hour of flow collected at LCWI02 and PDCM01 for November 21, 2016 represented stormwater before returning to baseline conditions, as determined by conductivity measurements. 24 hours of stormwater composite sampling was performed at ACJ01, PDCM01, SDCM02 and TCOL02. The February 2017 storm was focused on the first flush as well as flows extending 24 hours beyond the first flush. Due to favorable storm conditions, an additional 24-hour composite sample was collected at SJCL01 in May 2017. The total sampled volume in November 2016 for SDCM02

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). Data sets listed below are presented in tables available at the following link: https://ocgov.box.com/v/201617-TMAR-Datasets)

- **Table 1.3** contains the time-weighted event mean concentrations (EMC) of nutrients and trace elements.
- **Table 1.4** contains the stormwater mass loads of these constituents.
- **Table 1.5** presents the entire aqueous chemistry data set collected for 2016-17
- **Table 1.6** summarizes the comparisons of metals results to the CTR criteria. 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 and chronic criteria from the CTR, where applicable. Freshwater criteria are used to evaluate channel discharges.
- **Table 1.7** presents the entire set of toxicity data collected in 2016-17.

2 METALS

The complete summary of dissolved and total recoverable metals concentrations in comparison to CTR criteria are available in **Table 1.6** for acute and chronic CTR criteria in both dry and wet weather. Regional patterns of CTR exceedances chronic and acute exceedances during dry weather conditions are presented in **Figure 2.1** and **Figure 2.2**, respectively. **Figure 2.3** and **Figure 2.4** display wet weather chronic and acute exccedances. The total list of metals tested using the CTR criteria are silver, cadmium, copper, chromium, nickel, lead, selenium and zinc. Stations monitored as part of the Bioasssessment monitoring program are included for reference.

Figure 2.1: Patterns of chronic CTR criteria exceedances across the Region in Dry Weather, 2016-17

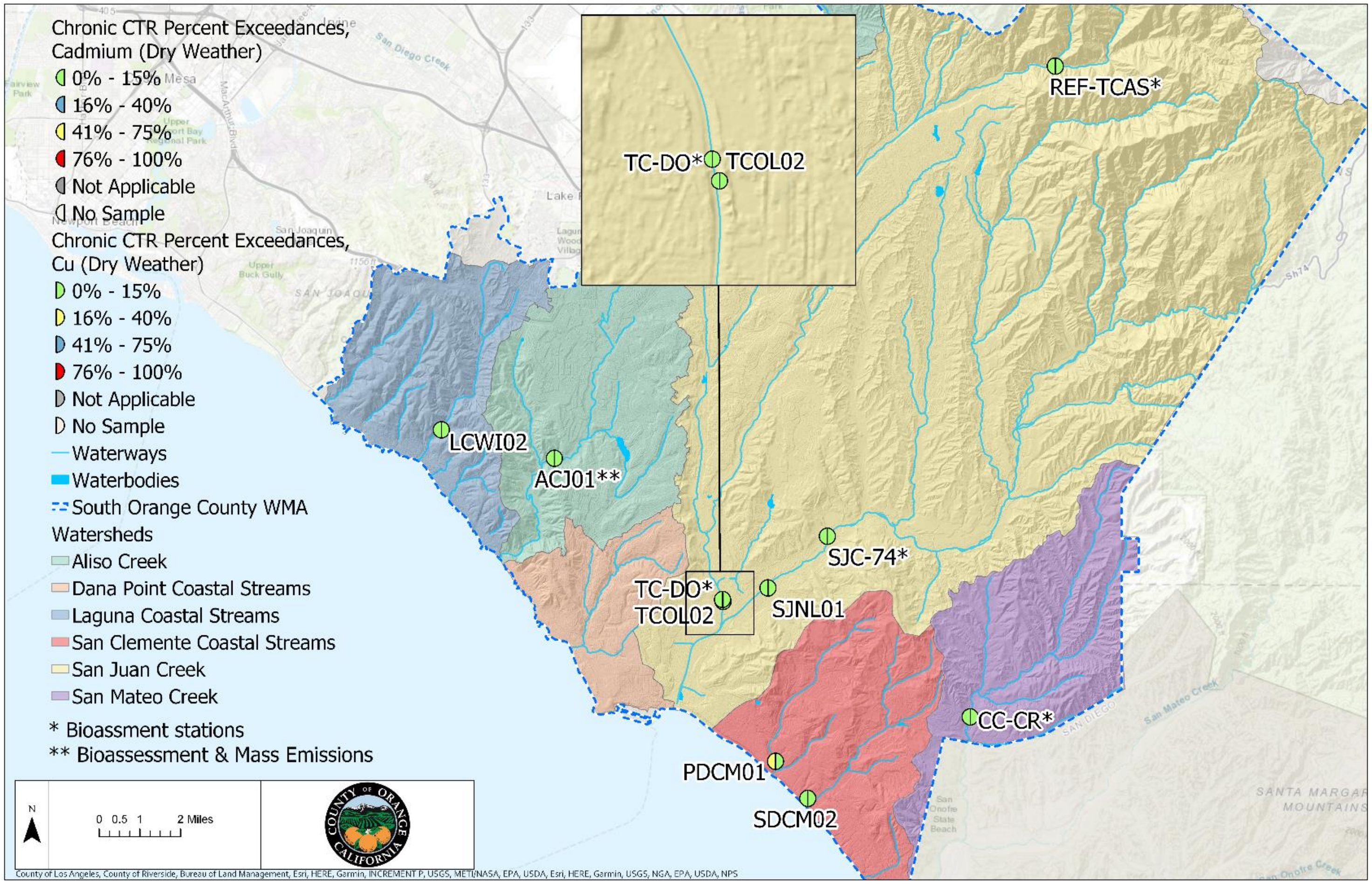


Figure 2.2: Patterns of acute CTR criteria exceedances across the Region in Dry Weather, 2016-17

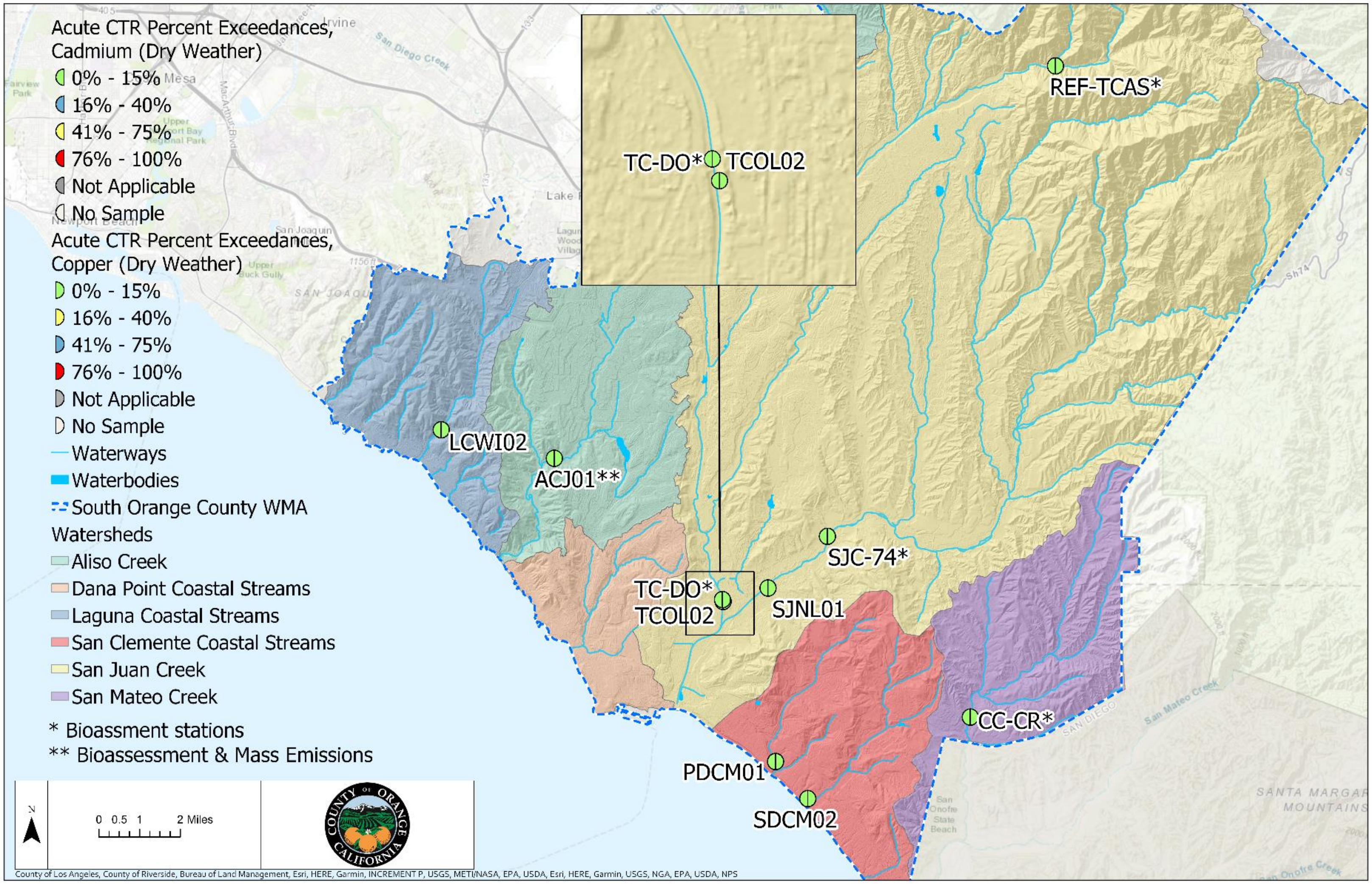


Figure 2.3: Patterns of chronic CTR criteria exceedances across the Region in Stormwater, 2016-17

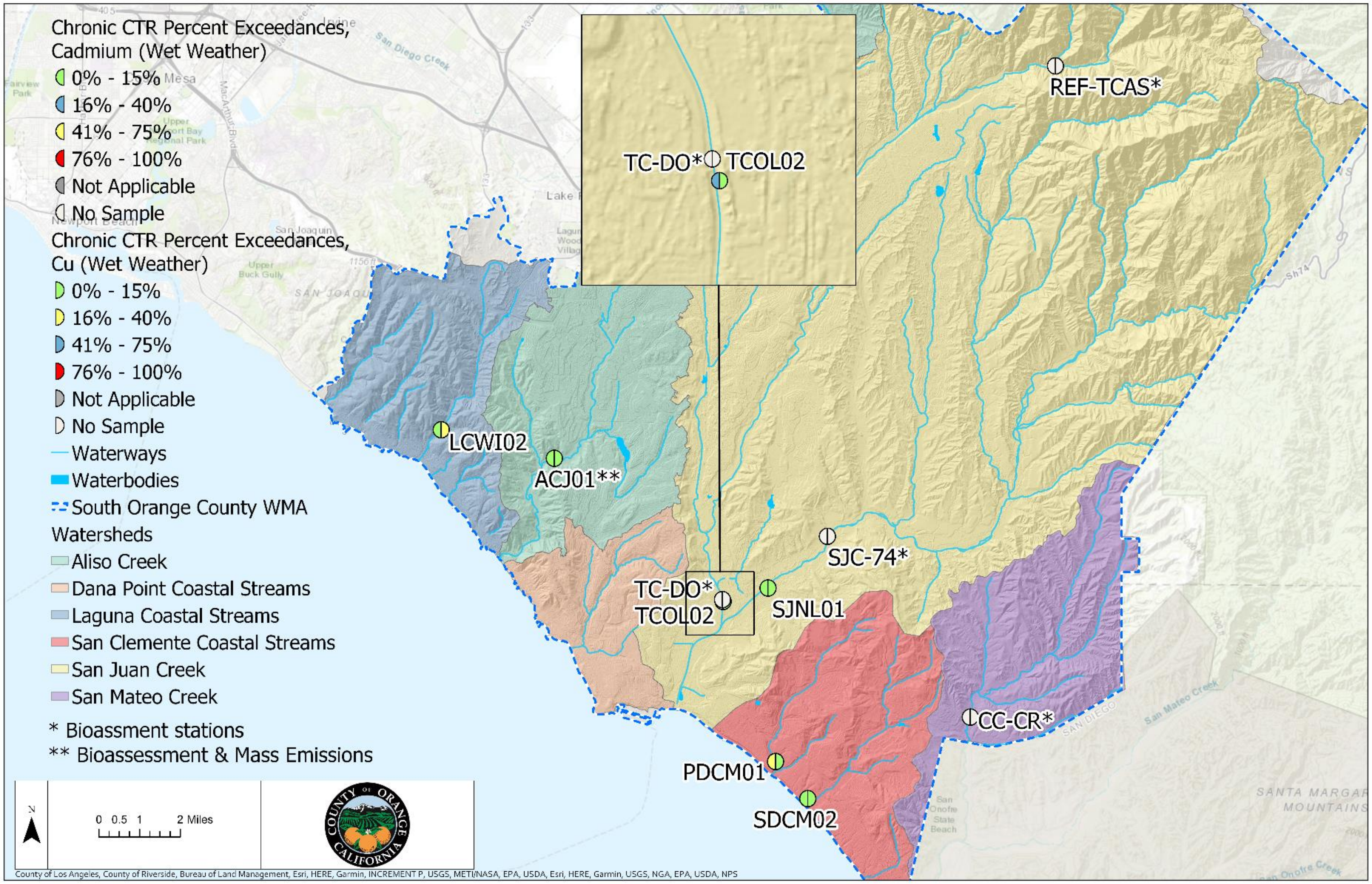
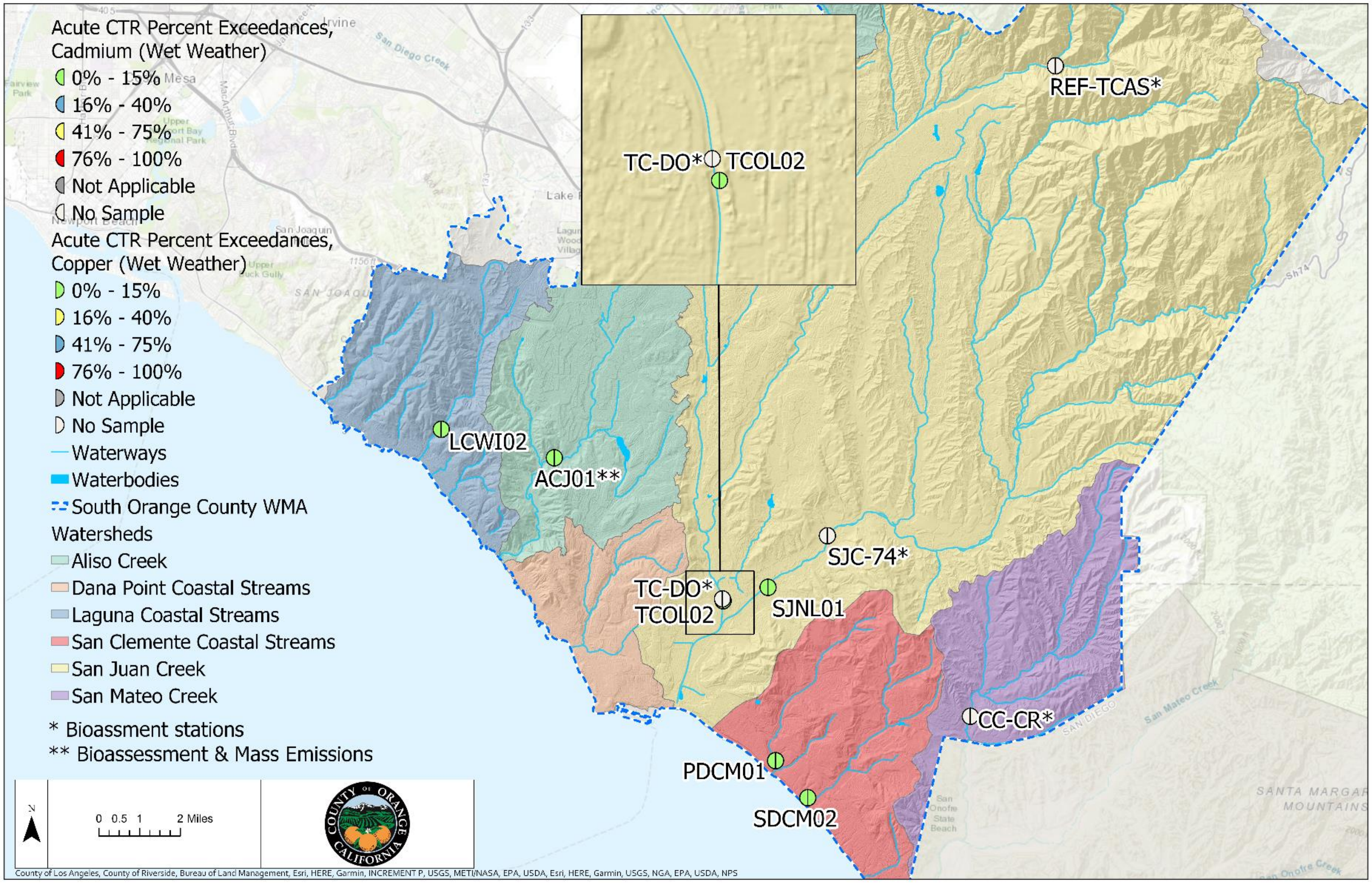


Figure 2.4: Patterns of acute CTR criteria exceedances across the Region in Stormwater, 2016-17



Of the 35 composite samples collected during 2016-17, exceedances of freshwater acute CTR criteria were limited to cadmium, copper, selenium, and zinc in wet weather (adjusted for hardness). Although the composite samples were collected during 24 hour periods as opposed to multi-day cycles, the sample results were also compared to chronic CTR criteria to assist in data evaluation and prioritization of issues, particularly related to cadmium, copper, and selenium. Of the 45 composite samples collected during 2016-17, exceedances of freshwater chronic CTR criteria were detected in cadmium, copper, lead, selenium and zinc.

Copper

Of 24 stormwater-influenced composite samples collected, 50% at Laguna Canyon Wash (LCWI02), 50% at Prima Deshecha Channel (PDCM01), 20% at Segunda Deshecha Channel (SDCM02) and 50% at Trabuco Creek (TCOL02) exceeded chronic CTR criterion for total copper. 25% of samples collected at both LCWI02 and TCOL02 exceeded both the chronic and acute CTR criterion for total copper.

Cadmium

Of the 11 dry weather composite samples collected, 100% of samples collected at PDCM01 exceeded the chronic CTR criterion for total cadmium. 75% of wet weather samples collected at PDCM01 also exceeded the chronic CTR criterion for total cadmium. One wet weather sample (20%) from both SDCM02 and ACJ01 exceeded. Two of three samples (67%) collected at PDCM01 and one of four samples (25%) collected at TCOL02 exceeded the chronic CTR criterion for dissolved cadmium.

Selenium

Of the 24 stormwater-influenced composite samples collected, one sample (25%) at PDCM01, three samples (60%) at SDCM02, one sample (25%) at TCOL02, and two samples (40%) at ACJ01 exceeded chronic CTR criterion for total selenium. Of 11 dry weather composite samples collected, two samples (100%) at PDCM01, two samples (100%) at SDCM02, and one sample (50%) at ACJ01 exceeded the chronic CTR criterion for total selenium. No samples collected in 2016-2017 exceeded the acute CTR criterion for total selenium in either dry weather or stormwater.

3 AQUATIC TOXICITY

Toxicity testing is conducted on selected samples of dry weather and stormwater runoff at mass emissions monitoring sites across the region. Toxicity testing provides a cumulative perspective of pollutant effects on receiving water aquatic species. Samples were analyzed using the Test of Significant Toxicity (TST) developed by the US EPA, and are considered to be toxic if the organism response test results (i.e., survival, reproduction, or growth) failed the TST. Toxicity occurred in 2 of 37 tests (5%) of dry weather samples and in 0 of 31 tests (0%) of stormwater samples collected from receiving waters. The tests on the dry weather and stormwater runoff samples are conducted with freshwater and marine organisms. The marine species *Strongylocentrotus purpuratus* was used for both dry weather toxicity samples at PDCM01 and one sample at SDCM02 due to the high conductivity of baseline conditions. Overall, the 2016-17 monitoring results indicate that sites in the San Diego Region were above the water quality objectives for toxicity in 68 of 70 (97%) laboratory tests completed. A summary of toxicity test result statistics for samples collected during dry weather is provided in **Table 3.1** below.

Table 3.1: Dry Weather Toxicity Testing Statistics, 2016-17
Results were considered to be toxic if an organism response result (ie. Survival, reproduction, or growth) failed the Test of Significant Toxicity (TST). Numbers represent the count of samples.

	Dry Weather TST Results		
	Fail	**Pass**	**Percent Non-Toxic**
Ceriodaphnia dubia chronic survival (96 hour)		7	100%
Ceriodaphnia dubia Reproduction (96 hour)	2	5	71%
Pimephales promelas larvae chronic survival (96 hour)		7	100%
Pimephales promelas larvae growth (96 hour)		7	100%
Selenastrum capricornutum growth (96 hour)		7	100%
Strongylocentrotus purpuratus embryo development		4	100%
Total Toxicity	**2**	**37**	**95%**

Toxicity was observed in 5% of dry weather samples collected for the Long Term Mass Emissions program, primarily related to *Ceriodaphnia dubia* reproduction toxicity at Aliso Creek during both September 13, 2016 and June 20, 2017 sampling events. Toxicity was not observed in any other test species or in the other 37 dry weather tests conducted for this program during 2016-17. The toxicity test results for stormwater samples collected during 2016-17 are summarized in **Table 3.2** below.

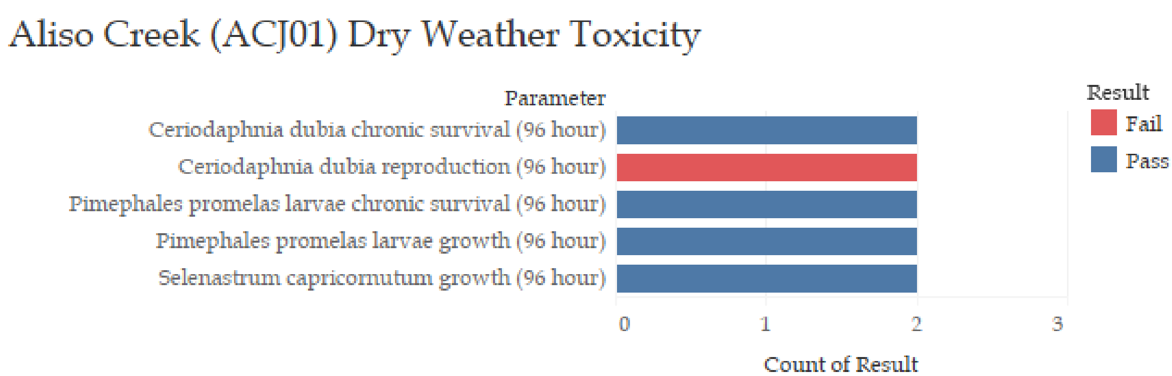
Table 3.2: Wet Weather Toxicity Testing Statistics, 2016-17
Testing results were considered to be toxic if the organism response results (i.e. survival, reproduction, or growth) failed the Test of Significant Toxicity (TST). Numbers represent the count of samples.

	Stormwater TST Results		
	Fail	**Pass**	**Percent Non-Toxic**
Ceriodaphnia dubia chronic survival (96 hour)		5	100%
Ceriodaphnia dubia Reproduction (96 hour)		5	100%
Pimephales promelas larvae chronic survival (96 hour)		5	100%
Pimephales promelas larvae growth (96 hour)		5	100%
Selenastrum capricornutum growth (96 hour)		5	100%

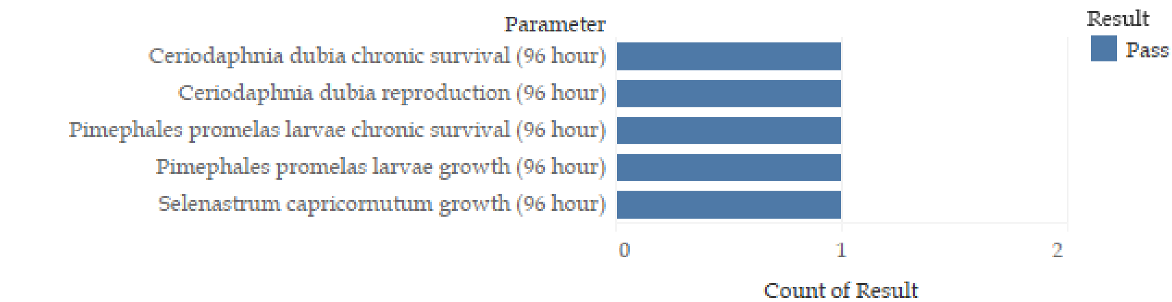
Strongylocentrotus pupuratus fertilization (96 hour)		6	100%
Total Toxicity	**0**	**31**	**100%**

Composite stormwater toxicity samples were collected and tested on November 21, 2016 during the first storm of the season at Aliso Creek, Laguna Canyon Wash, Prima Deshecha Channel, Segunda Deshecha Channel, Trabuco Creek, and San Juan Creek. Samples were also collected from Aliso Creek, Laguna Canyon Wash, Prima Deshecha Channel, Segunda Deshecha Channel, Trabuco Creek, and San Juan Creek during a second storm event on February 7, 2017. Aquatic Toxicity was observed in 0% of storm event sample tests conducted. **Figure 3.1** and **Figure 3.2** display toxicity sampling results for each monitoring station in dry and wet weather, respectively.

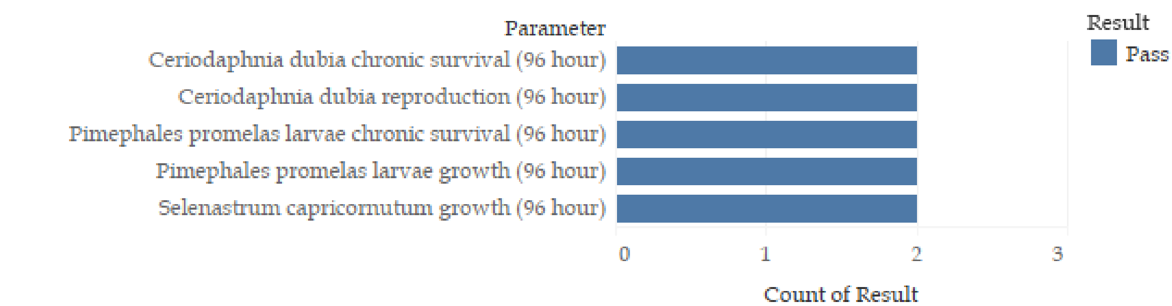
Figure 3.1: Patterns of Toxicity across the Region in Dry Weather, 2016-17
Charts include Mass Emissions data collected at ACJ01, LCWI02, TCOL02, PDCM01, SDCM02 and San Juan Creek at SJCL01 and SJNL01. Samples were collected during one dry weather event in September 2016 and June 2017. Due to dry conditions, insufficient sample volume was collected at LCWI02 in September 2016.



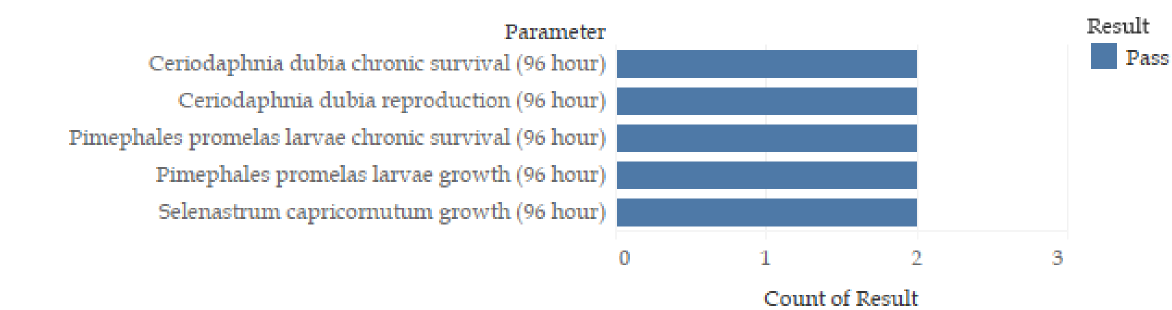
Laguna Canyon Wash (LCWI02) Dry Weather Toxicity



Trabuco Creek (TCOL02) Dry Weather Toxicity



San Juan Creek (SJCL01 and SJNL01) Dry Weather Toxicity



San Clemente Coastal Streams (PDCM01 & SDCM02) Dry Weather Toxicity

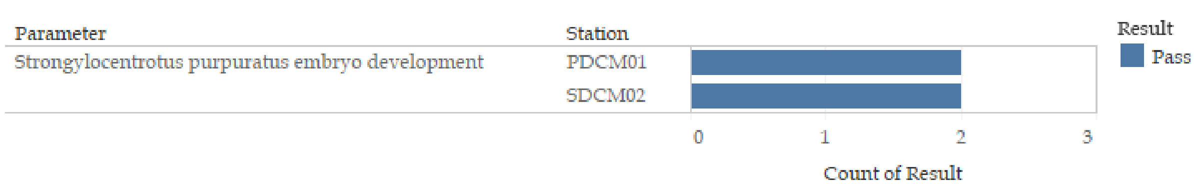
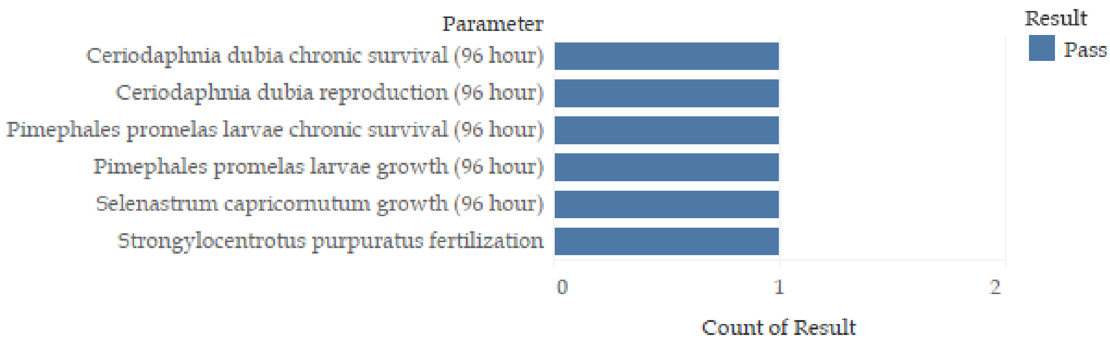
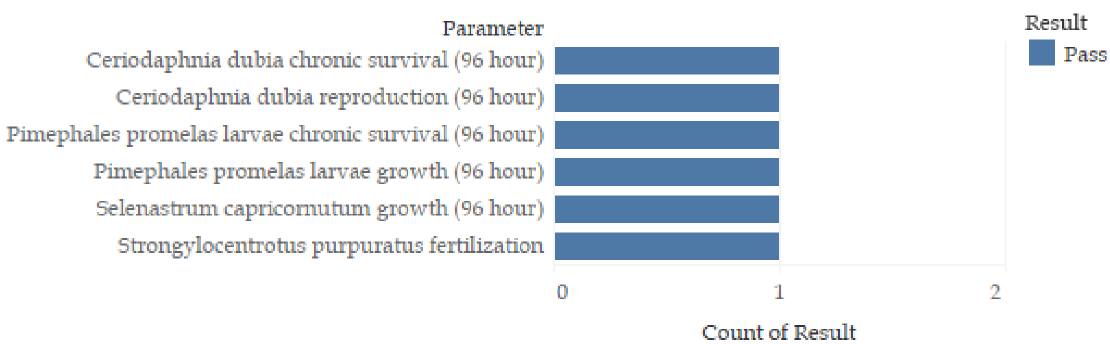


Figure 3.2: Patterns of Toxicity across the Region in Wet Weather, 2015-16
Charts include Mass Emissions data collected at ACJ01, LCWI02, TCOL02, PDCM01, and SDCM02. San Juan Creek was dry during the monitoring period. Samples were collected during two storm events in November 2016 and February 2017. Samples collected in November 2016 were mistakenly analyzed for *Strongylocentrotus purpuratus* fertilization.

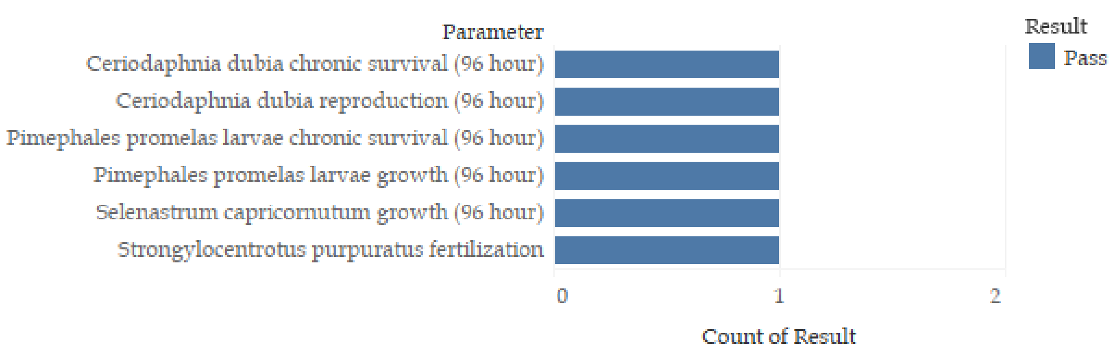
Aliso Creek (ACJ01) Stormwater Toxicity



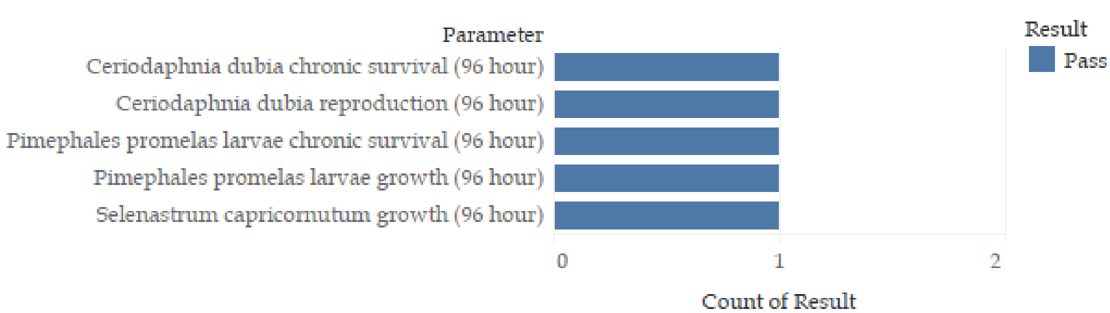
Laguna Canyon Wash (LCWI02) Stormwater Toxicity

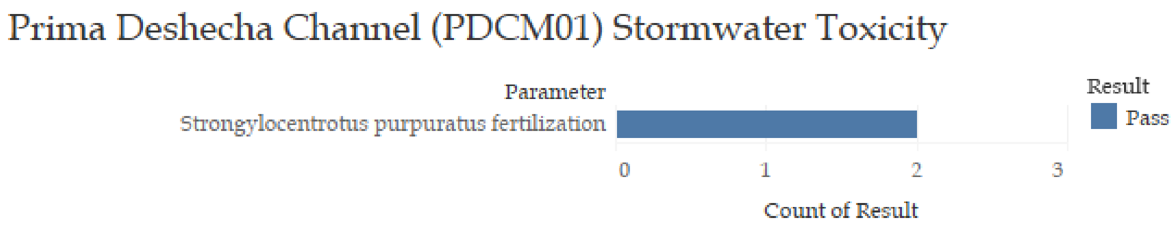


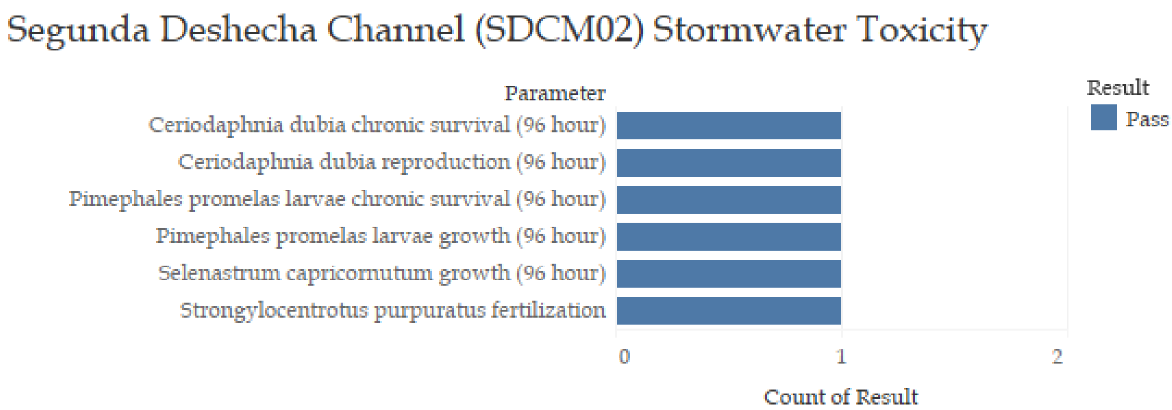
Trabuco Creek (TCOL02) Stormwater Toxicity



San Juan Creek (SJCL01 and SJNL01) Stormwater Toxicity







4 PESTICIDES

The standard suite of analyses at Mass Emissions sites in dry weather and stormwater samples includes pesticides. The pesticide analysis included organophosphate, synthetic pyrethroid, and carbamate pesticides. A overview of dry weather sampling results is incorporated into **Table 4.1** below. In general, exceedances for organophosphate pesticides were infrequent overall, with detections in 27% of (3 out of 11 samples) of dry weather samples. Bifenthrin was the most frequently detected pyrethroid pesticide, with 55% (6 out of 11 samples) of samples detected, followed by Cyfluthrin with 36% (4 out of 11 samples) detected. No carbamate results above reporting limits were observed at PDCM01 and SDCM02 during dry weather.

Table 4.1: Pesticides in Dry Weather (ng/L) at Mass Emissions Monitoring Sites, 2016-17

Organophosphates	Samples	Detections	Min (ng/L)	Max (ng/L)	Median (ng/L)
Chlorpyrifos	11	2	<1	29.3	<1
Dichlorvos	11	1	<6	53.5	<6
Pyrethroids					
Allethrin	11	2	<2	6	<2
Bifenthrin	11	6	<2	8.5	1.4
Cyfluthrin	11	4	<2	8.1	<2
Cypermethrin	11	1	<2	8.6	<2
Deltamethrin	11	2	<2	6.9	<2
L-Cyhalothrin	11	1	<2	7.8	<2
Prallethrin	11	2	<2	5.5	<2

Stormwater samples collected from first flush and the first 24 hour intervals were also collected and analyzed from the mass emissions stations. **Table 4.2** below summarizes stormwater pesticide results.

Table 4.2: Pesticides in Stormwater (ng/L) at Mass Emissions Monitoring Sites, 2016-17

Organophosphates	Samples	Detections	Min (ng/L)	Max (ng/L)	Median (ng/L)
Malathion	24	4	<6	1131.4	<6
Pyrethroids					
Bifenthrin	24	23	<2	513.5	26.8
Cyfluthrin	24	19	<2	436.3	4.3
Cypermethrin	24	14	<2	26.8	2.4
Deltamethrin	24	11	<2	123	<2
L-Cyhalothrin	22	5	<2	118.7	<2

*Medians calculated using full detection limit values.

For 2016-17, Malathion was detected in 4 of 24 samples (16%) Malathion is the most frequently detected organophosphate pesticide. Concentrations of Malathion ranged from < 6 to 1131.4 ng/L (parts per trillion). No other Organophosphate pesticides were detected in stormwater in 2016-17. The synthetic pyrethroid pesticide group was detected nearly six times as often as the organophosphate pesticides group during storm events. Among the pyrethroid pesticides constituents monitored, Bifenthrin and Cyfluthrin were detected most frequently at 96% and 79% respectively. Cis- and Trans-Permethrin isomers were not detected in samples collected from 2016-17. As with the dry weather sample results, carbamate pesticides were not detected above the laboratory reporting limit in the 4 stormwater-influenced samples collected from Prima and Segunda Deshecha channels.

APPENDIX C
URBAN STREAM BIOASSESSMENT

1 INTRODUCTION

This section reviews results and findings of the Urban Stream Bioassessment Monitoring Program, which consisted of field monitoring during the spring and summer of 2017 by the Permittees. Bioassessment monitoring is a means of assessing the biological quality of aquatic habitat by evaluating the assemblage of benthic macroinvertebrates (BMIs). Each site is rated on its ecological structure and taxonomic completeness by using the California Stream Condition Index (CSCI), which is a scoring tool that evaluates the biological condition of a site based on a statistical distribution of the conditions for reference sites in California (see the following link for the CSCI Fact Sheet and technical memo: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/883_CSCI-StatewideBioScoringTool.pdf).

The CSCI is calibrated so that the 50th percentile of reference sites is 1, and sites that approach 0 demonstrate a significant departure from reference conditions. **Section 2 Regional Monitoring** presents the CSCI scores for 2017 monitoring locations. BMI collection is just one of the multiple lines of evidence performed at each site. Physical habitat condition, algae assemblages, water chemistry, and in some cases, water and sediment toxicity are analyzed as well. The 2017 chemistry and toxicity data for the bioassessment program can be referenced at the following link: https://ocgov.box.com/v/201617-TMAR-Datasets.

2 REGIONAL MONITORING

In 2009, the Permittees began participating in a regional bioassessment monitoring program sponsored by the Southern California Stormwater Monitoring Coalition (SMC) and managed by the Southern California Coastal Water Research Project (SCCWRP). This program was designed to assess stream health using the resident stream BMIs to determine the biological conditions within a stream reach. The "SMC Program," as it is known, is based on a probabilistic sampling design that allows the ambient condition of streams in southern California to be assessed and compared to stream systems in watersheds with similar conditions and land use. The original five-year study spanned 2009 through 2013 with 2014 being a transitional year. The goal of this multi-agency program is to:

1. Determine the status of BMI conditions across southern California streams;
2. Identify key stressors that affect stream BMI conditions; and,
3. Monitor receiving water stressors over time.

Stream monitoring sites are stratified into urban, open space, and agricultural land uses to provide a better assessment across stressor gradients from chemical, biological, and physical influences.

The 2014 sampling effort was the sixth year after the original five-year study to assess stream macroinvertebrate conditions across southern California, which represented a transitional year for the regional program by expanding the original five-year period and preparing the program for its next five year monitoring cycle. The report on the first five years of the SMC Program can be found at the following link:
http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/844_SoCalStrmAssess.pdf

The second SMC Program five-year study began in 2015 and will span through 2019. The core questions from the original study have carried over with modifications to the program that reflect what was learned and what still needs additional understanding from the first five years. There has been a reduction in water quality analysis by eliminating metals, pesticides, and toxicity since these have not been correlated to the health of BMI assemblages. The new study emphasizes nutrients and elevated major ions as these have statistically shown to be drivers of impaired biology. The technical report for the current five-year study can be found at the following link:
http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/849_SMCWorkplan2015.pdf

Several new methods have been introduced to quantify effects on biological integrity since 2015. New field components include channel modification, hydromodification, vertebrate identification, and flow regime, which are reported to SCCWRP through the SMC Stream Data Submission webpage. Furthermore, a new experimental procedure was introduced in 2016 to assess algae taxonomy. DNA extractions were performed in coordination with SCCWRP and California State University, San Marcos as a potentially new taxonomic method. Contaminants of emerging concern (CECs) were sampled at trend sites in 2015 and 2016 as a SCCWRP special study, but this effort was discontinued in 2017.

SCCWRP has also generated a new probabilistic site draw to use for this study. For the first time, non-perennial and first order streams have been included in the site draw. The SMC Program requires two condition sites to be sampled every year in the San Diego Region, with a new set of two sites changing each season. There is also a requirement for two developed trend sites and one open trend site to be revisited each year of the study. These sites are intended to be static and not change unless there are undesirable flow conditions or accessibility issues. It is important to note that trend sites are not necessarily limited to the San Diego Region of Orange County as the SMC probabilistic site draws for trend sites are shared with the Santa Ana Region of the SMC Program. For 2017, the San Diego Region had two developed trend sites (stations SMC00206 and SMC00873, see **Table 2.1**, **Figure 2.1** below). Conversely, the open trend site was in the Santa Ana Region for 2015 through 2017, and likely will be for the remainder of the five-year study based on the seasonal flow condition and accessibility of this station.

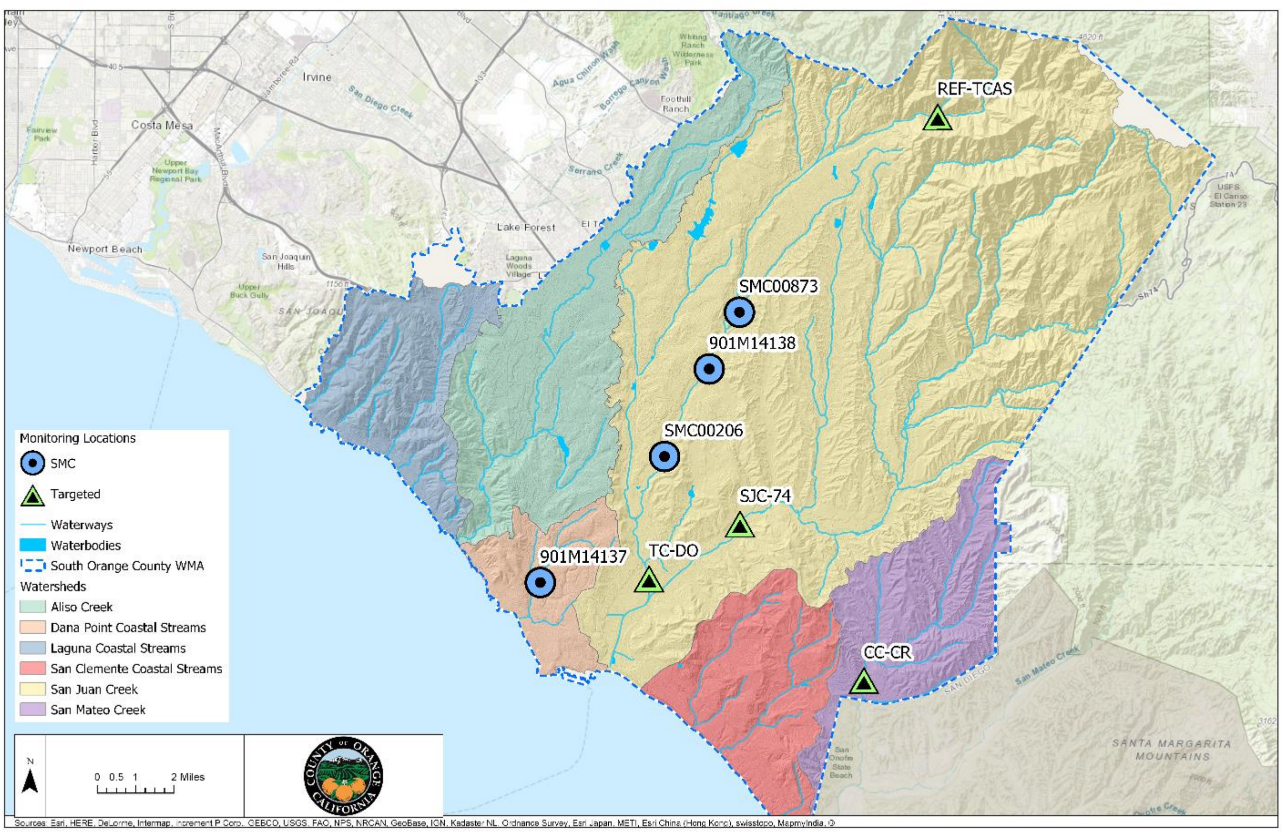
In addition to the SMC Program, the Permittees also perform bioassessment at ten NPDES targeted stations. Historically, these ten stations were monitored every year provided there was sufficient flow and accessibility. The Fifth Term Permit requires the ten stations to be monitored a minimum of one time over the duration of the permit term. The Permittees will revisit certain stations if there is a desire and interest to collect additional data, depending on the station. Five targeted stations were sampled in 2017 (see **Table 2.1**, **Figure 2.1** below). Targeted stations follow all of the SWAMP bioassessment protocols, however, unlike SMC stations, CRAM is not performed at the targeted stations. Grab samples for water chemistry mirror the mass emissions program list, and toxicity is monitored using the Test for Significant Toxicity (TST) method for *Ceriodaphnia dubia*, *Pimephales promelas*, *Selenastrum capricornutum* growth, and *Strongylocentrotus purpuratus* embryo development.

Table 2.1 and **Figure 2.1** below describe the bioassessment monitoring sites sampled during the April to June 2017 index period. A total of nine sites were visited in 2017: four as part of the SMC Program, and five sites (CC-CR, REF-FC, REF-TCAS, SJC-74, and TC-DO) as part of the NPDES targeted stations. REF-FC is located in Fremont Canyon north of Irvine Lake in the Santa Ana Region. This was site was selected as a reference station with elevated dissolved solids, which are typically ephemeral streams in the San Diego Region of Orange County.

Table 2.1: Receiving Water Locations for Bioassessment Monitoring Program Table. The table displays 2017 monitoring stations, stream name, sample date, and coordinates.

Station	Station Description	Sample Date	Latitude	Longitude
CC-CR	Christianitos Creek	10-Apr-17	33.45943	-117.56869
REF-FC	Fremont Canyon Creek	10-Apr-17	33.79102	-117.71934
REF-TCAS	Trabuco Creek	1-Jun-17	33.67407	-117.53834
SJC-74	San Juan Creek	1-Jun-17	33.51926	-117.62524
TC-DO	Trabuco Creek	22-Jun-17	33.49810	-117.66594
SMC00873	Tijeras Creek	12-Apr-17	33.59849	-117.62668
901M14137	Salt Creek	20-Jun-17	33.49418	-117.71660
901M14138	Trabuco Creek	20-Jun-17	33.57688	-117.64000
SMC00206	Trabuco Creek	22-Jun-17	33.54359	-117.65964

Figure 2.1: Receiving Water Locations for Bioassessment Monitoring Program Map. The map depicts 2017 monitoring stations in the San Diego Region within each watershed boundary. Note that station REF-FC is not depicted as it is north of Irvine Lake.

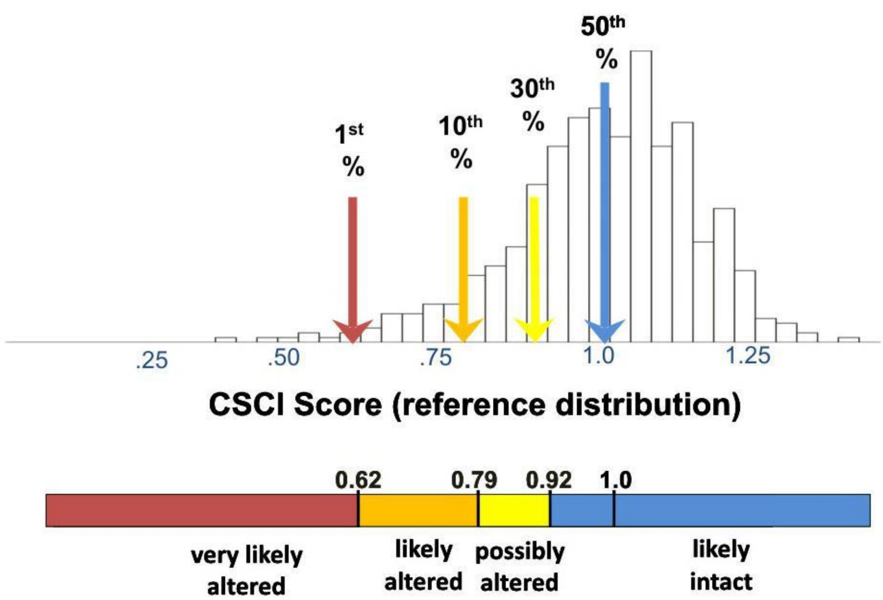


Biological integrity data analysis was conducted for the 2017 monitoring activities by using the CSCI. The following section details the CSCI scores for the stations monitored as part of the Regional SMC Program and targeted stations in 2017. **Appendix A. Monitoring Approaches and Methods** includes additional information on the methods used to develop this analysis.

CSCI Results

The CSCI was created to address some of the limitations of previous biological indices, such as the Southern California Index of Biotic Integrity (SoCal IBI). Several stream types exist within California, and regional indices like the SoCal IBI did not accurately represent the wide variation of reference conditions and climate regions. The CSCI was developed with a robust dataset of these reference locations and conditions to allow for representative biological benchmarks. Two indices are combined to create the CSCI, each quantifying different biological conditions of a stream: a multi-metric index (MMI) that measures ecological structure and function, and an observed-to-expected (O/E) index that measures taxonomic completeness. These indices are averaged to provide more comprehensive lines of evidence. Scoring of reference conditions has been calibrated so the 50th percentile is 1, and sites that begin to approach 0 demonstrate a significant departure from reference condition. A minimum threshold has not been established. **Figure 2.2** displays the CSCI scoring distribution with thresholds and condition categories. A SWAMP technical memo is available detailing the creation, scoring, and calculations of the CSCI at the following link:
http://www.waterboards.ca.gov/water_issues/programs/swamp/bioassessment/docs/csci_tech_memo.pdf

Figure 2.2: CSCI Scoring Distribution. This figure displays the scoring distribution of reference sites that were used to create the CSCI. Scoring thresholds and condition categories are included.



The CSCI, observed-to-expected (O/E) index, and the multi-metric index (MMI) scores for the nine sites collected in 2017 are presented in **Table 2.2** and **Figure 2.3** below. **Table 2.3** explains the six metrics that constitute the MMI, as well as their relative response to impairment.

CSCI scores ranged from 0.33 at station TC-DO located in a highly modified flood control channel (Trabuco Creek) to 0.93 at station REF-TCAS located in a reach of upper Trabuco Creek in Trabuco Canyon, which is a natural riparian area in a reference location. This station is a great example of the importance of habitat complexity as it is characterized by a steep gradient, cool natural flows, cobbles and boulders of varying size, and woody debris. Subsequently, it scored in the "likely intact" condition category. All other stations scored in the "likely altered" or "very likely altered" ranges (CSCI < 0.79) with the exception of 901M14138 (Trabuco Creek, CSCI score 0.83). This station has a relatively large amount of cobbles, instream vegetation, and a wide buffer zone for an urban stream.

An examination of the MMI and O/E indices provides greater detail, and O/E values are consistently higher than the MMI with the exception of REF-FC (Fremont Canyon) and 901M14137 (Salt Creek). The habitat complexity at Fremont Canyon was found to be impacted by sand dominating the substrate. Salt Creek is impacted by known issues of hydromodification and pesticides. Both of these stations are characterized by elevated dissolved solids, especially in Salt Creek. One noteworthy station is 901M14138 (Trabuco Creek), which scored relatively poorly on the MMI at 0.64 (2nd percentile), but had much better biological condition given the comparator sites with an O/E score of 1.03 (57th percentile). As previously mentioned, the physical habitat for this station has good complexity, as shown in **Figure 2.4** below, especially for a middle watershed location. Also of interest is the highest scoring station (REF-TCAS), which had the best scores for clinger, EPT, and intolerant taxa. SMC00206 was the only other station that identified intolerant taxa, which are almost exclusively found in reference and minimally disturbed locations. Conversely, TC-DO had poor diversity and was dominated by two tolerant taxa, the snail *Physa* and the crustacean Ostracoda. These stations are good examples that the individual indices, sub-metrics, and taxonomy should be examined to better understand the dynamic biological environment.

Furthermore, dissolved solids have shown to impact biology in reference locations. REF-FC is tucked away in secluded Fremont Canyon, yet the CSCI score was only 0.52, which is incredibly low for a station this rural. While there are elevated sands and fines, which certainly reduce the habitat complexity, so too are the dissolved solids. This certainly played a role in driving down not just the MMI (0.71, 5th percentile), but especially the O/E (0.34, 0.00 percentile).

It is important to stress there is not an established minimum disturbance threshold for the CSCI, however low values should be considered indicative of degradation. Furthermore, the CSCI percentiles show how similar the biological condition is for a given site compared to the distribution of reference sites it was compared against. For example, station REF-TCAS is similar in biological condition to the 32nd percentile of sites in the reference distribution to which it was compared. In contrast, seven of the other eight stations are located in modified streams, have water chemistry with elevated dissolved solids, or both, and fell outside the reference distribution of likely intact or possibly altered condition categories (percentile scores < 0.10). The exception was station 901M14138, which was comparable to 15% of the reference distribution (CSCI 0.83) and has a relatively complex habitat for an urban stream.

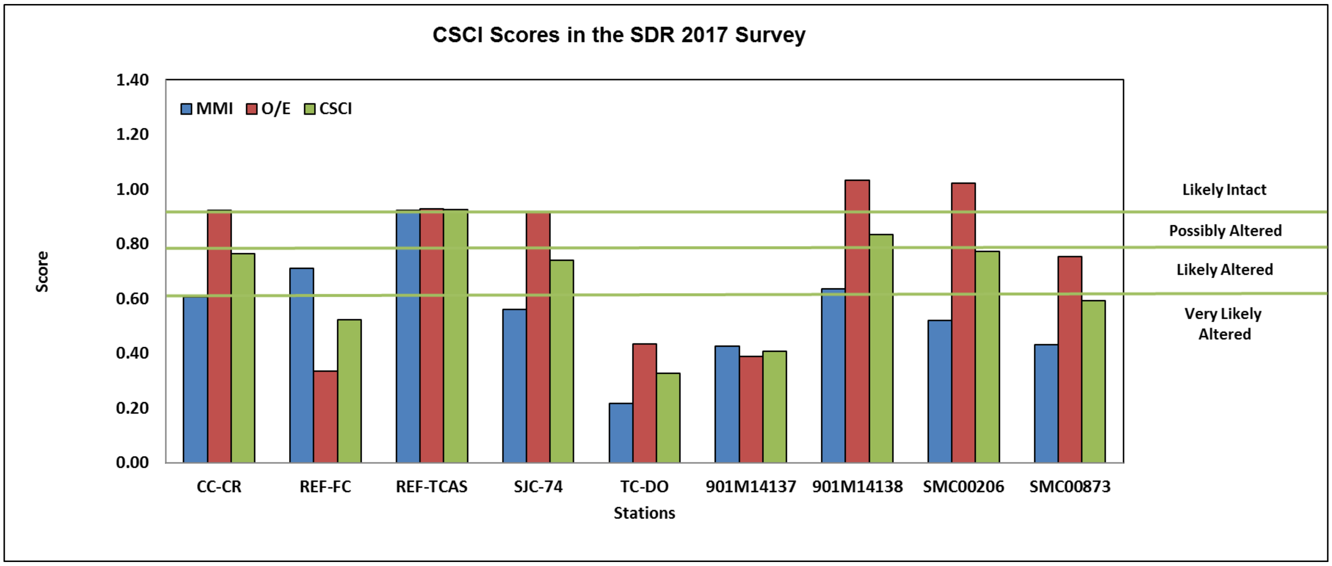
Table 2.2: CSCI Scores and Metrics for Sites Monitored in the San Diego Region, 2017. The CSCI is the average of the O/E and MMI indices. The percentile of the CSCI scores is relative to the reference distribution of sites they were compared to for the analysis. Station REF-TCAS in upper Trabuco Creek had a CSCI score of 0.93, which was the highest score for the stations monitored in 2017. It is located in a natural riparian area in a reference location.

CSCI Scores and Metrics 2017									
CSCI	CC-CR Christianitos Creek	REF-FC Fremont Canyon Creek	REF-TCAS Trabuco Creek	SJC-74 San Juan Creek	TC-DO Trabuco Creek	901M14137 Salt Creek	901M14138 Trabuco Creek	SMC00206 Trabuco Creek	SMC00873 Tijeras Creek
CSCI									
CSCI Score	**0.76**	**0.52**	**0.93**	**0.74**	**0.33**	**0.41**	**0.83**	**0.77**	**0.59**
CSCI Percentile	**0.07**	**0.00**	**0.32**	**0.05**	**0.00**	**0.00**	**0.15**	**0.08**	**0.01**
CSCI Category	**Likely Altered**	**Very Likely Altered**	**Likely Intact**	**Likely Altered**	**Very Likely Altered**	**Very Likely Altered**	**Possibly Altered**	**Likely Altered**	**Very Likely Altered**
MMI Metric									
% Clinger Taxa	33	26	45	24	0	38	23	22	27
% Coleoptera Taxa	7	0	5	7	0	0	9	9	0
Taxonomic Richness	13	5	21	14	10	12	20	20	6
% EPT Taxa	28	39	54	27	0	8	31	20	18
Shredder Taxa	0	1	2	0	0	1	0	1	0
% Intolerant	0	0	5	0	0	0	0	1	0
MMI Score	**0.61**	**0.71**	**0.92**	**0.56**	**0.22**	**0.43**	**0.64**	**0.52**	**0.43**
MMI Percentile	**0.01**	**0.05**	**0.33**	**0.01**	**0.00**	**0.00**	**0.02**	**0.00**	**0.00**
O/E									
Mean Observed Taxa	8	4	6	7	4	3	8	8	6
Expected Taxa	8	12	6	8	8	8	8	8	8
O/E	**0.92**	**0.34**	**0.93**	**0.92**	**0.43**	**0.39**	**1.03**	**1.02**	**0.75**
O/E Percentile	**0.34**	**0.00**	**0.35**	**0.33**	**0.00**	**0.00**	**0.57**	**0.55**	**0.10**

Table 2.3: Descriptions of the Six MMI Metrics. The MMI's six metrics represent different aspects of BMI assemblage composition and function. All of the taxa associated with each metric respond poorly to impaired habitat.

MMI Metric	Description	Response to Impairment
% Clinger Taxa	Percent of taxa that are adapted for attachment to surfaces in flowing water.	Decrease
% Coleoptera Taxa	Percent taxa from the insect order coleoptera.	Decrease
Taxonomic Richness	Total number of individual taxa.	Decrease
% EPT Taxa	Percent taxa in the orders Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly).	Decrease
Shredder Taxa	Number of taxa that shreds coarse particulate matter.	Decrease
% Intolerant Individuals	Percent of organisms in the sample that are highly intolerant to impairment as indicated by a tolerance value of 0, 1, or 2.	Decrease

Figure 2.3: CSCI, O/E and MMI Scores for Sites Monitored in the San Diego Region, 2017. This figure displays the tabular data for the O/E, MMI, and CSCI from **Table 2.2**. Green lines denote scoring thresholds at the 1st, 10th, and 30th percentiles.



Research and usage of the CSCI scoring system is expected to increase in the future as it has become the standard scoring index used by the SMC as well as other State bioassessment programs, such as SWAMP's Perennial Streams Assessment (PSA). Additional context and historical analysis of the San Diego Region bioassessment program using the CSCI can be found in **Section 3 Spatial Pattern Analysis**.

Physical Habitat and CRAM Methods

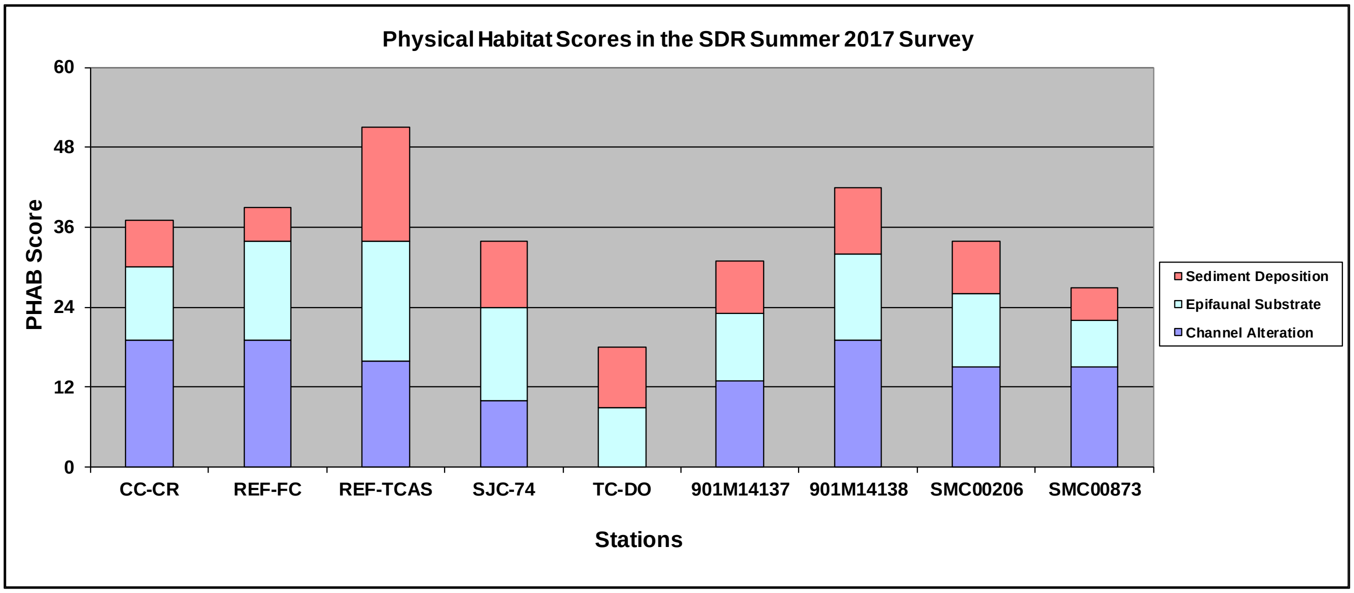
The bioassessment field data collection (benthic macroinvertebrates, algae, physical habitat) were conducted according to SWAMP protocols which can be found at the following link: http://www.waterboards.ca.gov/water_issues/programs/swamp/bioassessment/docs/combined_sop_2016.pdf

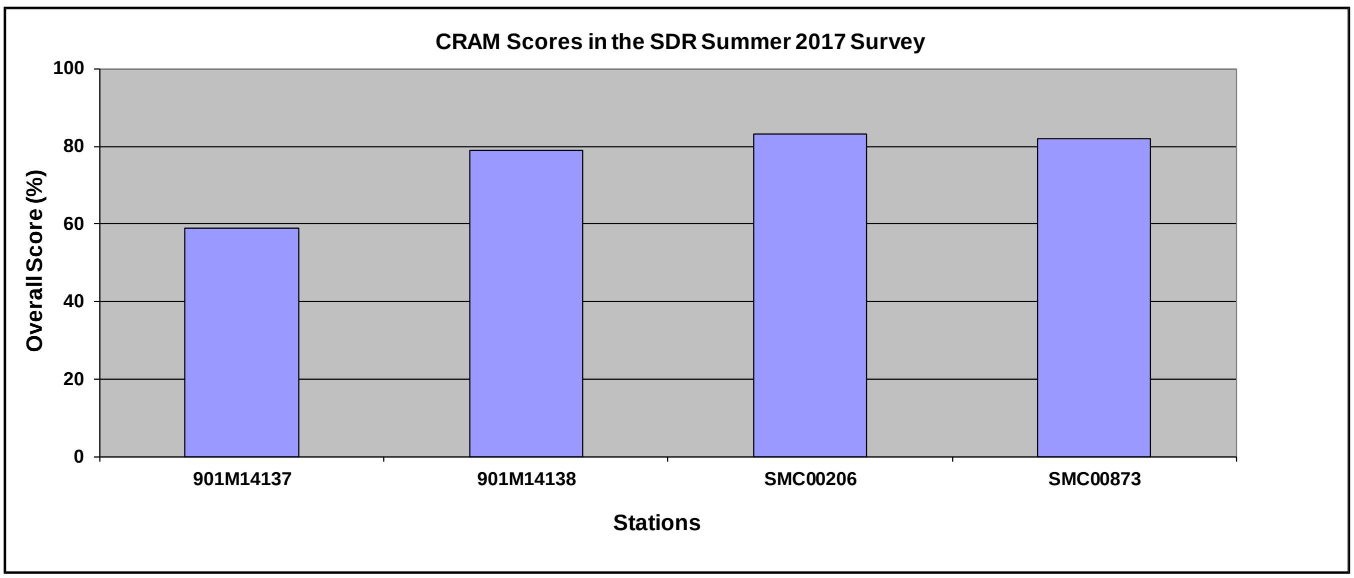
In addition to the SWAMP in-stream physical habitat condition measurements, the SMC Program also specifies that the California Rapid Assessment Method (CRAM) be conducted at each site. This protocol provides an assessment of not only the instream habitat condition, but also of hydrology and a larger buffer zone surrounding the site, including the biotic structure of the riparian zone. Details of the protocols for CRAM assessments can be found at the following link: http://www.cramwetlands.org/.

Physical Habitat and CRAM Scoring

Monitoring results of the physical habitat (phab) assessments and CRAM scores for 2017 are presented in **Figure 2.4** below.

Figure 2.4: Physical Habitat and CRAM Scores in 2017. The first chart includes physical habitat condition, which correlates to the biological condition. Physical habitat is assessed at each site by determining how much sediment deposition there is in the stream bed (more sediment yields a lower score), the amount of epifaunal substrate cover (more cover yields a higher score), and the amount of channel alteration that has occurred (more alteration yields a lower score). Site REF-TCAS had the best overall physical habitat condition, which was reflected in the highest CSCI score. As portrayed in the site location map (**Figure 2.1**), this site is located in an upper watershed where habitat conditions are the most favorable. The other sites had moderate to poor scores with sediment deposition being the most common cause of impairment. California Rapid Assessment Method (CRAM) scores are included in the second chart for the SMC stations. CRAM provides a measure of streambed, riparian, buffer zone, hydrologic, and biotic condition, thus providing a wider assessment of physical habitat. The trend for this measure was marginally different than the physical habitat assessment, but was a decent indicator of the corresponding CSCI scores.





The physical habitat (phab) conditions for each of the SMC Program and targeted sites were assessed using three attribute scores (sediment deposition, epifaunal substrate, channel alteration) that are summed together to a total score ranging from zero (poorest condition) to 60 (best condition). REF-TCAS had the highest overall physical habitat score of 51, which was the same score at this location in 2015. As portrayed in the site location map (**Figure 2.1**), this site is located in the upper San Juan Creek watershed where habitat conditions are the most favorable. The other sites had poorer physical habitat conditions, with the exception of 901M14138, which had the second highest CSCI score of 0.83. Sediment deposition was the main driver of impaired habitat in 2017. Significant sands and fines can bury complex habitat that would be beneficial to diverse and sensitive benthic assemblages. It is possible that the large winter storms deposited an unusual amount of sands and fines. This increased deposition was observed at several stations, including rural locations such as REF-FC (Fremont Canyon) and CC-CR (Christianitos Creek). The California Department of Fish and Wildlife is currently creating an Index of Physical Habitat Integrity (IPI), which is a predictive index with similar structure to the CSCI. Next year's reporting cycle will include IPI analysis if it is ready for use.

CRAM assessment is important in determining stream health since it evaluates not only the condition of the instream habitat, but also the condition of the buffer zones surrounding the riparian zone out to 250 meters on either side of the stream. CRAM scores for the 2017 stations were not always consistent with physical habitat scores, thus the CSCI scores as well. This was the case at SMC00206 and SMC00873 which had excellent CRAM scores (83 and 82, respectively), but both were below the 10^{th} percentile of the CSCI reference distribution. Since CRAM does not weigh instream habitat as much as phab assessments, it is possible that sediment deposition was the driving factor. On the contrary, 901M14138 (Trabuco Creek) had significantly more cobbles in the stream bed, which was reflected in a CSCI of 0.83. 901M14137 (Salt Creek) lacks habitat complexity for a riparian site, and is characterized by high dissolved solids.

Attached Algae

Soft-bodied algae and diatom community structure can be used to assess many aspects of stream water quality including the effects of nutrient loading and other contaminants, such as dissolved metals and trace organics. The Southern California Coastal Water Research Project (SCCWRP) scientists have created the Southern California Algae Index of Biotic Integrity (SoCA Algal IBI) which is similar to the index used for BMIs by using algal taxonomy to assess anthropogenic impacts. Algae samples were collected from 2007 through 2010 at a total of 451 distinct southern California stream reaches to develop the IBI scoring system. The SoCA Algal IBI is composed of three indices: 1) a diatom IBI (D18) is based solely on diatom metrics; 2) a soft algae IBI (S2) is based solely on non-diatom (soft) algae metrics; and 3) a hybrid (H20) of both diatom and soft bodied algae metrics. IBIs are composed of metrics chosen for their ability to differentiate between reference and non-reference stream conditions. The SoCA Algal IBI metrics, IBI score, and quality control results were calculated using the SCCWRP SoCA Algal IBI calculator and its underlying R script. SCCWRP is currently in development of a new algal scoring tool called the Algal Stream Condition Index (ASCI). Modeled after the CSCI, this will be an additional line of evidence to assess biological stream health. It is anticipated that the next reporting cycle will include ASCI analysis.

Figure 2.5 and **Figure 2.6** below contain algae data from the three indices for the bioassessment sites sampled in 2016 and 2017. **Figure 2.5** contains the 2016 SMC algae data that was not available during the previous reporting cycle. The 2017 SMC Program algae data is still being analyzed and quality controlled by the State and should be ready in early 2018, thus the five targeted stations are the only sites reported for this sampling period (**Figure 2.6**). The H20 boundary chosen to delineate between reference and non-reference condition (57 on a scale from 0 to 100) was based purely on statistical grounds, and was calculated as two standard deviations below the mean distribution of reference sites. As a result, it does not represent an ecologically meaningful change point in community composition and cannot be used in a regulatory framework. An H20 score above 57 is considered reference condition, and below 57 is considered non-reference. The S2 and D18 indices do not have accepted scoring thresholds to date.

Figure 2.5 demonstrates that both reference location sites (REF-BC, Bell Creek) often score better than urban locations with the H20 index. **Figure 2.**6 shows that reference location sites (REF-FC, Fremont Canyon) can also score poorly with the H20, and in some cases even worse than urban sites. Further study and trend analysis should be completed before any conclusions can be made from these assessments. The aforementioned ASCI could assist with this effort in the future.

Figure 2.5: Algal IBI Scores, 2016. The figure displays the 2016 SoCA Algal IBI and the three indices for the seven monitored stations, four SMC and three targeted. S2 is a soft algae metric, D18 is a diatom metric, and H20 is a hybrid of the S2 and D18 metrics. The four SMC stations were 901M14126, 901M14134, SMC00206, and SMC00873.

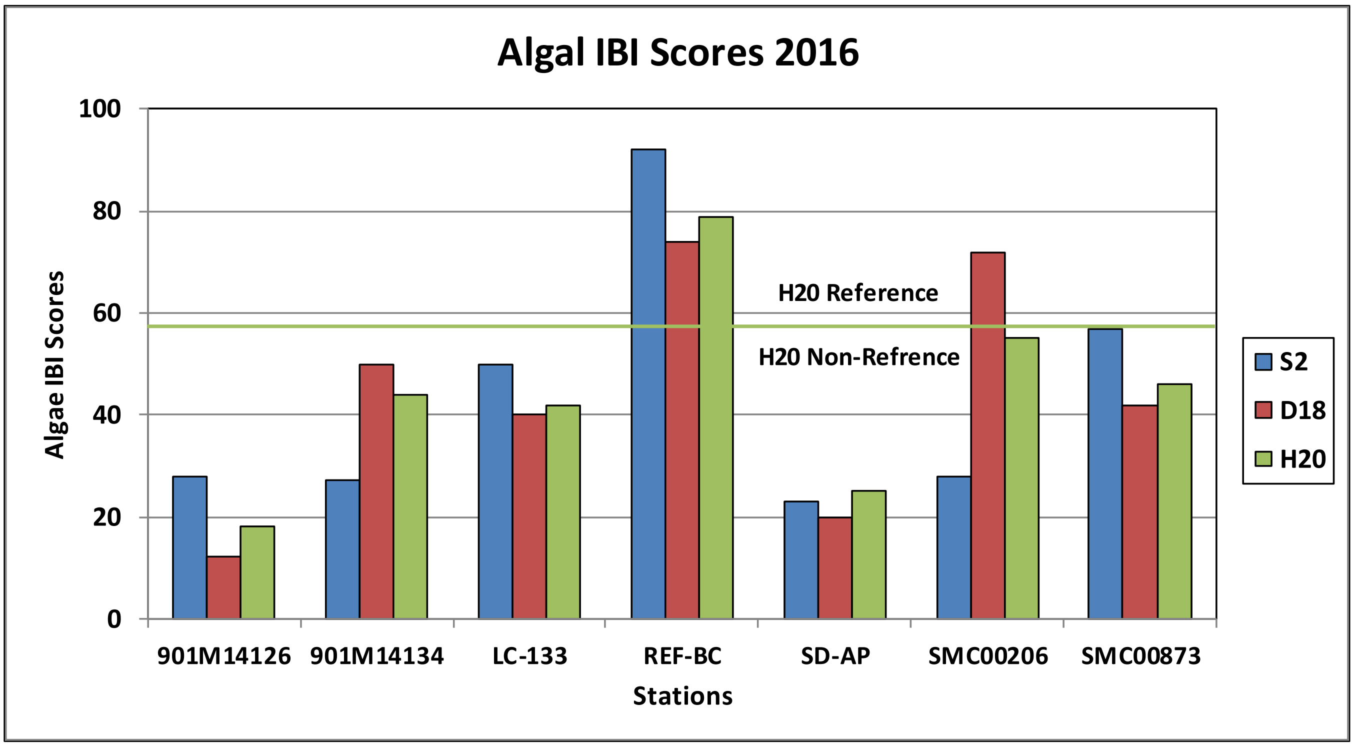
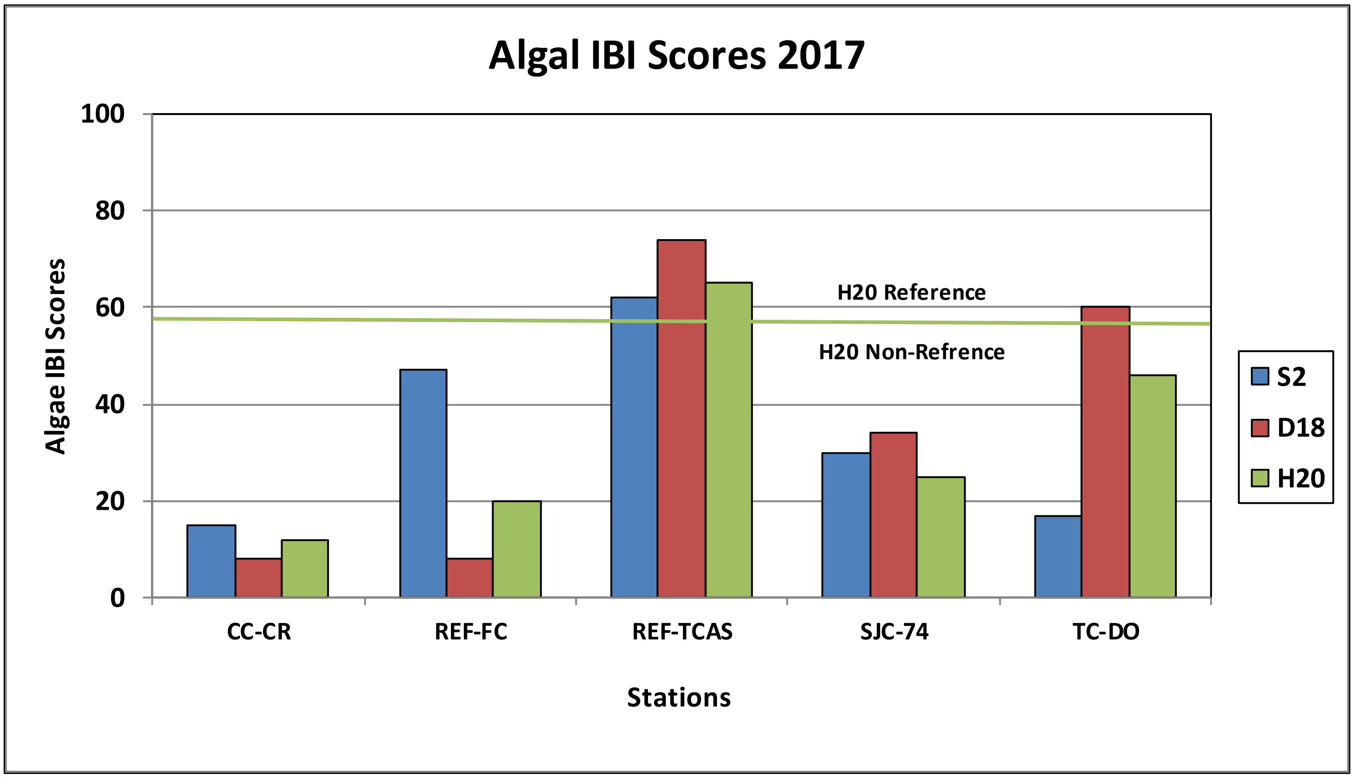


Figure 2.6: Algal IBI Scores, 2017. The figure displays the 2017 SoCA Algal IBI and the three indices for the five monitored targeted stations. 2017 results for SMC stations should be available in early 2018.



3 SPATIAL PATTERN ANALYSIS

In addition to describing patterns and trends in benthic macroinvertebrates, a further purpose of the SMC Program is to evaluate the triad of monitoring indicators to determine whether physical habitat, aquatic chemistry, and algae are correlated with CSCI scores. If strong correlations exist, then this would suggest the presence of a causal relationship between the various stressors and biological integrity. Previous analysis conducted by the SMC Program has shown that water chemistry and toxicity data do not have a strong correlation with impaired biology, thus the suspension of metals, pesticides, and toxicity collection in the water column (except with the long term targeted stations). Impaired and/or degraded physical habitat remains the strongest driver of lower CSCI scores.

The spatial pattern analysis of biotic integrity consists of five elements:

1. Spatial Distribution;
2. Relationship to Aquatic Chemistry and Toxicity;
3. Biological Cluster Analysis
4. Correlation with Algae; and,
5. Correlation with Metrics and Parameters

Spatial Distribution

Broad patterns exist in 2017 for interrelated indicators (i.e., CSCI and CRAM) and were mapped in **Figure 3.1** below. As with other years, impaired physical habitat is directly linked with undesirable benthic assemblages. These trends are most often seen in urbanized regions where streams are most susceptible to various anthropogenic impacts. **Figure 3.2** historically demonstrates consistently low CSCI scores across the urbanized portion of the County (CSCI < 0.79). Some sites in the upper San Juan Creek watershed had CSCI scores that were ≥ 0.79 indicating the health and diversity of biological communities at these locations were similar to those found at reference sites in the CSCI dataset. The physical habitat and surrounding riparian zones tend to be of better quality in these areas. This trend in more diverse and complex habitat is also captured by **Figure 3.3** which displays historical CRAM scores throughout the SMC Program.

Figure 3.1: Summary of Overall Conditions in 2017. This map depicts overall conditions observed at sites monitored in 2017. For this analysis, physical habitat was measured using the comprehensive California Rapid Assessment Method (CRAM) at the SMC stations.

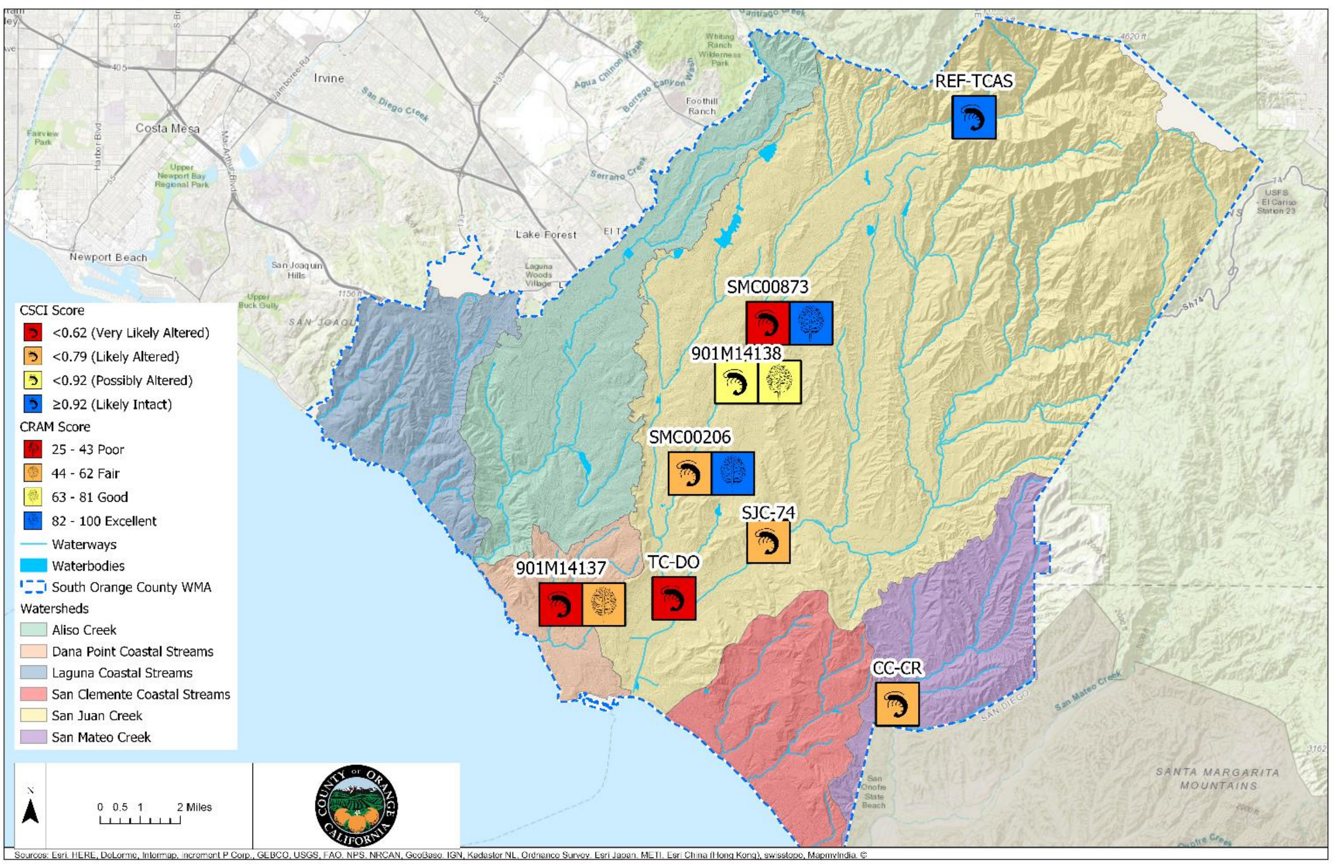
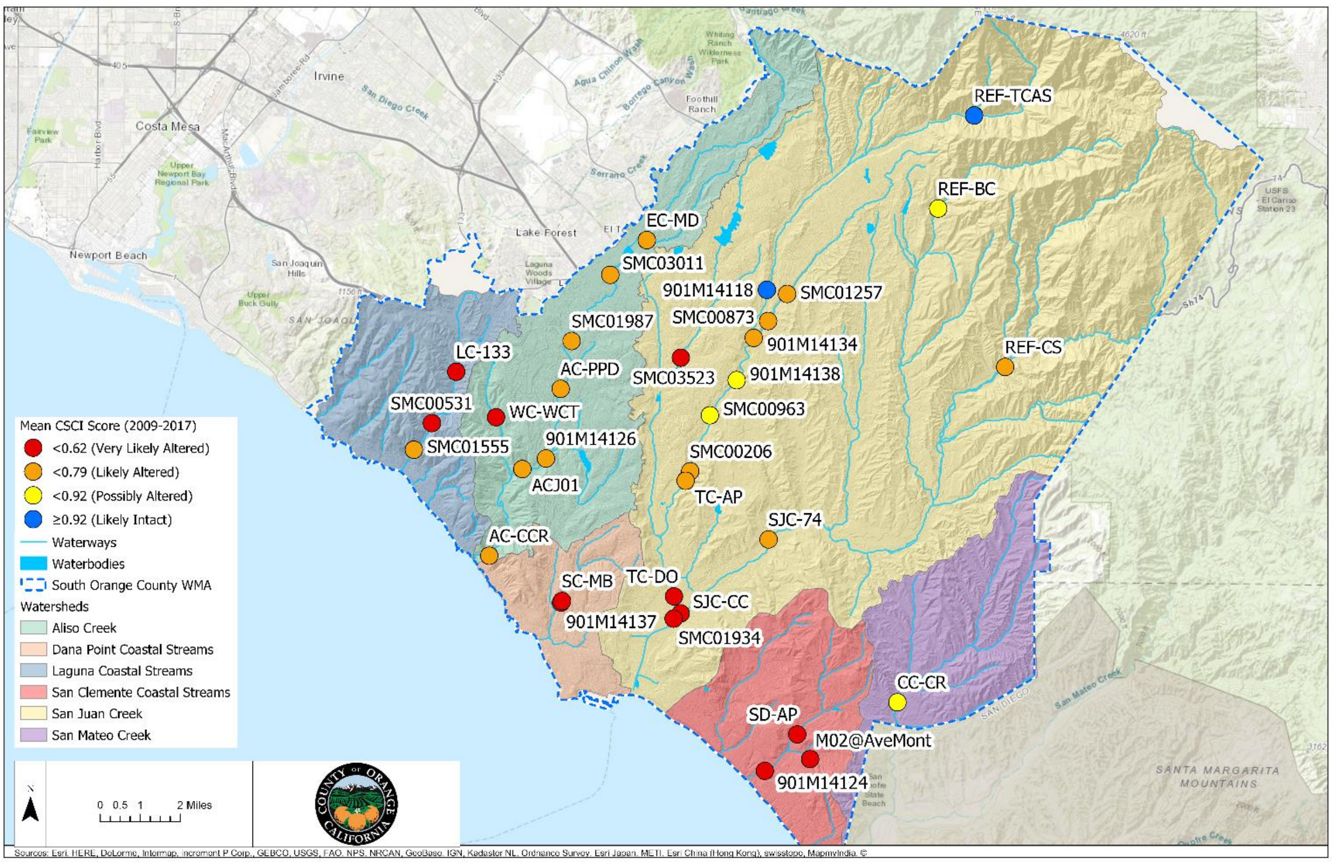


Figure 3.2: Patterns of CSCI Scores, 2009 - 2017. This map shows regional CSCI scores observed at targeted stations and as part of the SMC Program since inception in 2009. The color scheme for the scores has been adjusted from **Figure 2.2** to match the CSCI scale and condition categories used in the referenced SWAMP technical memo. Stations that have been sampled more than once during this period show the average CSCI score.



The CRAM scores perform much better in the San Juan Creek watershed, especially in the Trabuco and Tijeras Creek sub-watersheds, as shown below in **Figure 3.3**. These stations often have physical habitats that are dominated by strong canopy cover to keep the water temperature cooler, and to provide fallen debris in the stream for increased habitat complexity. Various woody debris and cobble rocks provide micro-habitats for “clinger” BMI’s, which are one of the six MMI sub-metrics and are more sensitive to impaired habitat. Some of the stations, especially on Tijeras Creek, have a large amount of sands and fines as the stream bed substrate. These impacts are not captured in CRAM assessments to the same extent as in the phab measurements. It is likely that the sandy benthos is limiting these stations from producing reference condition scores for the CSCI. Another trend with these locations is that certain geomorphic formations and groundwater sources are not as prominent, aiding in keeping the dissolved solids relatively lower at these stations. However, the other watersheds in the San Diego Region contain known high dissolved solid groundwater sources that impact benthic communities. Between 2009 and 2017, there was a fairly strong association between CSCI and CRAM scores (R^2 = 0.395) in these watersheds as shown in **Figure 3.4**. Stations with relatively good CRAM scores can have anomalously low CSCI scores due to high dissolved solids.

Figure 3.3: Patterns of CRAM Scores for the SMC Program, 2009 - 2017. This map shows overall CRAM scores observed in the SMC Program since its inception in 2009. Stations that have been sampled more than once during this period show the average CRAM score.

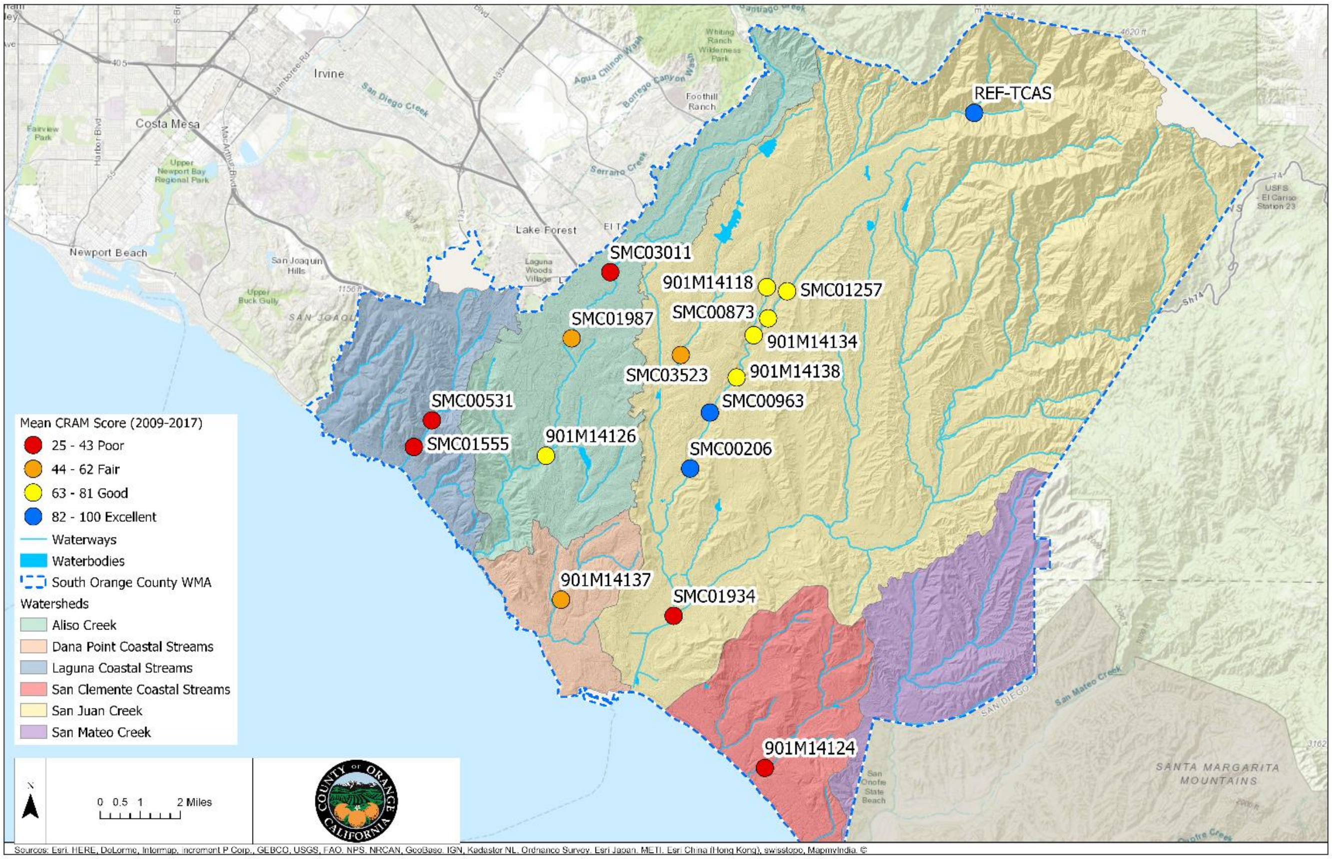
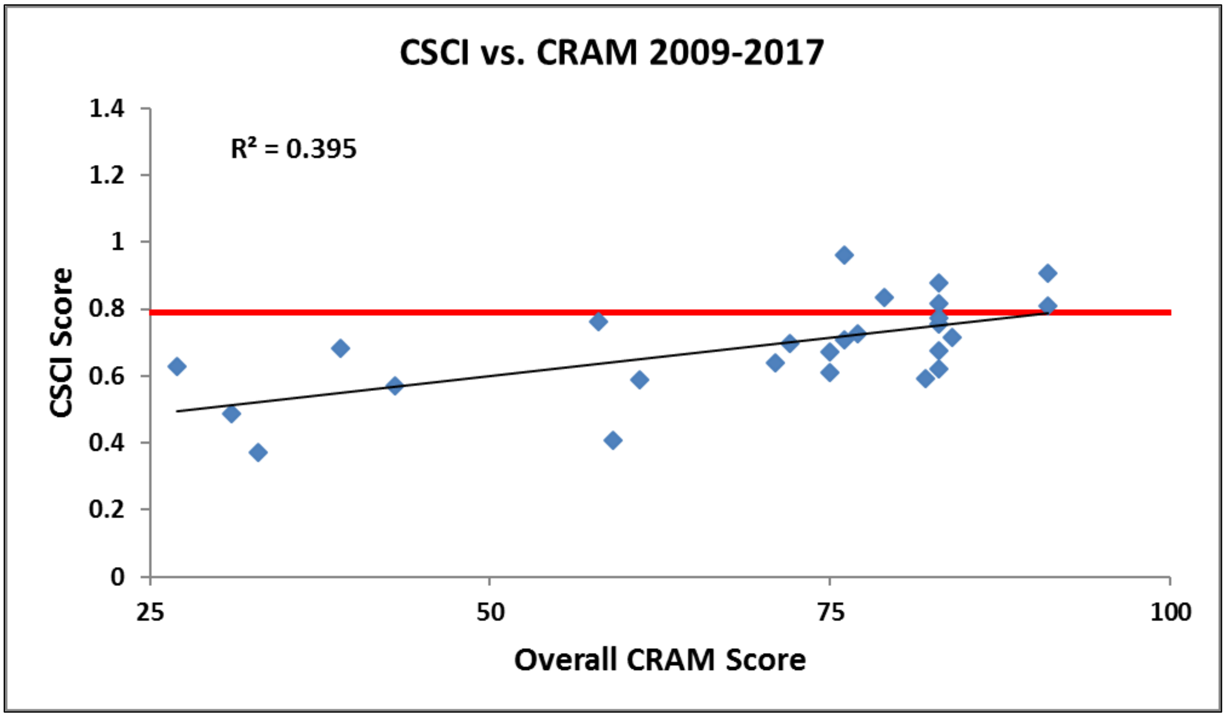


Figure 3.4: CSCI Score versus Overall CRAM Score. This graph shows the correlation between CRAM scores of the riparian and buffer zones surrounding a stream reach and the biological condition (CSCI score) through the 2017 sampling season. Correlations with biological condition nearing 0.4 or greater (R^2 = 0.395) are considered to be reasonably strong for this assessment. The red horizontal line indicates the 10th percentile of the CSCI (0.79), and scores below this line either fall in the likely or very likely altered condition categories.



Relationships to Aquatic Chemistry and Toxicity

Detailed monitoring data for aquatic chemistry and toxicity (toxicity at the targeted stations) were examined to determine whether there are any clear relationships to biotic integrity at a finer level of detail. No definitive relationships could be made between nutrient concentrations and CSCI scores. However, stations on streams with legacy geologic formations and/or groundwater sources (901M14137, REF-FC, and TC-DO) did have elevated dissolved solids, which more than likely contributed to the lower CSCI scores at these stations. It should be mentioned that these stations are also often characterized by hydromodification, channel alteration, or sediment deposition, so their physical habitat is also significantly impaired and certainly driving down the biotic integrity. Trying to determine the extent to which these factors have contributed to impaired biology is difficult to assess. Causal analysis could be considered to attempt to tease out the sources of impairments in these types of stream habitats. Trace metal CTR exceedances were not observed at the five targeted stations for both acute and chronic concentrations. Aquatic toxicity was not observed at these stations as well.

A more detailed analysis of the individual parameters monitored with a historical perspective can be seen in the Correlation with Metrics and Parameters section in **Figure 3.9** through **Figure 3.14**.

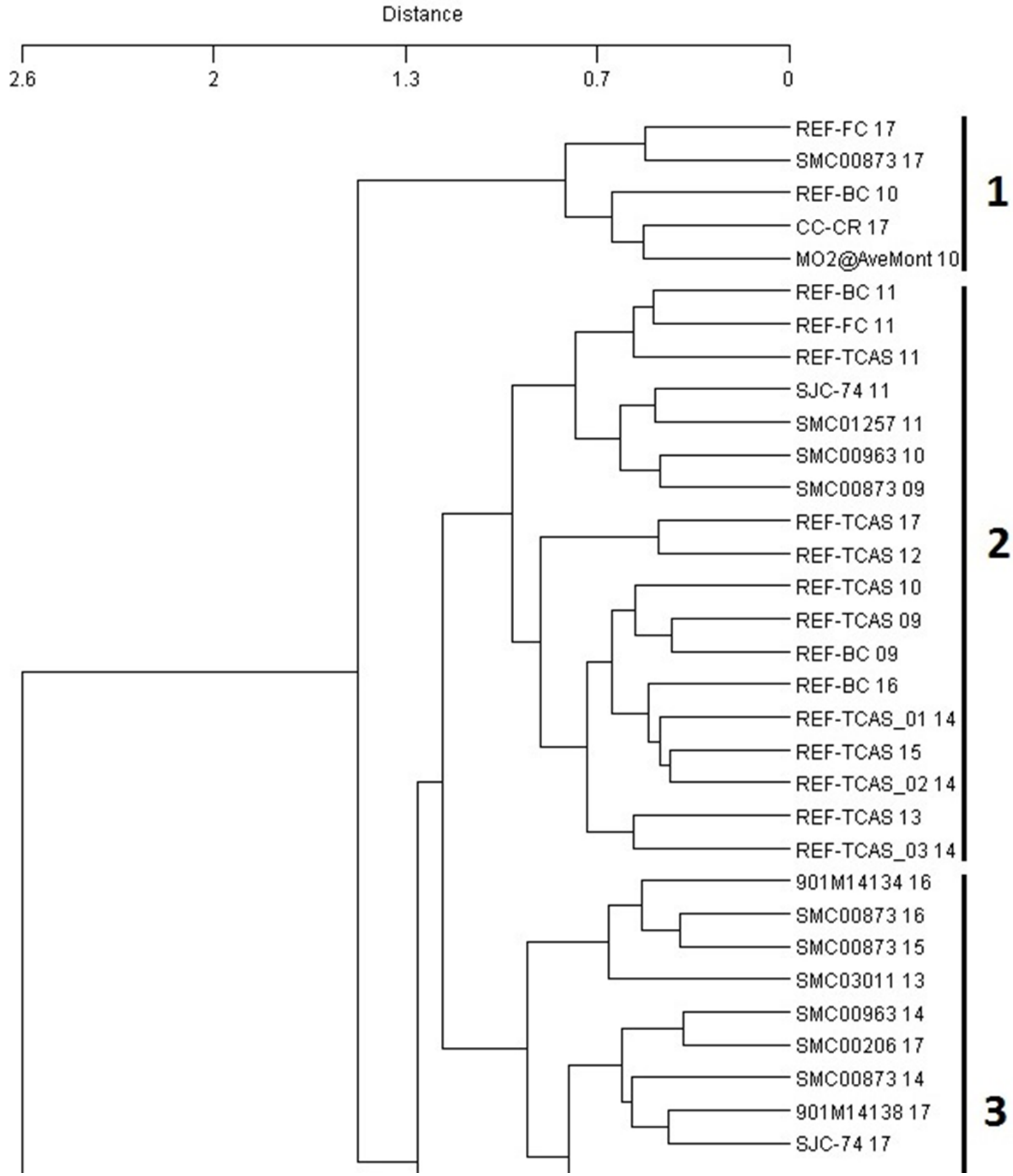
Biological Cluster Analysis

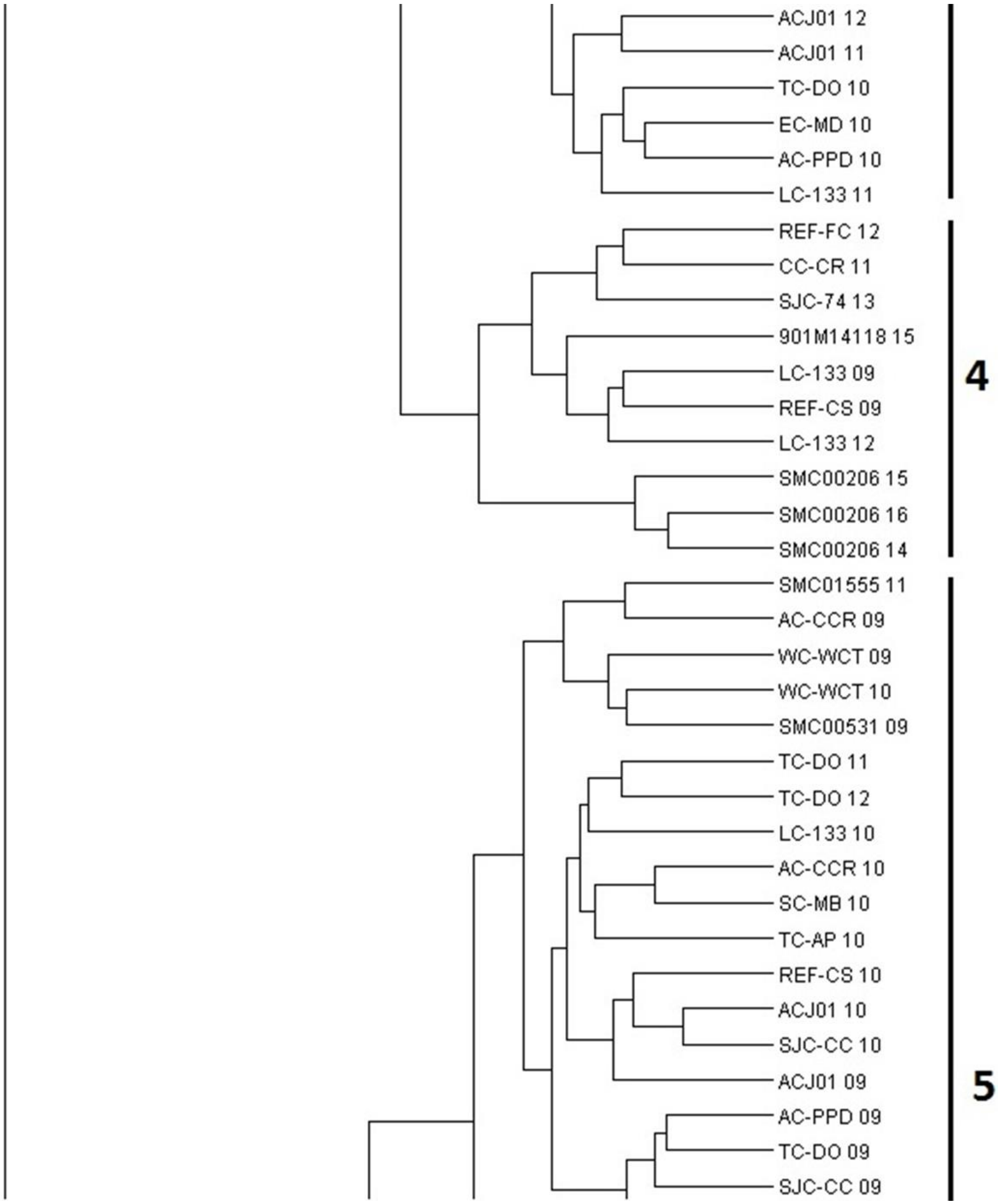
A more powerful set of analyses were used to discern relationships between the biological patterns in the benthic community and patterns in potential explanatory variables in physical habitat, aquatic chemistry, and aquatic toxicity, where sampled.

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. The dendrogram in **Figure 3.5** below shows the cluster analysis and groupings of all sites during surveys conducted from 2009 through 2017. Cluster analysis arranges sites that are similar to one another based on species composition and abundances. Sites that are near one another on a dendrogram node are similar to one another in terms of the BMIs collected at those locations. The clusters have years fairly evenly spread between them indicating that annual variation (i.e., drought years vs. wet years) was not as great a factor as location and habitat condition. Most of the sites in cluster Group 2 were located in the upper San Juan Creek watershed, especially Trabuco and Bell Creek, and have some of the best CSCI scores.

Figure 3.6 is the two-way coincidence table of the relative distribution of species at each site during each monitoring event. Horizontal and vertical lines on the two-way coincidence table identify major groupings of species and site locations, respectively. Sites are identified by their station number and year of sampling. Relative species abundances are shown as symbols in the table. Smaller symbols represent a lesser proportion of maximum abundance and larger symbols a greater proportion. The abundance of each species was standardized in terms of its maximum at each site over all surveys. Again, cluster Group 2 is dominated by upper San Juan Creek watershed site locations.

Figure 3.5: Dendrogram Analysis of Sites Surveyed in the San Diego Region, 2009 – 2017 (continued on the next two pages). Cluster analysis arranges sites that have similar BMI assemblages. Seven cluster groups represent the last nine years of the regional SMC Program and targeted stations. Data were square root transformed and distances between groups were calculated using the Bray-Curtis Similarity Index. Groups were defined by cluster analysis using a trimmed species list that excluded rare species.




ACJ01 12
ACJ01 11
TC-DO 10
EC-MD 10
AC-PPD 10
LC-133 11
REF-FC 12
CC-CR 11
SJC-74 13
901M14118 15
LC-133 09
REF-CS 09
LC-133 12
SMC00206 15
SMC00206 16
SMC00206 14
4
SMC01555 11
AC-CCR 09
WC-WCT 09
WC-WCT 10
SMC00531 09
TC-DO 11
TC-DO 12
LC-133 10
AC-CCR 10
SC-MB 10
TC-AP 10
REF-CS 10
ACJ01 10
SJC-CC 10
ACJ01 09
AC-PPD 09
TC-DO 09
SJC-CC 09
5

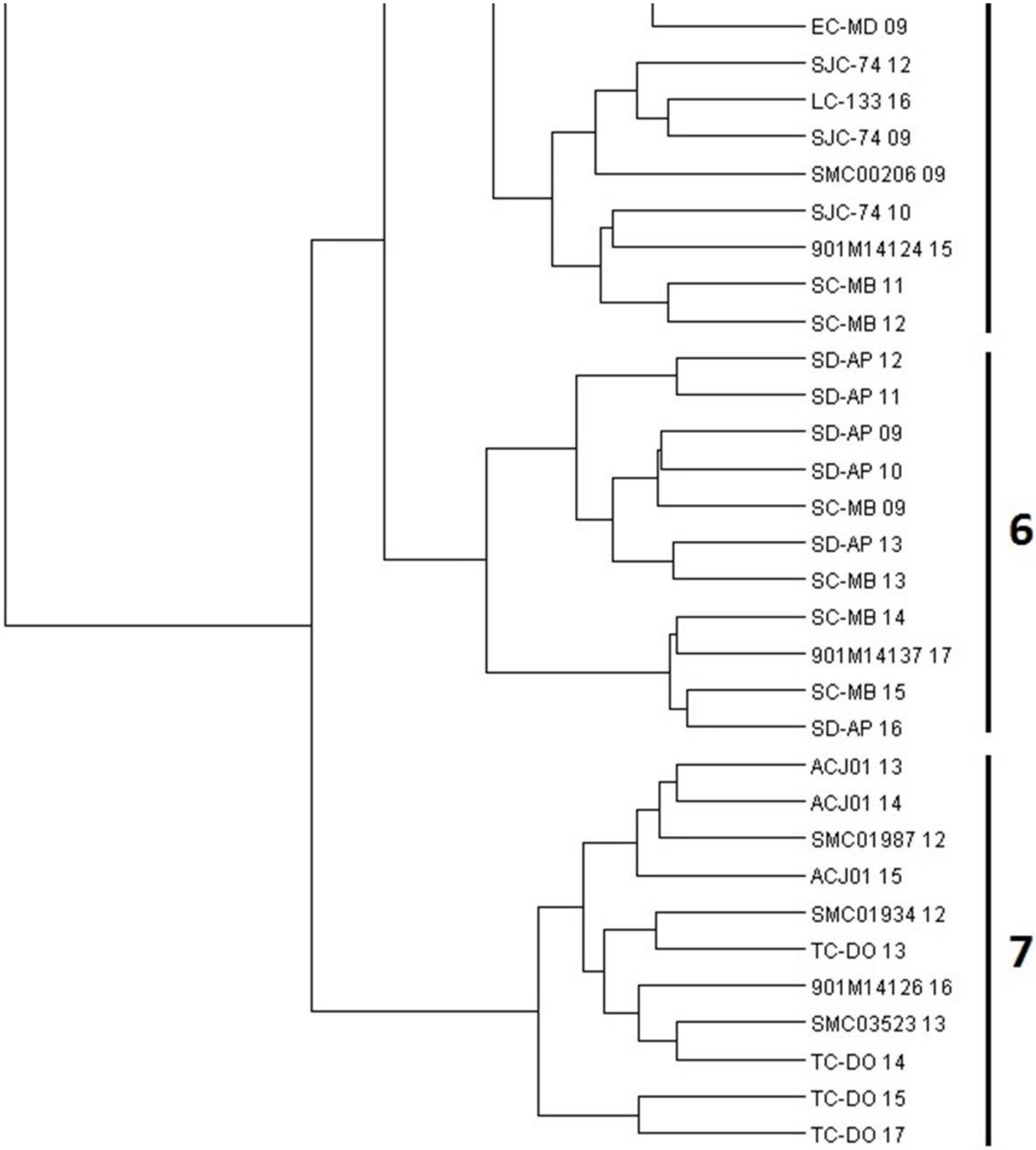
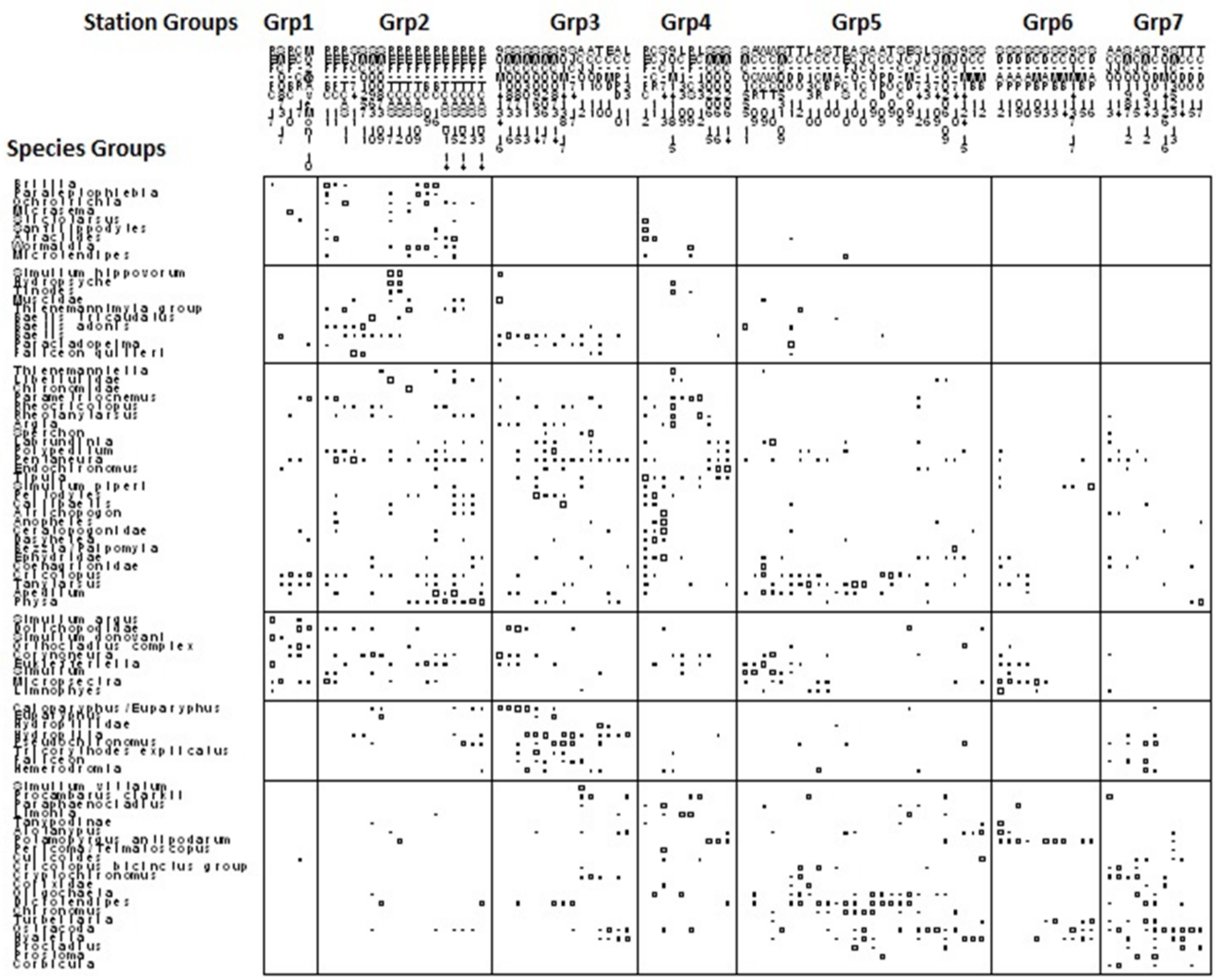

EC-MD 09
SJC-74 12
LC-133 16
SJC-74 09
SMC00206 09
SJC-74 10
901M14124 15
SC-MB 11
SC-MB 12
SD-AP 12
SD-AP 11
SD-AP 09
SD-AP 10
SC-MB 09
SD-AP 13
SC-MB 13
SC-MB 14
901M14137 17
SC-MB 15
SD-AP 16
ACJ01 13
ACJ01 14
SMC01987 12
ACJ01 15
SMC01934 12
TC-DO 13
901M14126 16
SMC03523 13
TC-DO 14
TC-DO 15
TC-DO 17
6
7

Figure 3.6: Two-Way Coincidence Table of Sites Surveyed in the San Diego Region, 2009 – 2017. The two-way coincidence table is simply a different way of looking at the cluster analysis. The same seven cluster groups of stations are depicted along the horizontal axis, while the species clusters are depicted along the vertical axis. The symbols in the graph show the relative abundance of each species and how important they are at a given site. Group A includes species that are more sensitive to pollution and impaired habitat, and are dominant at sites in the upper San Juan Creek watershed (Trabuco and Bell Creeks).

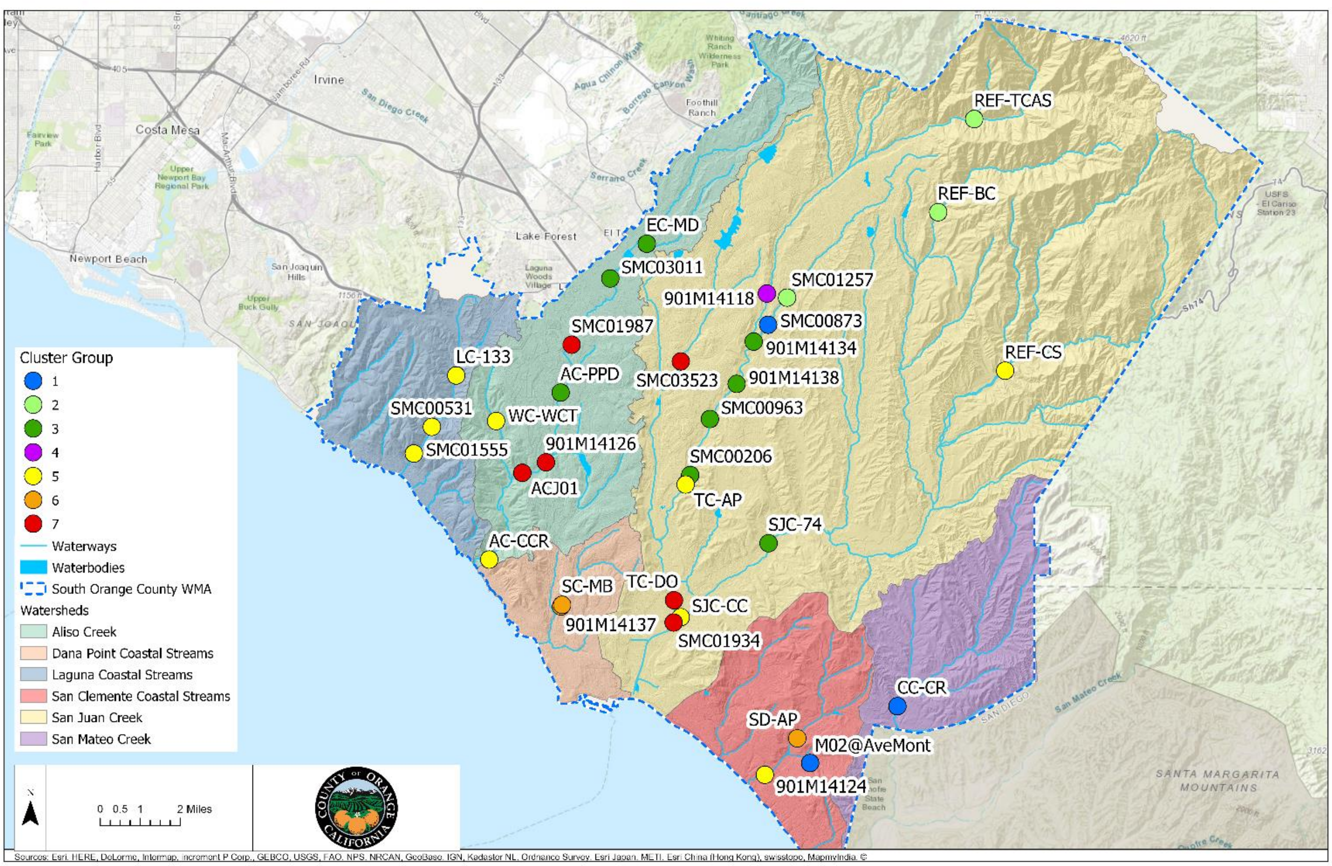


These two figures clearly show several dominant patterns. First, sites that are at or near reference conditions based on the CSCI are concentrated at the upper end of the dendrogram, which is equivalent to station Group 2, located on the left side of the two-way coincidence table. These sites are mostly located in the Upper San Juan Creek watershed (see **Figure 3.6** above and **Figure 3.7** below).

Secondly, there is no clear clustering of sites based on the sample year. This suggests that annual variability in weather conditions is not driving the composition and abundances of taxa in the watersheds. Rather, it is predominantly based on habitat conditions (**Figure 3.4**), as well as some geographic correlations (**Figure 3.7**). Cluster Groups 1, 2, 3, and 7 tend to be gathered in tightly assembled geographical areas. This suggests that similar habitat conditions are found in each of the respective cluster groups. The similarities could extend beyond those in habitat condition, and additionally include similarities in geomorphic and groundwater sources, or lack thereof. It can be inferred that taxa in the higher cluster groupings have more specific habitat requirements that are limited or do not exist in urbanized regions.

Lastly, species with broader spatial and temporal distributions are concentrated in the lower four species groups (Groups C through F) on the two-way coincidence table. Species with such extensive distributions tend to be more pollution and/or disturbance tolerant, such as *Hyalella* and *Chironomus*. In contrast, species in the upper two species groups (Groups A and B) have much more restricted distributions, and are found primarily at the upper San Juan Creek watershed where the habitat is of greater complexity and anthropogenic impact is relatively minimized. A closer examination of the species groups in the two-way coincidence table shows that species Group B contains a diverse assemblage of several sensitive types of organisms such as the trichopteran (caddisfly) *Hydropsyche* and the sensitive species of the ephemeropteran (mayfly) *Baetis*. Furthermore, many of the dominant taxa at the upper and lower vertical ends of the two-way coincidence table are characterized by larger symbols, thus a larger proportion of species abundance. **Figure 3.7** is effective at spatially capturing these patterns.

Figure 3.7: Map of the Cluster Group Distribution across the San Diego Region, 2009 - 2017. This map includes historical and current year bioassessment data and is intended to show the locations of cluster group sites. As indicated above, Group 2 is found in the upper San Juan Creek watershed, particularly Trabuco and Bell Creeks.

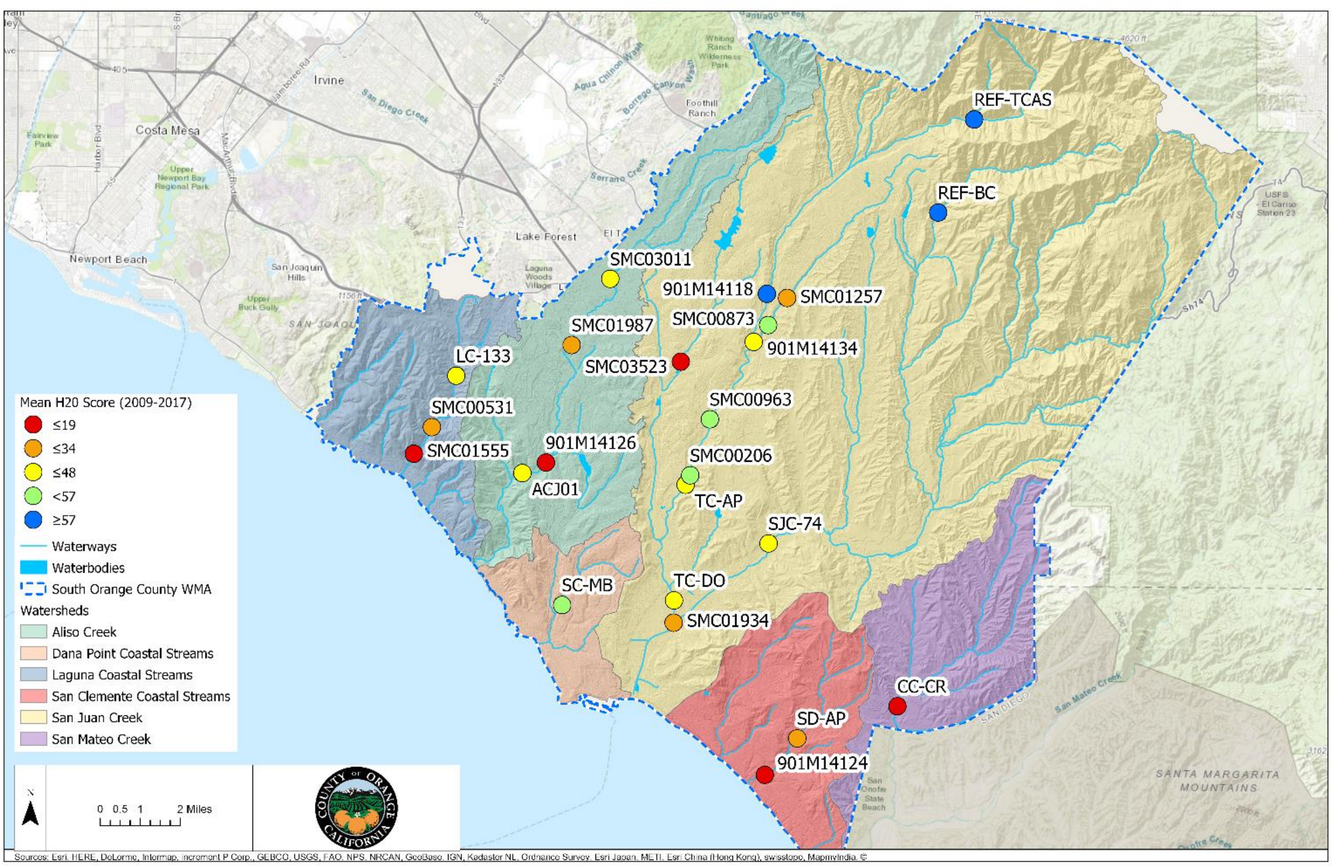


Correlation with Algae

Historical spatial analysis was completed for algae using the soft algae and diatom hybrid H20 index. **Figure 3.8** shows the H20 scores for all SMC stations from 2009 through 2016 and targeted stations from 2013 through 2017. A score ≥ 57 indicates reference condition and less than 57 is considered non-reference. The rest of the scoring range is arbitrary and without corresponding condition categories, but it assists in providing some spatial context. H20 scores more or less reflect the CSCI scores for the seven cluster groups with scores generally improving the more reference in location they are. Occasionally there are breaks from this trend suggesting that site specific differences are altering the algal taxonomy, such as nutrient availability.

The 2017 SMC algal scores should be available in spring 2018 once they are analyzed and quality controlled by the State. 2016 marked the beginning of a DNA extraction method, which is intended to assist in future algal taxonomy studies and analysis. However, greater studies and analysis is needed to understand algal taxonomy in urban watersheds. To date there is not an accepted scoring threshold for the soft algae (S2) and diatom (D18) indices. There is currently an Algal Stream Condition Index (ASCI) in production at SCCWRP which is scheduled to be launched in 2018. Next year's reporting period will include this new algal index if it is ready for use.

Figure 3.8: Historical Algal H20 Index, 2009 – 2017. This map shows the historical stations with their corresponding H20 scores. Stations sampled more than once during this period show the average H20 score. The scoring range is arbitrary, but 57 or greater is considered reference. 2017 SMC algae data should be available in spring 2018.



Correlation with Metrics and Parameters

Variables measured during the surveys conducted from 2009 to 2017 were then grouped into biotic condition (e.g. CSCI scores), physical habitat parameters (e.g. channel alteration), water quality physical measurements (e.g. pH, dissolved oxygen), nutrients (e.g. nitrate), potential pollutant parameters (e.g. dissolved metals) and ions (e.g. sulfate). The median values of each parameter were then plotted for each cluster group using box and whisker plots. “Cluster Group” on the x-axis of the box and whisker plots refers to the site groupings based on taxa from the dendrogram and two-way coincidence table.

The box and whisker plots below show the condition of each cluster group as determined by the scoring mechanism for the respective analysis (see **Figure 3.9** to **Figure 3.14** below). Median CSCI scores (**Figure 3.9**) were just below the “likely intact” condition category threshold of 0.92 for Group 2 (median CSCI 0.89), which were the sites located in the upper San Juan Creek watershed. Median CSCI scores were below the 0.79 threshold in Group 1 and Groups 3 through 7, placing these groups in the “likely altered” or “very likely altered” condition categories. These sites are largely characterized by hydromodification or other anthropogenic influences. CSCI scores were somewhat better in Group 4 (median CSCI 0.77), suggesting that the habitat and possibly reduced geomorphic influences are positively affecting these locations.

Figure 3.9: CSCI Score versus Cluster Group, 2009 - 2017. This boxplot shows how the median biological condition (CSCI score) is expressed for each of the station groups derived from cluster analysis. There is a general gradient of decreasing CSCI scores from cluster Group 2 through 6. Group 2 includes sites located in the upper San Juan Creek watershed where physical habitat conditions are relatively beneficial.

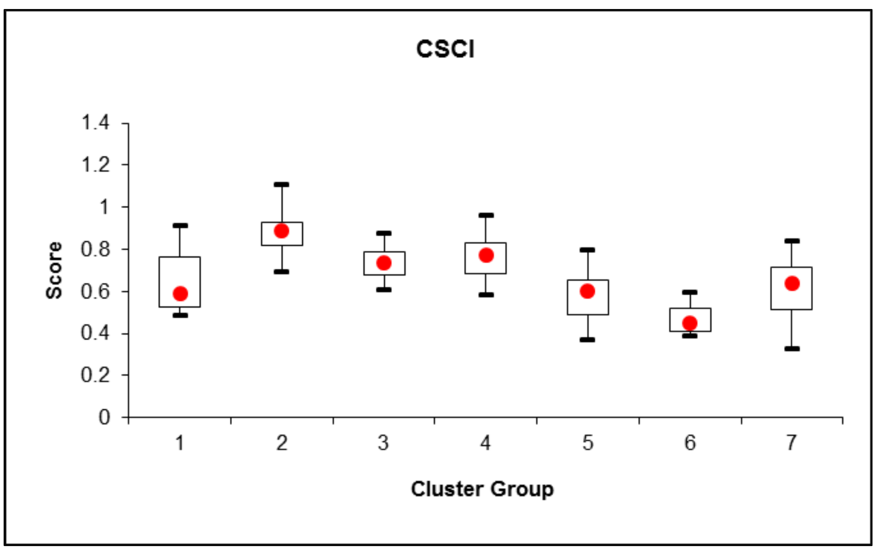


Figure 3.10: Algal H20 Index versus Cluster Group, 2009 - 2017. This boxplot shows algal condition using the SoCA Algal IBI (H20 score), and is expressed for each of the station groups derived from cluster analysis. There does not appear to be a clear trend in H20 scores across cluster groups, however Group 2 had the best scores (median 70), which is considered reference condition. Site specific factors such as undesirable nutrient concentrations and elevated dissolved solids could be suppressing the scores in the other groups. 2017 SMC algae data is not included in this analysis.

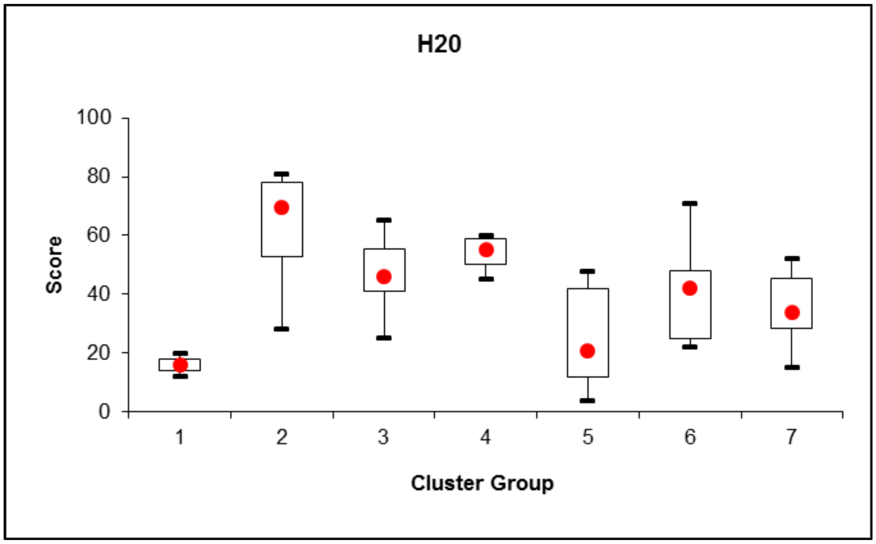
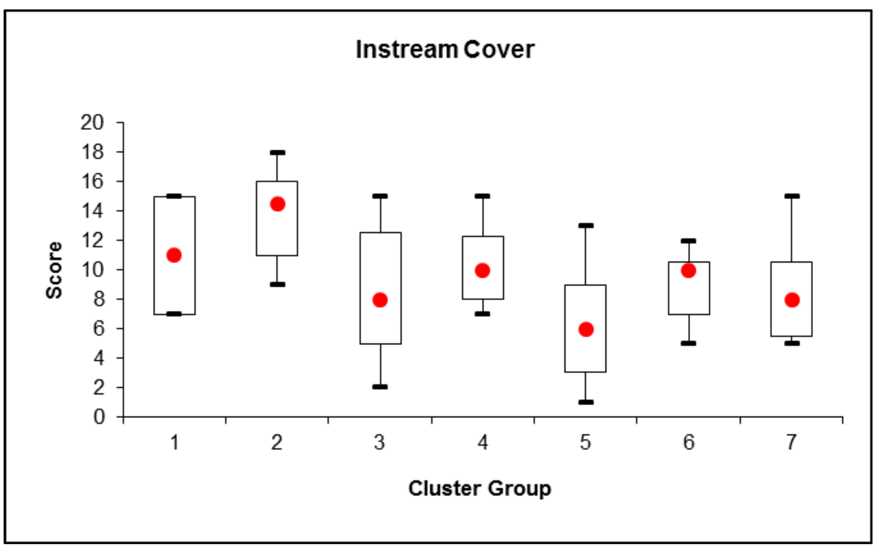
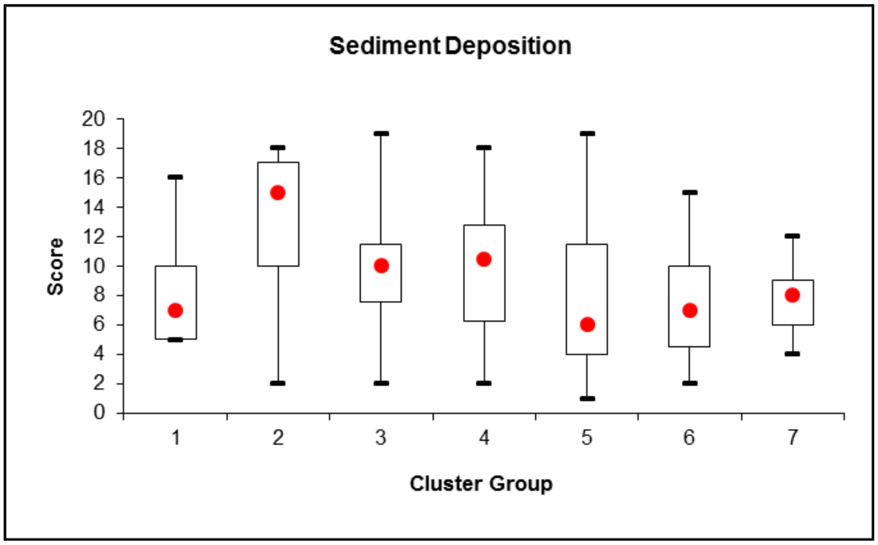


Figure 3.11: Physical Habitat Condition versus Cluster Group as it relates to Instream Cover, Sediment Deposition, and Channel Alteration, 2009 – 2017 (Continued on Next Page). These graphs show the three key physical habitat measures by station cluster groups. Instream cover and sediment deposition show the strongest trends.




Sediment Deposition
20
18
16
14
12
10
8
6
4
2
0
Score
1
2
3
4
5
6
7
Cluster Group

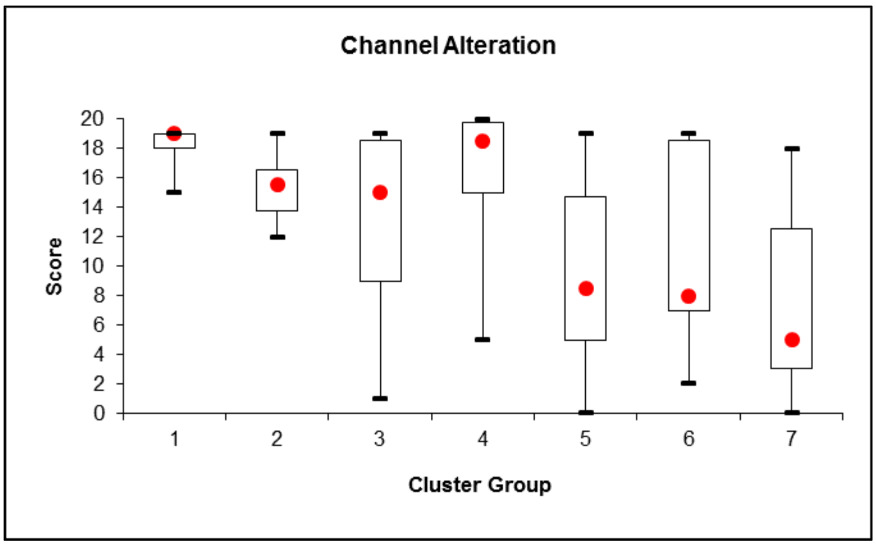
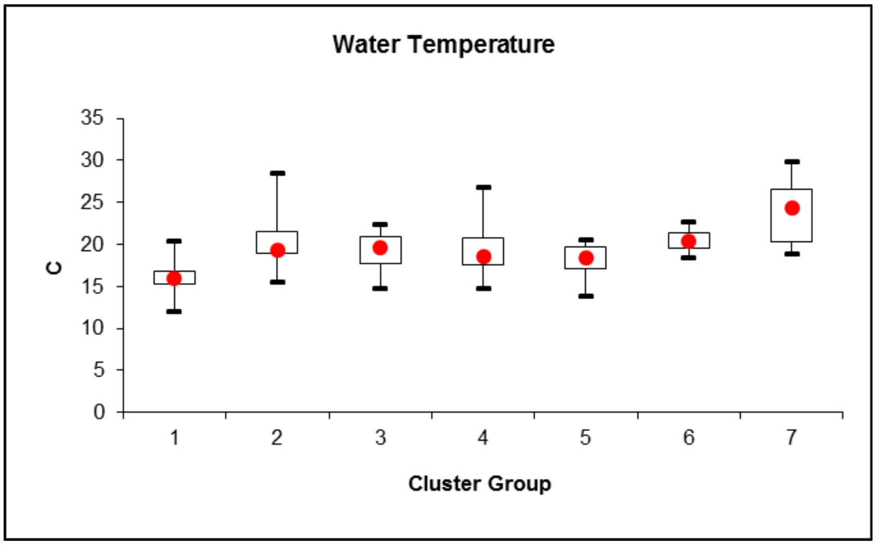
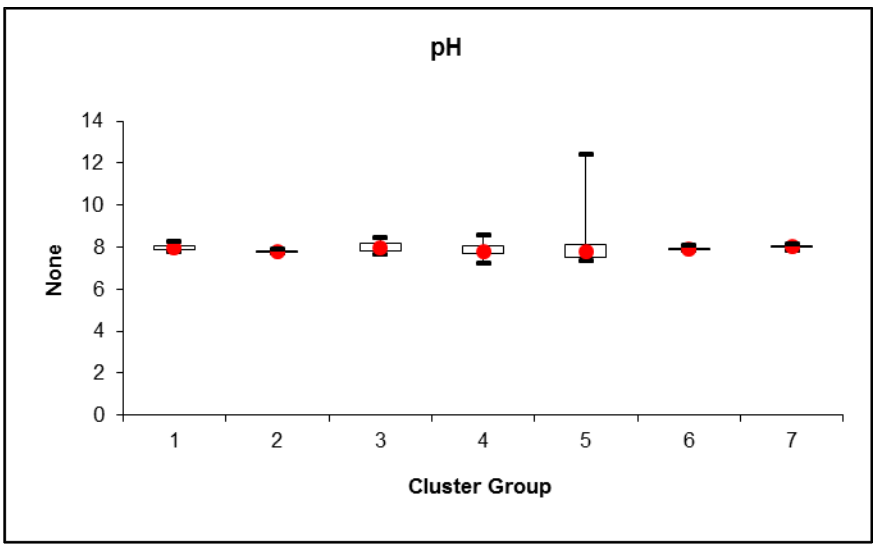
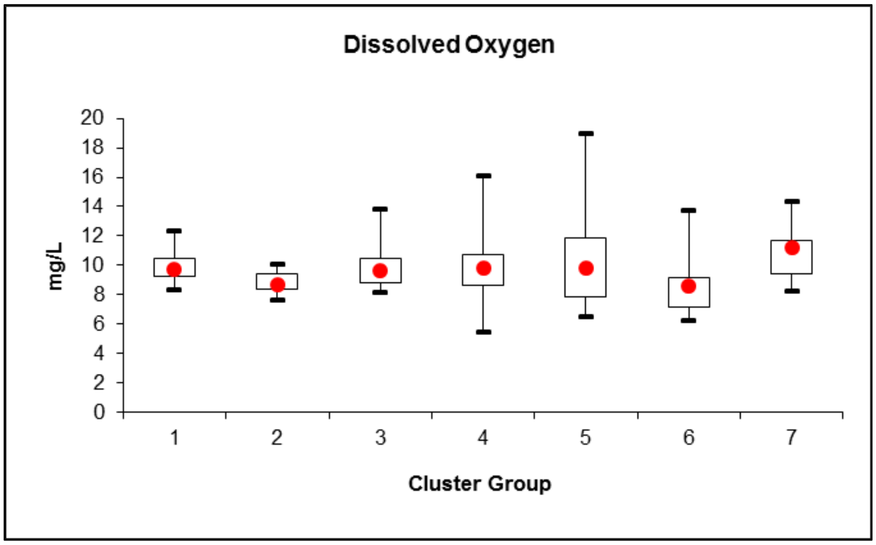
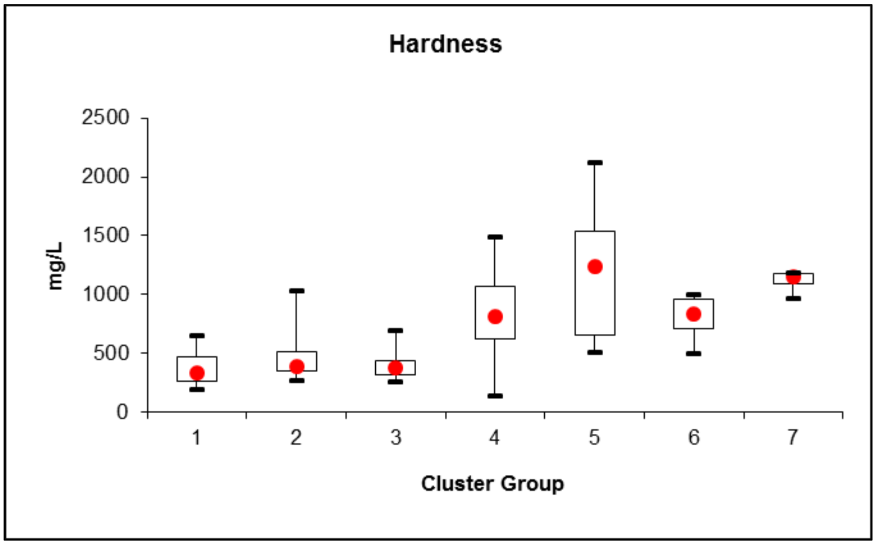

Channel Alteration
20
18
16
14
12
10
8
6
4
2
0
Score
1
2
3
4
5
6
7
Cluster Group

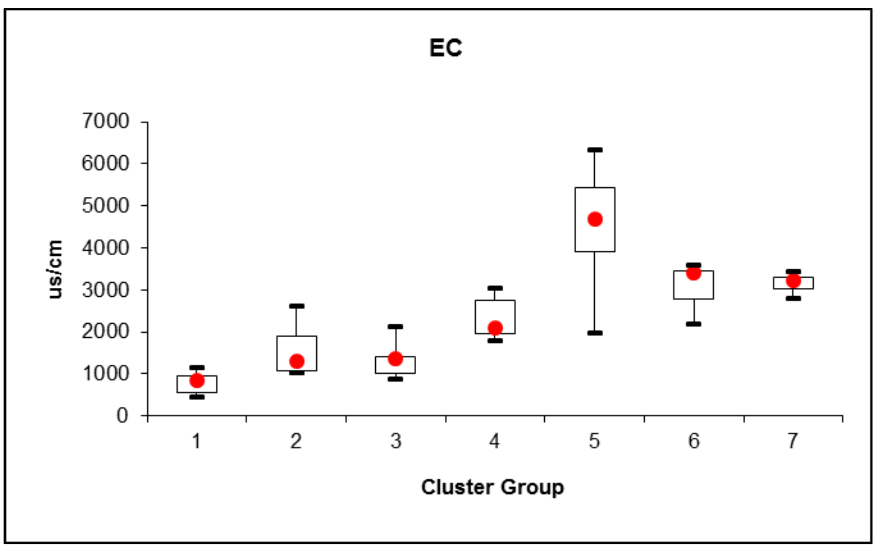
Figure 3.12: Physical Parameters versus Cluster Group, 2009 – 2017 (Continued on Next Two Pages). Water quality conditions were generally similar across cluster groups for pH, dissolved oxygen, and suspended solids, indicating these results probably do not have a strong influence on the biological condition. There is a stronger trend in regards to hardness, conductivity, and to a lesser extent temperature. The hardness and conductivity trends highlight the probable impacts of elevated dissolved solids from geomorphic formations.






Dissolved Oxygen
mg/L
20
18
16
14
12
10
8
6
4
2
0
1
2
3
4
5
6
7
Cluster Group


Hardness
mg/L
2500
2000
1500
1000
500
0
1
2
3
4
5
6
7
Cluster Group


EC
us/cm
7000
6000
5000
4000
3000
2000
1000
0
1
2
3
4
5
6
7
Cluster Group

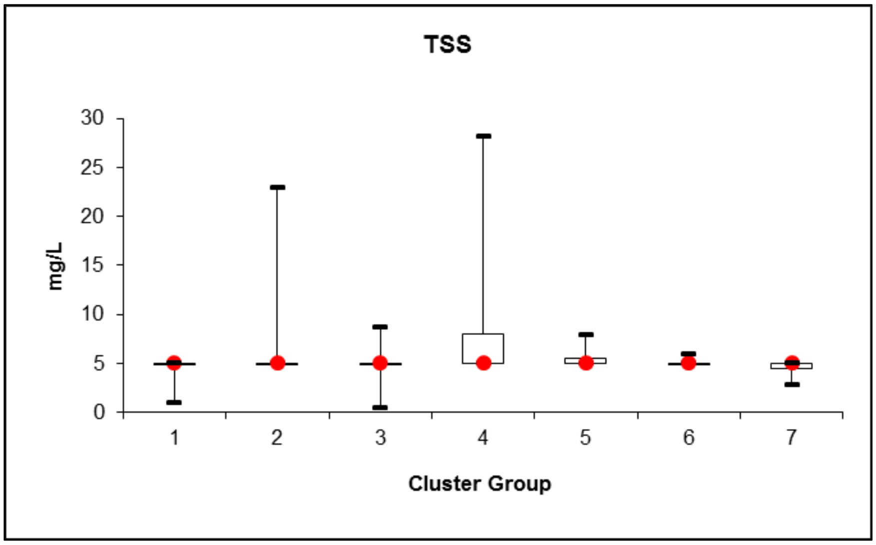
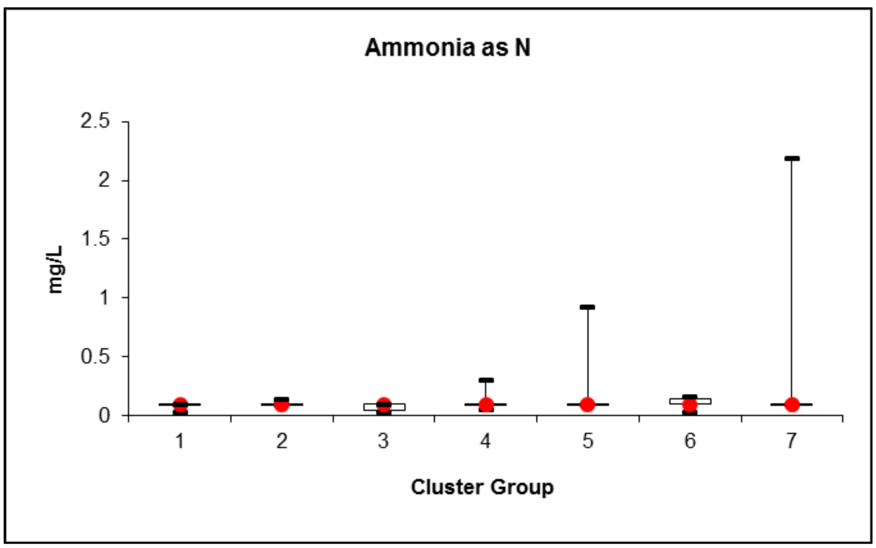
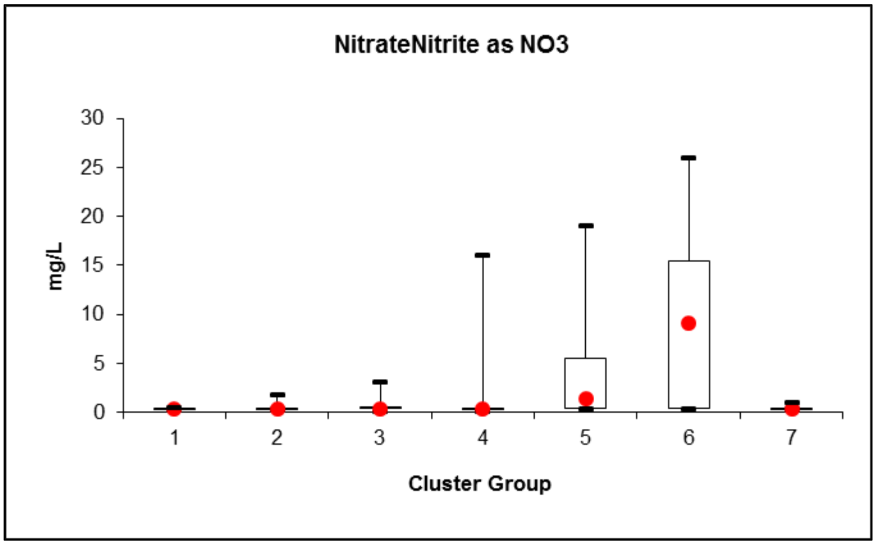
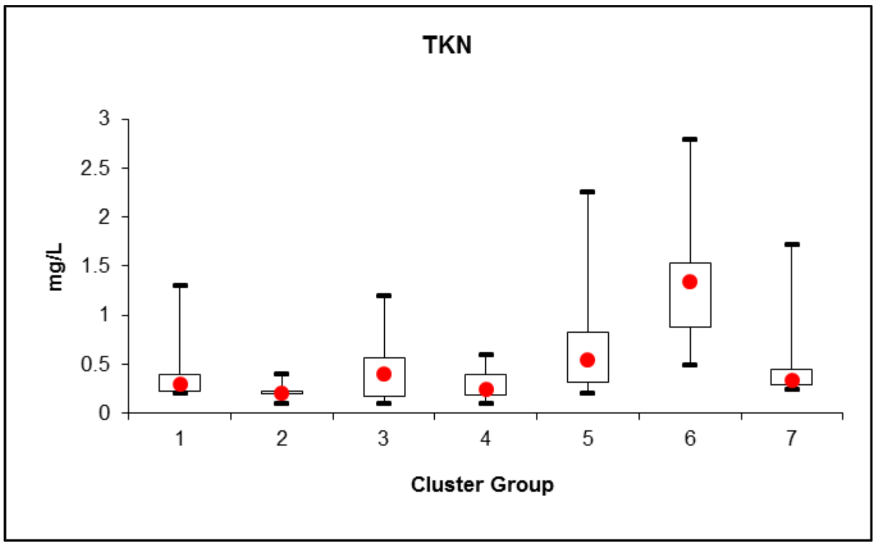
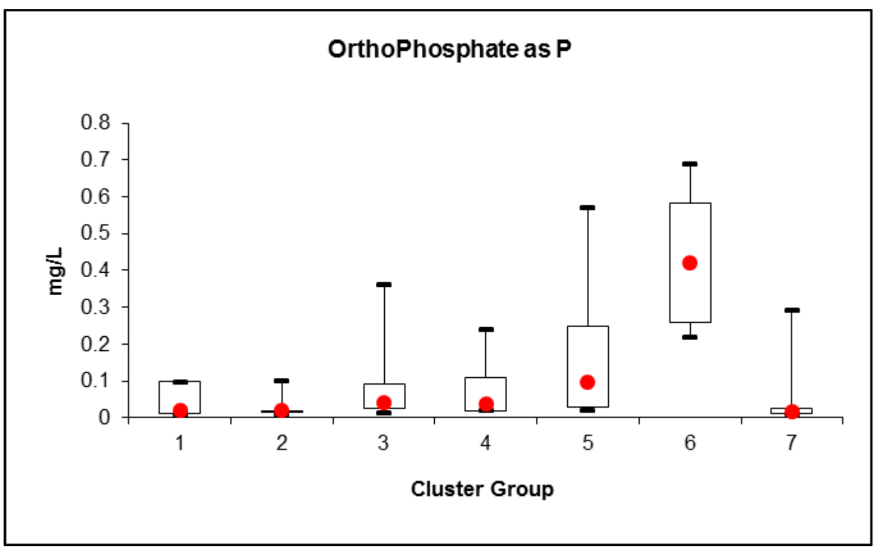


Figure 3.13: Nutrient Parameters versus Cluster Group, 2009 – 2017 (Continued on Next Two Pages). Nutrient conditions do not show a pattern across cluster Groups 1 through 4. There are instances of elevated nitrogen and phosphorus in Groups 5 through 7. However, these are probably site specific and are just one potential factor in regards to undesirable CSCI scores for these cluster groups.




NitrateNitrite as NO3
mg/L
0
5
10
15
20
25
30
1
2
3
4
5
6
7
Cluster Group


TKN
mg/L
0
0.5
1
1.5
2
2.5
3
1
2
3
4
5
6
7
Cluster Group


OrthoPhosphate as P
mg/L
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
1
2
3
4
5
6
7
Cluster Group

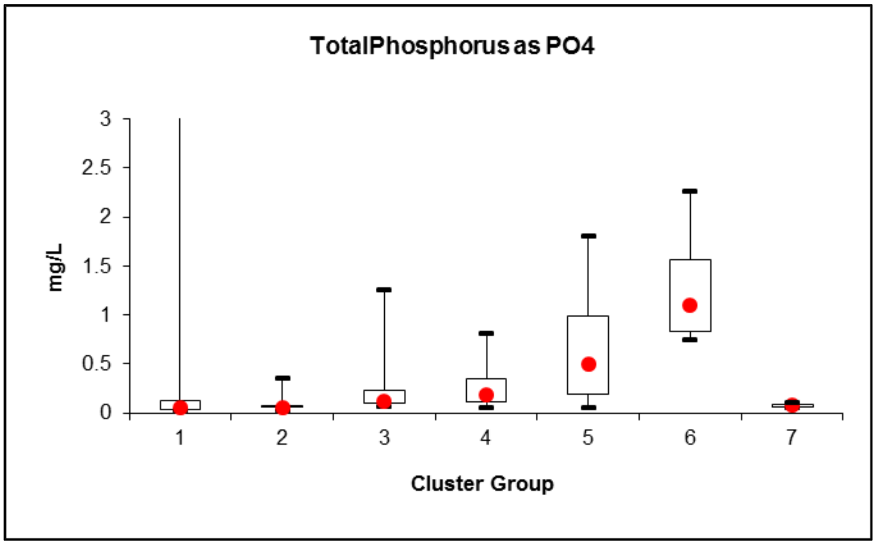
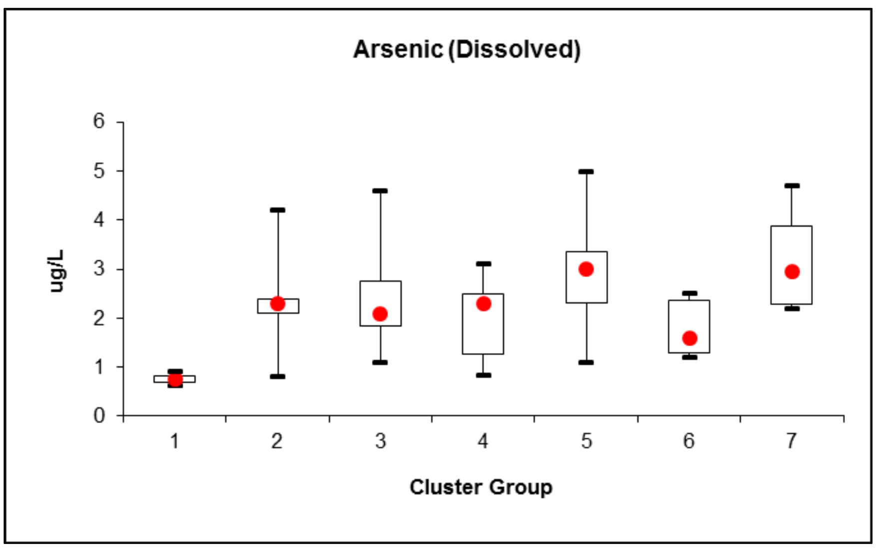
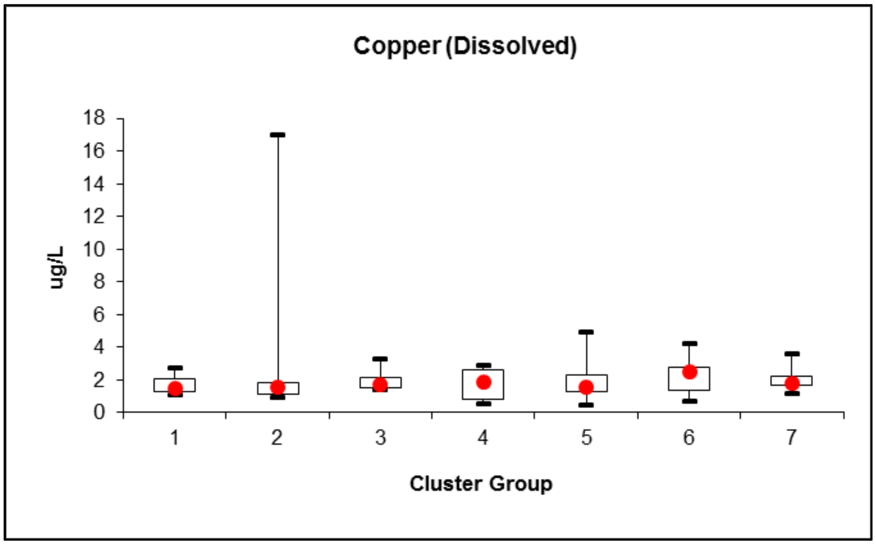
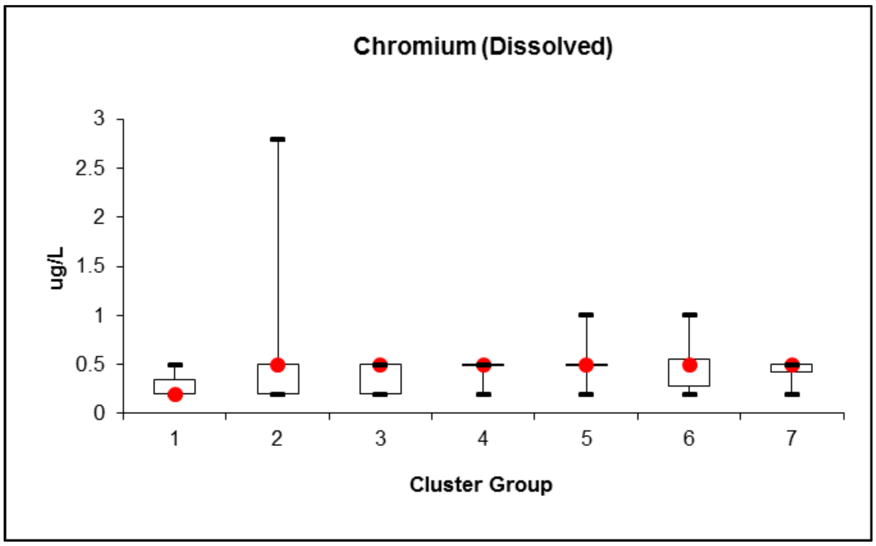
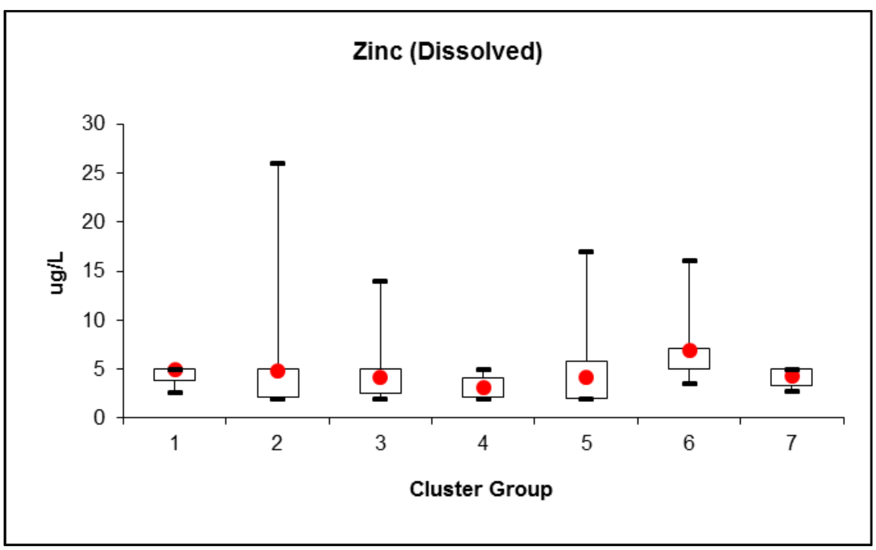


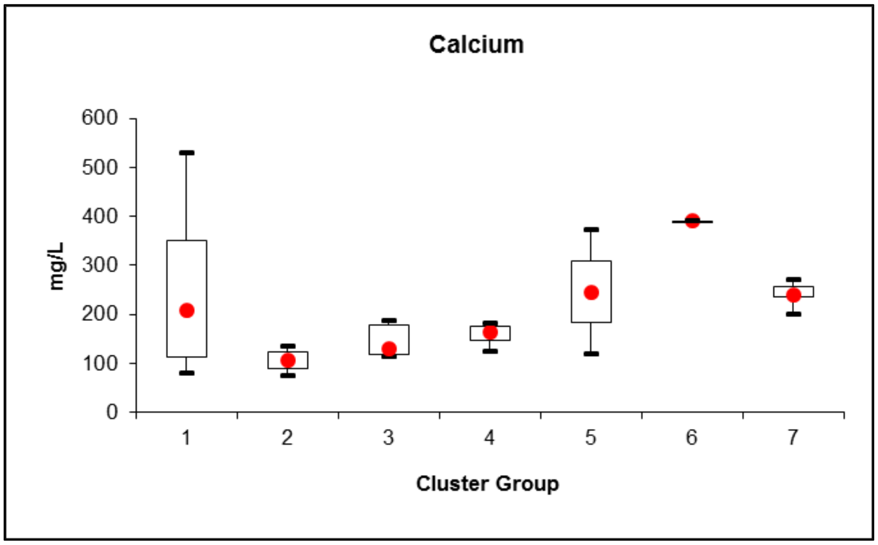
Figure 3.14: Box and Whisker Plots of Dissolved Metals and Major Ions versus Cluster Groups, 2009 – 2017 (Continued on Next Three Pages). No clear dissolved metal trends are observed between the cluster groups outside of occasional elevated outliers. Note that beginning in 2015, metals are no longer collected at SMC sites, but are continued at targeted sites. With the exception of Group 1, chloride and sulfate tend to increase with cluster group order, giving more weight to the issue with elevated dissolved solids and corresponding lower CSCI scores. Calcium and fluoride show no clear trend.

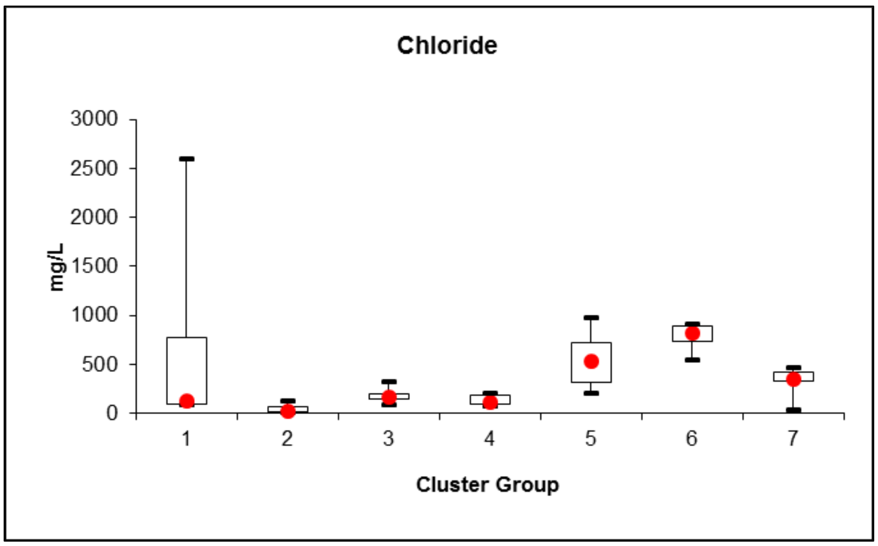


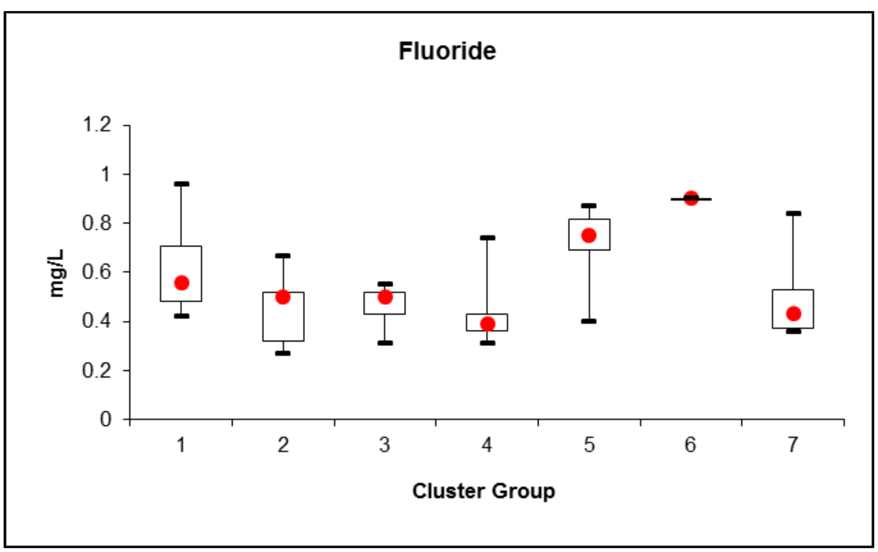

Copper (Dissolved)
ug/L
18
16
14
12
10
8
6
4
2
0
1
2
3
4
5
6
7
Cluster Group

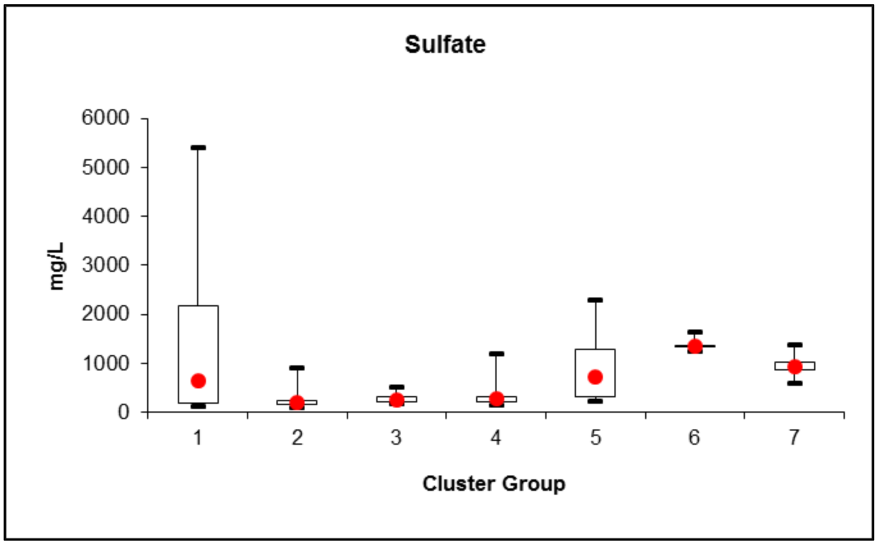

Chromium (Dissolved)
ug/L
3
2.5
2
1.5
1
0.5
0
1
2
3
4
5
6
7
Cluster Group


Zinc (Dissolved)
ug/L
30
25
20
15
10
5
0
1
2
3
4
5
6
7
Cluster Group


Calcium
mg/L
600
500
400
300
200
100
0
1
2
3
4
5
6
7
Cluster Group


Chloride
mg/L
3000
2500
2000
1500
1000
500
0
1
2
3
4
5
6
7
Cluster Group


Fluoride
mg/L
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
Cluster Group



Physical habitat parameters generally differed across the site groups. In general, physical habitat scores for instream cover, sediment deposition, and to a lesser extent channel alteration were in better condition at reference sites and worse in the lower watershed urban sites (**Figure 3.11**). This is expected because diverse and more sensitive biological communities, such as those found in the upper watershed reference sites, require undisturbed and relatively complex instream habitat, coupled with low disturbance in the buffer zone. These relationships are consistently reflected in higher CSCI scores. The sites with the best median CSCI scores (Group 2) had the best measures in terms of instream cover and sediment deposition. Lower watershed sites scored poorly on channel alteration, which captures the engineering influences on stream reaches.

Values for physical parameters such as water temperature (**Figure 3.12**) were elevated at the lower watershed site groups, which is most likely associated with reduced canopy cover in highly urbanized areas. Several parameters were relatively similar across cluster groups including pH, dissolved oxygen, and total suspended solids (TSS). The exception was the elevated conductivity (EC) and hardness, which are most prominent in urban locations where the CSCI scores tend to be the lowest. This trend is reflective of the legacy issue surrounding geomorphic formations and corresponding high conductivity groundwater, as well as the SMC's prioritization on elevated ions in the water column.

Nitrogen and phosphorus were elevated in Groups 4 through 7 (**Figure 3.13**). The most notable trend was in Group 6, where phosphorus and orthophosphate were significantly elevated, and to a lesser extent nitrate+nitrite and TKN. It is interesting that Group 6 is comprised of stations from only Salt Creek and Segunda Desheca Cañada. Both of these streams are known for their groundwater influences, but perhaps there is another source contributing to the phosphorus and nitrogen.

No clear trends in dissolved metals were observed across the cluster groups outside of occasional elevated outliers which could be affected by geological conditions (**Figure 3.14**). It should be noted that the SMC Program discontinued metals analysis in 2015, although this data is still collected as a part of the targeted station program. The major ions chloride and sulfate are elevated in Groups 1 and 5 through 7. These two trends provide more evidence that elevated dissolved solids high in chloride and sulfate salts are greatly impacting instream biology as they prevent sensitive species from establishing, thus reducing the diversity of local biota.

The evaluation of nine years of SMC Program monitoring data in the San Diego Region shows there is a robust relationship between the biological community patterns and physical habitat integrity. This relationship has been observed in a number of other bioassessment programs, including the County's bioassessment monitoring in the Santa Ana Region. On the other hand, strong relationships between biological patterns and water chemistry have not been typically observed in these programs, with the exception of elevated dissolved solids and potentially nutrients. 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. These issues will be evaluated further as more data become available and the scoring metrics for biotic health and habitat integrity can more accurately model a complex and dynamic environment.

4 SPECIAL STUDIES

Urban Stream Bioassessment field monitoring efforts for 2017 included a special study that examined sediment toxicity and chemistry at SMC stations. All four SMC stations (901M14137, 901M14138, SMC00206, SMC00873) contained sampleable sediment. Targeted stations are not a part of this assessment.

For the toxicity component, the standard sediment test for *Hyalella azteca* at 23 °C was performed as well as testing the same organism at 15°C. Previous studies conducted by SWAMP's Stream Pollution Trends (SPoT) Monitoring Program have found that fipronil and pyrethroid pesticides can be significantly more toxic at colder temperatures due to slower metabolic breakdown of trace organics at colder temperatures, as well as increased nerve sensitivity of the organism. Furthermore, cooler temperatures more accurately reflect the ambient average surface water temperature in California streams where sediment is present, especially during the typical sampling index period. Sediment chemistry was analyzed for fipronil, pyrethroids, organic carbon, nitrogen, and phosphorus.

Acute toxicity was not observed at the four stations. However, mean survival of *Hyalella azteca* at 15°C was only 85% for 901M14137 and SMC00873. While this does not definitively indicate chronic effects, it is worth noting that bifenthrin was observed at 3.34 ng/g at 901M14137. Although this is a low concentration, bifenthrin is known to cause effects in the low range. Coupled with the bioassay at the colder temperature, it gives possible cause to the lower mean survival. It is not clear why SMC00873 had a lower value as fipronil and pyrethroids were not detected. In previous special studies, the colder temperature test has also revealed issues with acclimation of the organism to the lower temperature. It should be noted that the 23°C test demonstrated 100% mean survival for both stations. More study will be needed to better understand the differences in the two tests in regards to temperature variation.

Proposed special studies for the 2018 sampling season include a continuation and refinement of the sediment chemistry and toxicity assessment in conjunction with an examination of the presence of pyrethroids and fipronil. There is also a proposed trash assessment at SMC stations that will help support Bight '18. Special studies continue to be discussed amongst the SMC Bioassessment Workgroup, and the proposed study design should be completed in early 2018.

APPENDIX D
UNIFIED BEACH WATER QUALITY MONITORING AND ASSESSMENT

1 CORE MONITORING PROGRAM

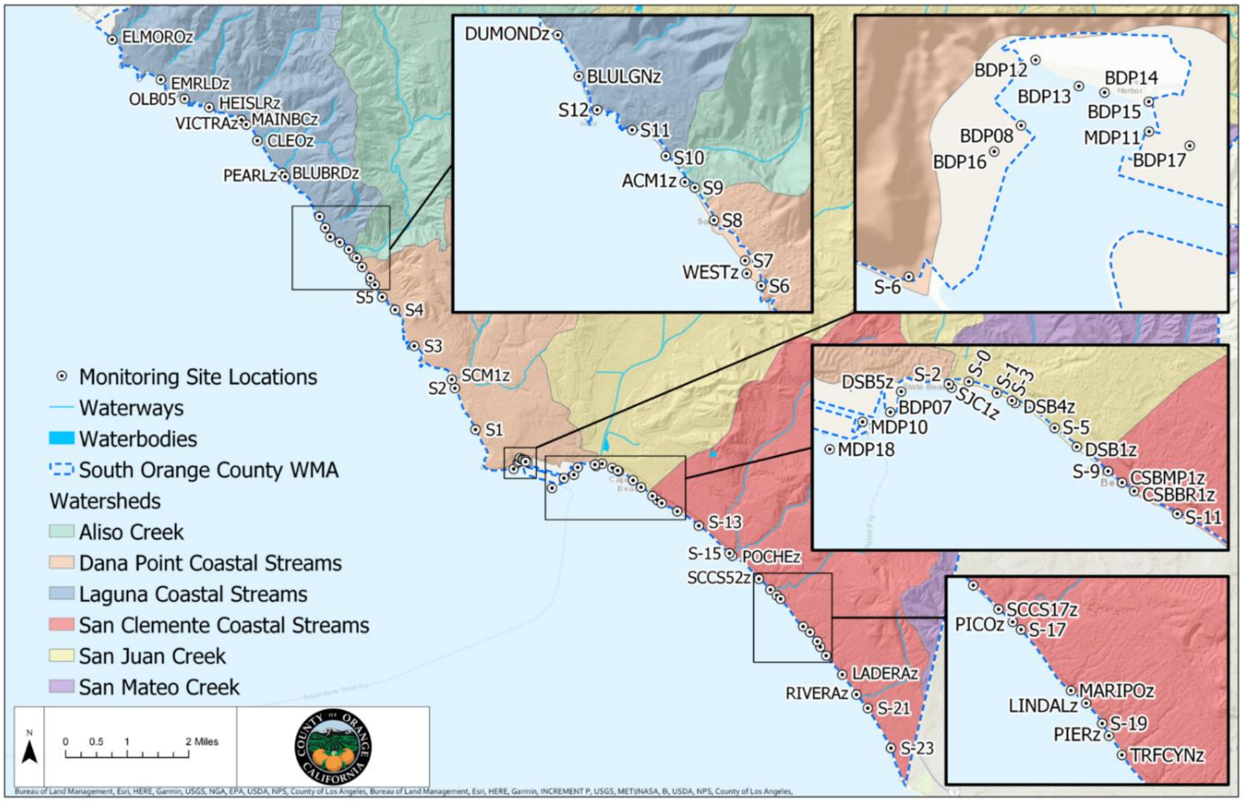
Orange County beaches are used year-round for water contact recreational activities such as swimming and surfing. To protect the health of beachgoers, routine monitoring is required to ensure that water quality meets State standards. The purpose of south Orange County's regional Unified Beach Water Quality Monitoring and Assessment Program (Unified Program) is to continually assess coastal water quality compliance with the beneficial use standards of water contact recreation.

Prior to 2015, this monitoring was performed by multiple agencies in accordance with several different sets of requirements that overlapped spatially and temporally. With the adoption of a State Water Board resolution in 2010, followed by a San Diego Regional Water Quality Control Board meeting in 2012, a workgroup was formed to develop a regional program that consolidated the redundancies in monitoring. The Unified Program began implementation in April 2015.

The concentrations of fecal indicator bacteria are monitored weekly during dry weather conditions at dozens of coastal sites. This program's jurisdiction spans from Emerald Bay in the north, to the San Diego County line at the southern end of San Clemente. The following map provides the coastal monitoring site locations and corresponding watershed boundaries for the Unified Program.

Sampling responsibilities are shared between three partners: Orange County Public Works (OCPW) on behalf of the Permittees, Orange County Health Care Agency (OCHCA), and South Orange County Wastewater Authority (SOCWA) with the water quality data being hosted at www.ocbeachinfo.com.

Figure 1.1: Receiving Water Locations for the Unified Program. Monitoring locations are depicted in the figure below in each corresponding watershed.



There are two types of sampling stations associated with this program, fixed stations and outlet stations. Fixed stations do not change and one sample is taken in the surf zone. Outlet stations are located where flows from creeks, canyons, or storm drains enter the ocean. As the positions along the shoreline where flows meet the ocean may change due to beach sand movement, the location where the sample is taken changes accordingly. If there is surface flow directly to the ocean, samples are taken at "Point zero" (where the surface flow meets the ocean) and 75 feet up and down coast of that point. If there is no direct flow to the ocean, a single sample is collected at the "Virtual point zero" (where it appears the surface flow would meet the ocean).

Three analyses for pathogen indicator bacteria (*Enterococcus*, Fecal Coliform, and Total Coliform) are conducted on each sample. The established single sample standards for *Enterococcus,* fecal and total coliform bacteria are called the AB411 Ocean Water-Contact Sports Standards and are as follows:

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

The proportion of exceedances for each monitoring site is calculated as:

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

1.1 Unified Program

The Unified Program's reporting period extends from October 1st through September 30th. A summary of the monitoring conducted in the 2016-17 season is provided below in **Table 1.1**. *Enterococcus* has the highest exceedance rate among the indicator bacteria. Additionally, drains that flowed directly to the ocean had greater exceedance rates than those that did not flow to the ocean. It should be noted that the sample size of flowing drains is smaller than that of drains that did not flow.

Table 1.1: Fecal Indicator Bacteria Exceedance Frequencies during 2016-2017 reporting period. A summary of exceedances for *Enterococcus*, Fecal Coliform, and Total Coliform in the 2016-2017 reporting season.

2016-17 Reporting Period						
Sample Type	**Site Visits**	**# of Samples**	**Ent**	**FC**	**TC**	**Total**
All Samples	3016	3607	6%	3%	2%	4%
Drains Flowing to Ocean	308	899	15%	8%	6%	10%
Drains *Not* Flowing to Ocean	2708	2708	3%	1%	1%	2%

The exceedance rates for individual sites during the 2016-17 reporting period are shown below in **Table 1.2**. While overall exceedance rates remain relatively low, some sites elevated rates of indicator bacteria exceedance. Stations at POCHE, SJC1, and DSB5 have exceedance rates greater than 20% while most other stations remained under 10%. At SJC1 and DSB5 it should be noted that the sample sizes the for up and down coast stations were smaller than the Point Zero sample due to the lack of flow events observed.

Table 1.2: Fecal Indicator Bacteria Exceedance Frequencies during the 2016-2017 reporting period for all stations. Raw data can be found at https://ocgov.box.com/v/201617-TMAR-Datasets.

Station ID	Site Location	2016-2017
	Laguna Beach	
ELMOROu	El Moro Beach	0%
ELMOROz		1%
ELMOROd		0%
EMRLDu	Emerald Bay	0%
EMRLDz		1%
EMRLDd		0%
OLB05	Crescent Bay	0%
HEISLRu	Diver's Cove	0%
HEISLRz		1%
HEISLRd		0%
MAINBCu	Laguna Main Beach	4%
MAINBCz		8%
MAINBCd		0%

VICTRAu		11%
VICTRAz	Hotel Laguna	0%
VICTRAd		0%
CLEOu		0%
CLEOz	Cleo Street	1%
CLEOd		0%
BLUBRDu		0%
BLUBRDz	Bluebird Canyon	4%
BLUBRDd		0%
PEARLu		0%
PEARLz	Pearl Street	1%
PEARLd		0%
DUMONDu		0%
DUMONDz	Victoria Beach	0%
DUMONDd		0%
BLULGNu		0%
BLULGNz	Blue Lagoon Drain	1%
BLULGNd		0%
S12	Treasure Island Pier	0%
S11	Treasure Island Sign	1%
S10	Aliso Beach - North	0%
ACM1u		0%
ACM1z	Aliso Creek	8%
ACM1d		10%
S9	Aliso Beach - North	3%
S8	Aliso Beach - North	0%
S7	Camel Point	0%
WESTz	West Street Drain	0%
S6	Table Rock	0%
S5	Laguna Lido Apartment	0%
S4	9th St / 1000 Steps Beach	1%
Dana Point		
S3	Three Arch Bay	0%
SCM1u		1%
SCM1z	Salt Creek	13%
SCM1d		2%
S2	Salt Creek Beach	0%
S1	Dana Strands	0%
S-6	Ocean Institute Beach	0%

Dana Point Harbor		
BDP16	Pilgrim Dock	2%
BDP08	Pier	0%
BDP12	Baby Beach - West End	2%
BDP13	Baby Beach - Bouy Line	0%
BDP14	Baby Beach - Swim Area	2%
BDP15	Baby Beach - East End	0%
MDP11	Guest Dock	0%
BDP17	Youth Dock	0%
MDP18	M Dock (East Basin)	6%
MDP10	Harbor Patrol Dock	1%
BDP07	Fuel Dock	0%
Doheny State Beach		
DSB5u	North Beach Creek	39%
DSB5z		16%
DSB5d		31%
S-2	North of San Juan Creek	7%
SJC1u	San Juan Creek Interface	25%
SJC1z		23%
SJC1d		22%
S-0	Surfzone at Outfall	6%
S-1	1000' South Outfall	5%
S-3	2000' South Outfall	3%
DSB4u	Day Use Area	17%
DSB4z		7%
DSB4d		0%
S-5	3000' South Ourfall	2%
DSB1z	End of the Park	1%
Capistrano Beach		
S-9	Capistrano County Beach	1%
CSBMP1z	Drain near Point Zero	1%
CSBBR1z	Capo Community Beach	0%
S-11	Capistrano Bay Dist - North	0%
S-13	Capistrano Bay Dist - South	0%
Poche Beach		
S-15	Poche Beach	0%
POCHEu	Poche Creek	0%
POCHEz		21%
POCHEd		3%

San Clemente City & State Beach		
SCCS52u		0%
SCCS52z	Capistrano Shores North Drain	7%
SCCS52d		4%
PICOu		0%
PICOz	Pico Drain at North Beach	7%
PICOd		5%
S-17	North Beach Creek	2%
MARIPOz	Mariposa Lane Drain	0%
LINDALu		0%
LINDALz	Linda Lane Drain	5%
LINDALd		0%
S-19	450 Feet North of Pier	1%
PIERu		0%
PIERz	San Clemente Pier Drain	16%
PIERd		15%
TRFCYNu		5%
TRFCYNz	Trafalgar Canyon Creek	3%
TRFCYNd		5%
LADERAz	Boca Del Canon Drain	0%
RIVERAz	Riviera Beach Drain	0%
S-21	Avenida Califia	0%
S-23	Las Palmeras	0%

1.2 AB411 Period

A summary of the AB411 monitoring conducted during our reporting period is provided in the following table. Since the AB411 season (April 1 – October 31) does not align directly with the County's reporting period, the summary in **Table 1.3** below includes data from the October 2016 AB411 season and data from April through September of the 2017 AB411 season. Similar to the reporting period analysis, there are higher exceedance rates in samples that flowed directly to the ocean. Again, it should be noted that the sample size for flowing stations is smaller than for non-flowing stations. *Enterococcus* accounted for the highest percentage of exceedance among the indicator bacteria.

Table 1.3: Fecal Indicator Bacteria Exceedance Frequencies during AB411 season. A summary of exceedances for *Enterococcus*, Fecal Coliform, and Total Coliform during the AB411 season.

AB411 Season						
Sample Type	**Site Visits**	**# of Samples**	**Ent**	**FC**	**TC**	**Total**
All Samples	1928	2198	4%	2%	1%	2%
Drains Flowing to Ocean	144	414	11%	5%	4%	7%
Drains *Not* Flowing to Ocean	1784	1784	2%	1%	1%	1%

Individual station exceedance rates during the AB411 season are presented below in **Table 1.4**. Similar to the full reporting period, most of the stations during the AB411 season did have exceedance rates higher than 10%. A few stations, POCHE, SJC1, and DSB5, did have exceedance rates of higher than 20%. For stations SJC1 and DSB5 high exceedance rates were noted at the up and down coast stations. As these stations are only sampled when the drains flow to the ocean, they have a smaller sample size than non-flowing drains.

Table 1.4: Fecal Indicator Bacteria Exceedance Frequencies during AB411 Season for all stations. Raw data can be found at https://ocgov.box.com/v/201617-TMAR-Datasets.

Station ID	Site Location	AB411
	Laguna Beach	
ELMOROu		0%
ELMOROz	El Moro Beach	1%
ELMOROd		0%
EMRLDu		0%
EMRLDz	Emerald Bay	1%
EMRLDd		0%
OLB05	Crescent Bay	0%
HEISLRu		0%
HEISLRz	Diver's Cove	2%
HEISLRd		0%
MAINBCu		17%
MAINBCz	Laguna Main Beach	4%
MAINBCd		0%
VICTRAu		N/A
VICTRAz	Hotel Laguna	0%
VICTRAd		N/A
CLEOu		0%
CLEOz	Cleo Street	1%
CLEOd		0%
BLUBRDu		0%

BLUBRDz	Bluebird Canyon	4%
BLUBRDd		0%
PEARLu		0%
PEARLz	Pearl Street	1%
PEARLd		0%
DUMONDu		N/A
DUMONDz	Victoria Beach	0%
DUMONDd		N/A
BLULGNu		0%
BLULGNz	Blue Lagoon Drain	0%
BLULGNd		0%
S12	Treasure Island Pier	0%
S11	Treasure Island Sign	2%
S10	Aliso Beach - North	0%
ACM1u		0%
ACM1z	Aliso Creek	3%
ACM1d		8%
S9	Aliso Beach - North	0%
S8	Aliso Beach - North	0%
S7	Camel Point	0%
WESTz	West Street Drain	0%
S6	Table Rock	0%
S5	Laguna Lido Apartment	0%
S4	9th St / 1000 Steps Beach	1%
Dana Point		
S3	Three Arch Bay	0%
SCM1u		2%
SCM1z	Salt Creek	11%
SCM1d		3%
S2	Salt Creek Beach	0%
S1	Dana Strands	0%
S-6	Ocean Institute Beach	0%
Dana Point Harbor		
BDP16	Pilgrim Dock	1%
BDP08	Pier	0%
BDP12	Baby Beach - West End	3%
BDP13	Baby Beach - Bouy Line	0%
BDP14	Baby Beach - Swim Area	3%
BDP15	Baby Beach - East End	0%

MDP11	Guest Dock	0%
BDP17	Youth Dock	0%
MDP18	M Dock (East Basin)	8%
MDP10	Harbor Patrol Dock	1%
BDP07	Fuel Dock	0%
Doheny State Beach		
DSB5u		33%
DSB5z	North Beach Creek	6%
DSB5d		13%
S-2	North of San Juan Creek	0%
SJC1u		100%
SJC1z	San Juan Creek Interface	4%
SJC1d		50%
S-0	Surfzone at Outfall	3%
S-1	1000' South Outfall	2%
S-3	2000' South Outfall	1%
DSB4u		17%
DSB4z	Day Use Area	2%
DSB4d		0%
S-5	3000' South Ourfall	0%
DSB1z	End of the Park	0%
Capistrano Beach		
S-9	Capistrano County Beach	1%
CSBMP1z	Drain near Point Zero	0%
CSBBR1z	Capo Community Beach	0%
S-11	Capistrano Bay Dist - North	0%
S-13	Capistrano Bay Dist - South	0%
Poche Beach		
S-15	Poche Beach	0%
POCHEu		0%
POCHEz	Poche Creek	25%
POCHEd		1%
San Clemente City & State Beach		
SCCS52u		N/A
SCCS52z	Capistrano Shores North Drain	0%
SCCS52d		N/A
PICOu		0%
PICOz	Pico Drain at North Beach	5%
PICOd		3%

S-17	North Beach Creek	1%
MARIPOz	Mariposa Lane Drain	0%
LINDALu		0%
LINDALz	Linda Lane Drain	1%
LINDALd		0%
S-19	450 Feet North of Pier	0%
PIERu		0%
PIERz	San Clemente Pier Drain	13%
PIERd		0%
TRFCYNu		0%
TRFCYNz	Trafalgar Canyon Creek	0%
TRFCYNd		0%
LADERAz	Boca Del Canon Drain	0%
RIVERAz	Riviera Beach Drain	0%
S-21	Avenida Califia	0%
S-23	Las Palmeras	0%

The bacteria exceedance rate during the AB411 season is also reviewed by the OCHCA in their "Annual Ocean, Harbor & Bay Water Quality Report" found here: http://ocbeachinfo.com/download/

The OCHCA report provides more information on how these exceedances relate to beach closures, sewage spills, and rain advisories.

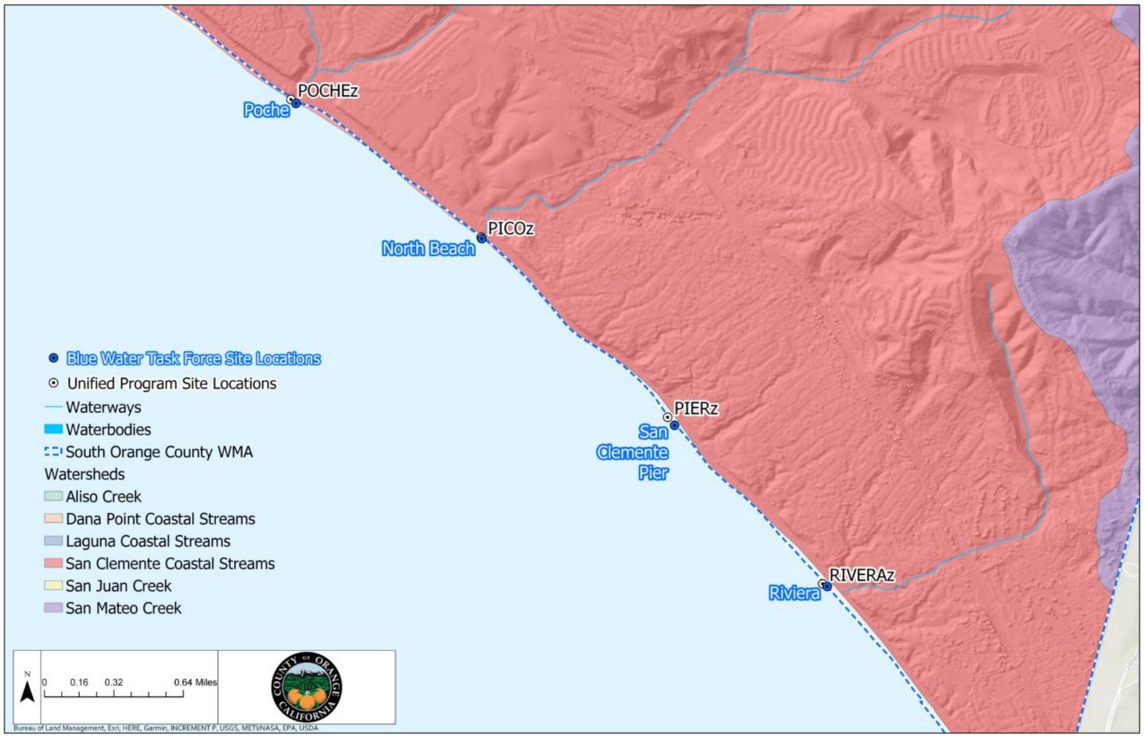
2 SUPPLEMENTARY PROGRAMS

2.1 Blue Water Task Force

The Blue Water Task Force (BWTF) is a program run by the Surfrider Foundation that enlists volunteers to collect water quality data to inform citizens and communities about water quality issues. In this comparative analysis, data gathered by the BWTF was compared with data from the Unified Program to assess exceedance rates in four locations. Full data sets and mapped site locations for the Blue Water Task Force can be found at: http://www.surfrider.org/blue-water-task-force.

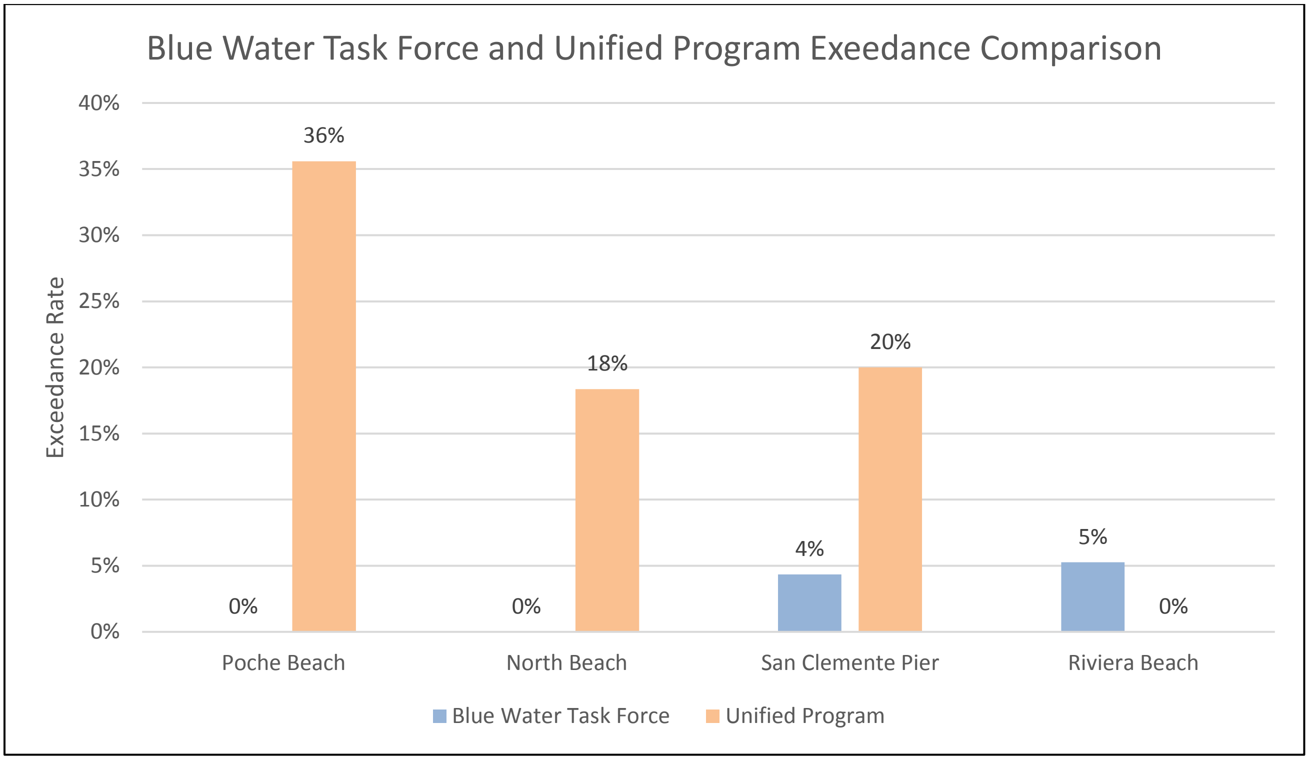
The sampling locations used by the BWTF are shown in the figure below and are located (from North to South) at Poche Beach, North Beach, San Clemente Pier, and Riviera Beach. Unified Program sites located near those listed above were chosen for comparison and include POCHEz, PICOz, PIERz, and RIVIERAz, respectively.

Figure 2.1: Blue Water Task Force and corresponding Unified Program sampling locations in South Orange County.



For comparison the same date ranges were selected for both data sets. The most robust data collection period for the Blue Water Task Force was between October, 2016 and March, 2017 for the *Enterococcus* indicator bacteria. This analysis compared the BWTF data to the County's data collected during its reporting period. **Figure 2.2** below shows the compared exceedance rates for this time period.

Figure 2.2: Fecal Indicator Bacteria Exceedance Frequencies during 2016-17 the reporting period for four sites in the San Clemente region. Exceedance rates as determined by the Unified Program are in orange while the Blue Water Task Force data is in blue.



The figure above depicts generally higher exceedance rates being detected by the Unified Program than by BWTF. Since the data collected by either program were collected by different personnel, have similar but possibly different sampling locations, and were not sampled on the same day or times, it is difficult to make any steadfast conclusions.

Additionally, these two programs utilize different analysis techniques to determine indicator bacteria concentrations. The Unified Program uses a "Membrane Filtration Technique" in compliance with the Environmental Protection Agency's Standard Methods for the Examination of Water and Wastewater. This method identifies the number of colony forming units (CFU) per 100 ml of sample. The BWTF program uses the IDEXX Quanti-tray/Enterolert method, 1:10 dilution to analyze samples. This method identifies the Most Probably Number (MPN) of CFUs per 100 ml of sample.

2.2 Heal the Bay

While yearly and seasonal data is important to analyze to determine the most current areas of concern, it is also important to look at long term trends in data. These trends can show successes and failures in management programs. Heal the Bay's annual report card for swimming beaches gives letter grades to recreational beaches throughout south Orange County. The full reports can be found at http://brc.healthebay.org/default.aspx?tabid=3&c=1.

Figure 2.3 below shows the percent grades of San Diego Region beaches from 2002 to 2017 during dry weather conditions. The year to year "A" percentages fluctuate but the overall trend indicates upward growth and cleaner beaches.

Figure 2.4 shows an even more progressive trend of clean beaches over time. This graph depicts letter grade percentages during wet weather events from 2002 to 2017. At the beginning of the monitoring period in 2002 there were more "F" graded beaches than any other. Now, "A" rated beaches are the most abundant of the swimmable beaches during wet weather events.

Figure 2.3: San Diego Region Dry Weather Heal the Bay report card. Data points were collected during dry weather events between April and October.

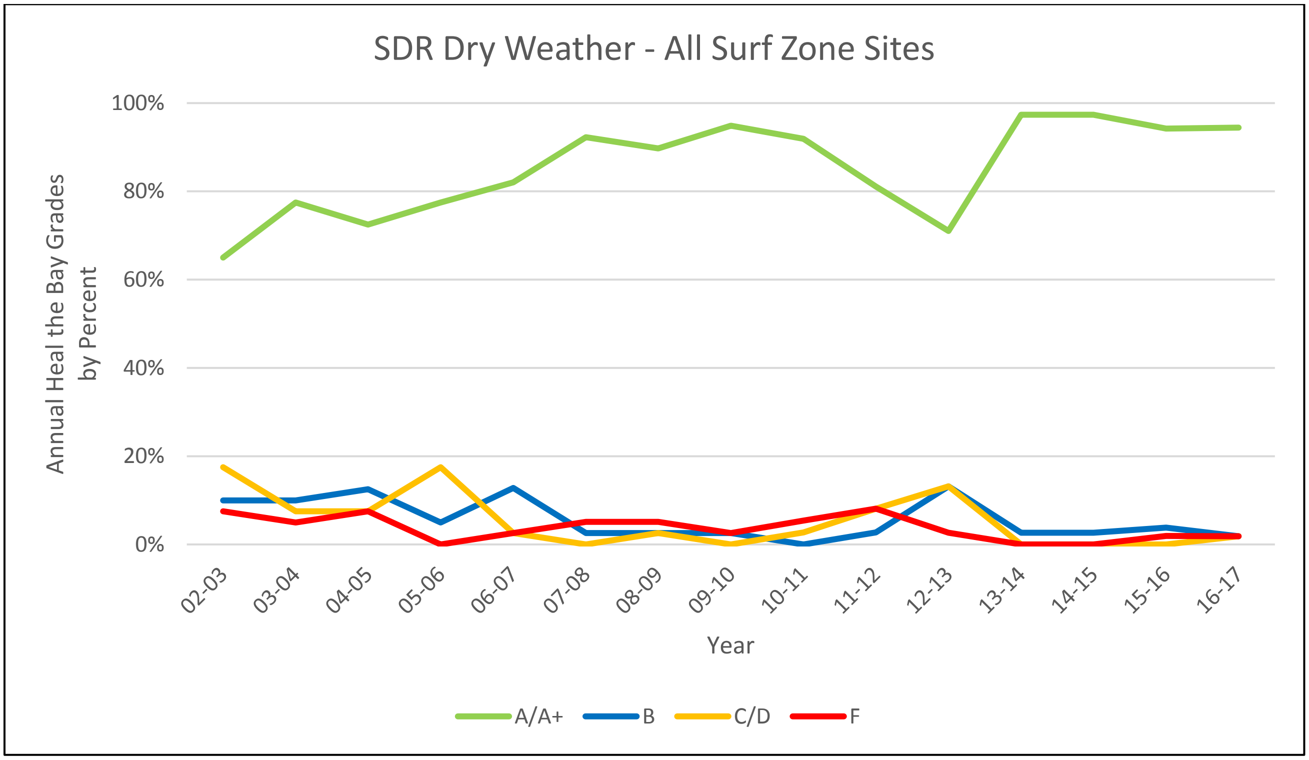
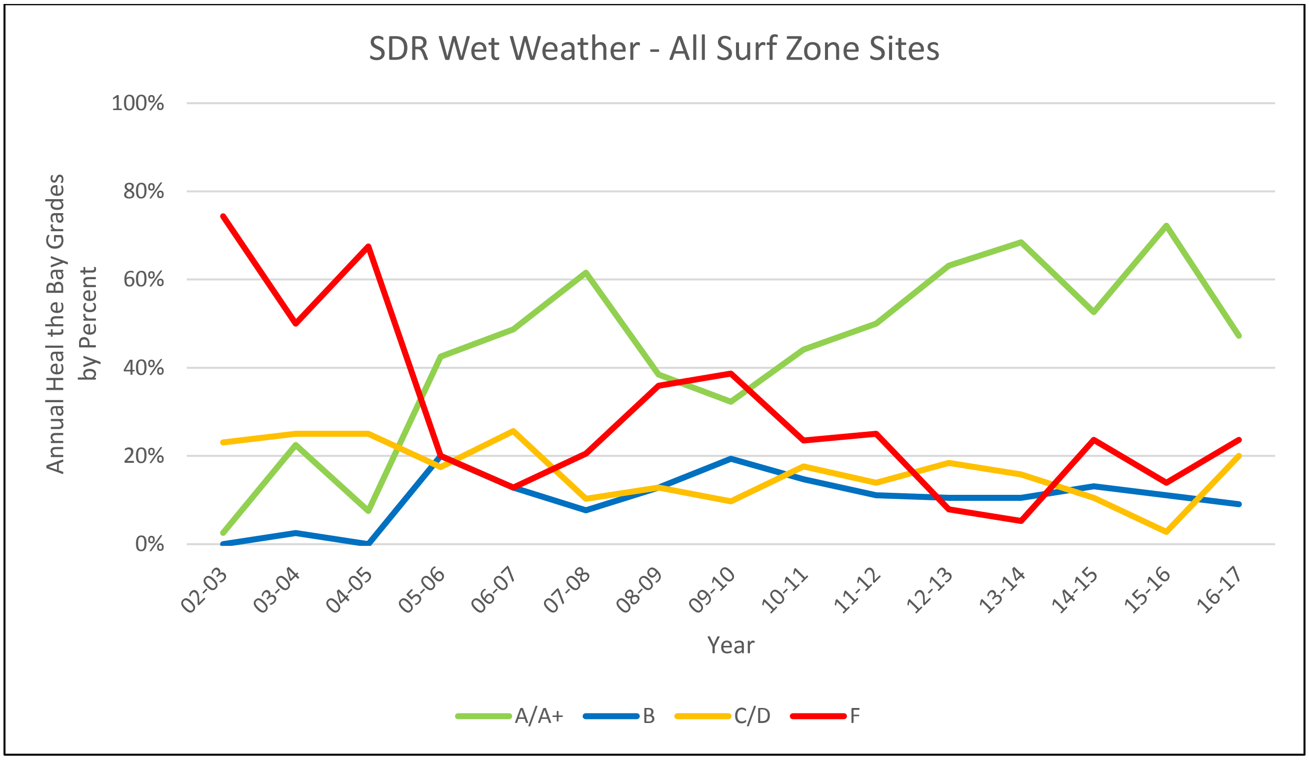


Figure 2.4: San Diego Region Wet Weather Heal the Bay report card. Data points were collected during wet weather events.



2.3 Monarch Beach Falconry Project

As seen in the previous section, the San Diego Region has been experiencing a trend of cleaner beaches. Monitoring programs in this region help to assess the levels of pollution and find their sources but monitoring itself is not a solution for cleaner waters. Programs such as the Unified Beach Water Quality Monitoring and Assessment Program attempt to investigate and inform mitigating actions to deal with the sources of pollution. One such example is the Monarch Beach Falconry Project.

When monitoring data revealed that indicator bacteria concentrations were often above exceedance levels at Monarch Beach/Salt Creek County Beach, an investigation took place that ultimately found marine birds as a potential cause of the exceedances. As a result, a pilot program was implemented to utilize a natural predator of the gulls (a Harris Hawk) and a falconer to deter the presence of the nuisance animals.

Monitoring efforts conducted prior to, during, and after this pilot program showed a significant drop in exceedance rates during the time of the program. Additionally, bird counts during the program dropped. This correlation suggests that the birds were a primary source of bacterial loading to the beach. More detail on this project can be found at https://ocgov.box.com/v/201617-TMAR-Datasets.

3 SUMMARY

The Unified Beach Water Quality Monitoring and Assessment Program showed only a 4% exceedance rate for all samples during the reporting season. While exceedance rates at individual sites were subject to variation, primarily due to the presence of surface water connectivity to the ocean, the overall exceedance rates remained consistent amongst most of the sampled stations. The AB411 season showed similar trends as the reporting period. With an average exceedance rate of 2% over all sites, site-by-site exceedances remained low with only a few stations deviating from the average.

In addition to the yearly summary, Heal the Bay's annual report cards reinforced a continuing trend in "A" rated beaches for the region during both the dry and wet seasons. When the Unified Program's results were compared to that of other monitoring programs, it was found that the Unified Program had consistently different rates at four sites of interest. Inconsistencies in monitoring and assessment protocols may be the reason for discrepancies in the results, and the Permittees will continue to monitor the results of the available data sets in the future.

On June 28, 2017, the three partnering agencies submitted a letter to the San Diego Regional Water Quality Control Board (RWQCB) outlining recommended updates and revisions to the Unified Program per the 2016 annual program review and assessment. The updates and revisions to the Unified Program will serve to:

- Strengthen coordination and improve efficiency between overlapping monitoring program requirements for the Unified Program and the Twenty Beaches and Creeks Bacteria Total Maximum Daily Load (Bacteria TMDL) Program;
- Reallocate monitoring efforts for sites deemed inaccessible due to private property access issues; and,
- Promote technological enhancements in laboratory testing methods to improve future monitoring efforts and promote public health.

On January 18, 2018, the RWQCB approved the recommended updates and revisions to the Unified Program. Additional details on the updates and revisions to the Unified Program will be provided in the 2017-18 assessment report.

APPENDIX E
BEACHES AND CREEKS TOTAL MAXIMUM DAILY LOAD

BEACHES AND CREEKS BACTERIA TMDL
(SOUTH ORANGE COUNTY)

2016-17 TRANSITIONAL MONITORING AND ASSESSMENT ANNUAL REPORT

COUNTY OF ORANGE
ORANGE COUNTY FLOOD CONTROL DISTRICT AND
SOUTH ORANGE COUNTY CITIES

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EXECUTIVE SUMMARY

The Fecal Indicator Bacteria Total Maximum Daily Load (TMDL), which includes 30 water bodies in the south Orange County, was adopted in 2011. The requirements in the Bacteria TMDL were subsequently incorporated into the south Orange County's fifth term Municipal Separate Storm Sewer System (MS4) Permit on February 11, 2015. The Fifth Term Permit requires the County of Orange, Orange County Flood Control District and south Orange County cities[1] (Permittees) to develop a water quality improvement plan (WQIP) as a watershed management area by April 1, 2017. In response, the Permittees have developed and submitted the WQIP to the San Diego Regional Water Quality Control Board (Regional Board) during the 2016-17 reporting period. Before the WQIP is officially approved by the Regional Board, the Fifth Term Permit requires the Permittees to:

1) Implement the monitoring programs developed as part of any implementation plans or load reduction plans (e.g. Bacteria Load Reduction Plans, Comprehensive Load Reduction Plans) for the TMDL.
2) Submit the TMDL monitoring and assessment results as part of the Transitional Monitoring and Assessment Program and WQIP Annual Reports according to the assessment and reporting requirements in Attachment E.6 of the Fifth Term Permit.

This report summarizes the Bacteria TMDL monitoring and assessment results for reporting year 2017 and fulfills the Fifth Term Permit requirements. The reporting period is from October 1, 2016 to September 30, 2017, which covers a complete year of monitoring during the wet season (October 1 – April 30) and dry season (May 1-September 30) as defined in the Bacteria TMDL. Monitoring results were calculated in accordance with permit requirements for Dry Weather 30-Day geometric means, Wet Weather Single Sample Maximum (SSM), and Wet Weather 30-Day geometric means. Results were compared against the final and interim Receiving Water Limitation (RWLs) and assessment findings are as follows:

- **Dry weather:** Among the 27 monitored water segments, 22 have met the final dry weather RWLs which include all Clean Water Act (CWA) Section 303(d) (CWA 303(d)) delisted segments and Poche Beach. San Clemente City Beach at Pier has limited exceedance of 3 percent for *Enterococcus* (ENT). The dry weather 30 day geometric mean exceedance rate for San Juan Creek and Creek mouth is not available due to limited data and flow being intermit. Similar to last year, the water bodies with elevated bacteria levels that do not meet dry weather final RWLs are Aliso Creek (CTPJ01) and Aliso Creek mouth (ACM1).

  ACM1 is approximately 1 ¼ miles downstream of CTPJ01 and CTPJ01 is downstream of major drains and tributaries; however, the dry weather exceedance levels at ACM1 were consistently higher than CTPJ01. Potential sources of elevated bacteria levels between the two stations are bacteria regrowth and droppings from birds that congregate at the Creek mouth. The beach water bacteria concentrations remain low but fluctuate with the creek mouth's condition due to the sand berm being intermittently open.

[1] South Orange County Cities include: Aliso Viejo, Dana Point, Laguna Beach, Laguna Hills, Laguna Niguel, Lake Forest, Mission Viejo, Rancho Santa Margarita, San Clemente, San Juan Capistrano

- **Wet weather:** Among the 27 monitored water body locations, 15 met the wet weather final RWLs which predominately are CWA 303(d) delisted segments and Poche Beach (POCHEd) and San Clemente City Beach under Pier (PIERd). Stations with elevated bacteria levels are: Laguna Beach segments (at Heisler park(HEISLERz), at main beach (MAINBCz), at ocean avenue(VICTRAz), at Cleo Street (CLEOz) and at Arch Cove at Bluebird Canyon Road(BLULRNz)), Aliso Creek(ACJ01), ACM1, San Juan Creek (SJCL01), sufzone at San Juan Creek (SJC1d), San Juan Creek mouth(SJC1), San Clemente City Beach at Mariposa Street (MARIPOz), and Trafalgar Canyon (TRFCYNz).

  The 2016-17 storm season was much wetter than average. An average of 17 inches of rain occurred across South Orange County. There were 65 wet weather days during the 2016-17 reporting year. A total of 4 targeted storms were sampled at the CWA 303(d) listed water bodies at stations ACM1, SJC1, SJCL01, SJC1d, POCHEd and PIERd on October 25-27, November 21-23, January 6-8, and February 8-10. For CWA 303(d) delisted beach segments, analysis was conducted using data from the routine weekly sampling events during wet weather conditions. As wet weather attainment is highly impacted by rainfall pattern and available number of samples, which vary from year to year, it is critical to recognize attainment of RWL should not be the sole representation of the site condition.

1. INTRODUCTION

1.1 Background

In 2002, a total of 30 water segments from 6 Hydrologic Subareas (HSAs) (**Table 1.1**) within south Orange County were placed on the 2002 Clean Water Act (CWA) Section 303(d) List (CWA 303(d) list) of impaired water bodies. Levels of Fecal Indicator Bacteria (FIBs) at these 30 water segments exceeded the water quality objectives (WQOs) for contact water recreation (REC-1) beneficial uses. Those water segments include creeks, creek mouths, and beaches. Following the 2012 CWA 303(d) listing, the San Diego Regional Water Quality Control Board (Regional Board) adopted Order No. R9-2010-0001: Revised Total Maximum Daily Loads for Indicator Bacteria, Project I – Twenty Beaches and Creeks in the San Diego Region (Including Tecolote Creek)) (hereinafter, Bacterial TMDL) on February 10, 2010, and became effective on April 4, 2011. The goal of the Bacteria TMDL is to limit bacteria load into the water bodies and to restore the REC-1 beneficial use. In response to the adoption of the Bacteria TMDL, the Permittees developed the Aliso Creek, San Juan Creek and San Clemente Comprehensive Load Reduction Plans (CLRPs) in 2012.

The Bacteria TMDL includes 30 water segments that were based on the 2002 CWA 303(d) listing. During the 2010 CWA 303(d) listing cycle 23 of the beach segments were subsequently delisted for FIB. The Bacteria TMDL acknowledged the delisted waterbodies being "not subject to any further actions as long as monitoring data continues to support compliance with water quality standards". **Table 1.1** summarizes the Bacteria TMDL water segments from the current 2012 CWA 303(d) list.

The Fifth Term Municipal Stormwater Permit (Fifth Term Permit, Order R9-2013-0001 as amended by R9-2015-0001 and R9-2015-0100) was adopted for south Orange County on February 11, 2015. It incorporates specific provisions to implement the Bacteria TMDL. According to the requirement of the permit, the County of Orange, Orange County Flood Control District and south Orange County cities[1] (Permittees) developed a water quality improvement plan (WQIP) as a region wide water quality planning strategy and submitted the WQIP on April 1, 2017. While the WQIP is under approval process by the Regional Board, the Fifth Term Permit requires the Permittees to:

1) Implement the monitoring programs developed as part of an implementation plans or load reduction plans (e.g. Bacteria Load Reduction Plans or Comprehensive Load Reduction Plans) for the TMDL; and

2) Submit TMDL monitoring and assessment results as part of the Transitional Monitoring and Assessment Program and WQIP Annual Reports. For delisted water bodies, the Fifth Term Permit allows the Permittees to propose alternative monitoring procedures to demonstrate compliance.

[1] South Orange County Cities include: Aliso Viejo, Dana Point, Laguna Beach, Laguna Hills, Laguna Niguel, Lake Forest, Mission Viejo, Rancho Santa Margarita, San Clemente, San Juan Capistrano

This report fulfills the two requirements above by summarizing the Bacteria TMDL monitoring and assessment results in accordance with the requirements in the Fifth Term Permit. The reporting period, as defined in the Permit, is from October 1to September 30and including both wet season (October 1 – April 30) and dry season (May 1 – September 30) monitoring.

Due to the reason stated above regarding CWA 303(d) delisting, monitoring activities defined in the CLRP have been focusing on water bodies that remain on the CWA 303(d) list through TMDL targeted monitoring. The delisted segments are currently monitored weekly through the Unified Beach Water Quality Monitoring Program (Unified Program), which is a collaborative monitoring and assessment program between the Permittees, South Orange County Wastewater Authority, and the Orange County Health Care Agency (see **Appendix D**). In order to fulfill the permit's assessment requirements, analyses performed in this report utilize available data from various monitoring beyond CLRPs and additional monitoring needed to better assess the Bacteria TMDL compliance will be proposed in the WQIP and subsequently reported in future annual reports.

Table 1.1 TMDL Water Segments and CWA 303(d) Listing Condition

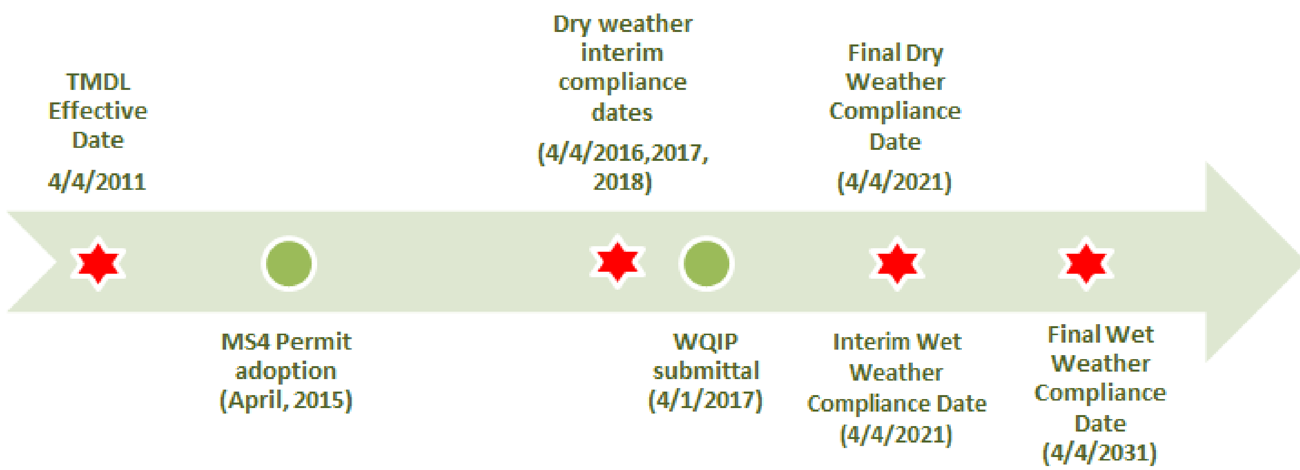
Watershed Management Area	Water Body	Segment	2012 303(d) List	
			Listed	Delisted
San Joaquin Hills(901.11) and Laguna Beach(901.12)	Pacific Ocean Shoreline	Cameo Cove at Irvine Cove Drive –Riviera Waya*		X
		At Heisler Park -- North		X
	Pacific Ocean Shoreline	At Main Laguna Beach		X
		Laguna Beach at Ocean Avenue		X
		Laguna Beach at Cleo Street		X
		Arch Cove at Bluebird Canyon Road		X
		Laguna Beach at Dumond Drive		X
Aliso (901.13)	Pacific Ocean Shoreline	Laguna Beach at Lagunita Place /Blue Lagoon Place at Aliso Beach		X
	Aliso Creek	Aliso Creek	X	
	Aliso Creek Mouth	at mouth	X	
DanaPoint(901.14)	Pacific Ocean Shoreline	Aliso Beach at West Street		X
		Aliso Beach at Table Rock Drive		X
		1000 Steps Beach at Pacific Coast Hwy at Hospital (9th Ave)		X
		At Salt Creek (large outlet)		X
		Salt Creek Beach at Salt Creek service road		X
		Salt Creek Beach at Dana Strand Road		X
Lower San Juan (901.15)	Pacific Ocean Shoreline	at San Juan Creek	X	
	San Juan Creek	lower 1 mile	X	
	San Juan Creek Mouth	at mouth	X	
San Clemente (901.16)	Pacific Ocean Shoreline	at Poche Beach	X	
		Ole Hanson Beach Club Beach at Pico Drain		X
		San Clemente City Beach (SCCB) at El Portal Street Stairs*		X
		SCCB at Mariposa Street		X
		SCCB at Linda Lane		X
		SCCB at South Linda Lane*		X
		SCCB at Lifeguard Headquarters		X
		Under San Clemente Municipal Pier	X	
		SCCB at Trafalgar Canyon (Trafalgar Lane)		X
		San Clemente State Beach (SCSB) at Riviera Beach		X
		SCSB at Cypress Shores*		X
Non-TMDL New listed water bodies				
Aliso (901.13)	Pacific Ocean Shoreline	at Aliso Creek mouth	X	
		at Aliso Beach - middle	X	
Lower San Juan (901.15)		at North Beach Creek	X	
		at North Doheny State Park Campground	X	
San Clemente (901.16)		at South Capistrano County Beach	X	
		at South Capistrano Beach at Beach Road	X	

* Water segments were omitted since the 2010 303(d) list

1.2 TMDL Requirements

The Bacteria TMDL provides a timeline for the interim and final compliance dates over a 20-year period (2011–2031), as shown in **Figure 1.1** below.

Figure 1.1 Bacteria TMDL Timeline



Water quality-based effluent limitations (WQBELs) are the basis for assessing the monitoring data (as provided in Attachment E of the Fifth Term Permit). The WQBELs include Receiving Water Limitations (RWLs) for beaches and creeks and effluent limitations for outfall discharges. These limitations may be expressed as concentration limits, allowable exceedance frequencies or load reduction targets. This report focuses on the assessment of the attainment of the allowable exceedance frequencies as they are most closely linked to REC-1 beneficial use and is supported by current available data sets. Monitoring results are compared with the final and interim RWLs in the form of allowable exceedance frequencies.

Interim Receiving Water Limitations

The interim RWLs for dry weather are a 50 percent reduction in "existing dry weather exceedance frequencies of the 30-day geometric mean WQOs" calculated from available data between January 1, 1996 and December 31, 2002. They have to be calculated and included in the proposed WQIP which will be finalized and presented in future reports upon the WQIP is approved. The interim RWLs for wet weather, as defined in the Fifth Term Permit, are shown in **Table 1.2**.

Table 1.2 Interim RWLs for Wet Weather

Hydrologic SubArea (HSA)	Water Body	Segment	Interim Dry Weather Compliance Date	Interim Wet Weather Limitation			Interim Wet Weather Compliance Date
				ENT	FC	TC	
San Joaquin Hills(901.11) and Laguna Beach(901.12)	Pacific Ocean Shoreline	Cameo Cove at Irvine Cove Drive –Riviera Waya*	4/4/2016	39%	37%	38%	4/4/2021
		At Heisler Park -- North	4/4/2016	39%	37%	38%	4/4/2021
	Pacific Ocean Shoreline	At Main Laguna Beach	4/4/2016	39%	37%	38%	4/4/2021
		Laguna Beach at Ocean Avenue	4/4/2016	39%	37%	38%	4/4/2021
		Laguna Beach at Cleo Street	4/4/2016	39%	37%	38%	4/4/2021
		Arch Cove at Bluebird Canyon Road	4/4/2016	39%	37%	38%	4/4/2021
		Laguna Beach at Dumond Drive	4/4/2016	39%	37%	38%	4/4/2021
Aliso (901.13)	Pacific Ocean Shoreline	Laguna Beach at Lagunita Place /Blue Lagoon Place at Aliso Beach	4/4/2016	41%	41%	42%	4/4/2021
	Aliso Creek	Aliso Creek	4/4/2018	41%	41%	42%	4/4/2021
	Aliso Creek Mouth	at mouth	4/4/2018	41%	41%	42%	4/4/2021
DanaPoint(901.14)	Pacific Ocean Shoreline	Aliso Beach at West Street	4/4/2016	36%	36%	36%	4/4/2021
		Aliso Beach at Table Rock Drive	4/4/2016	36%	36%	36%	4/4/2021
		1000 Steps Beach at Pacific Coast Hwy at Hospital (9th Ave)	4/4/2016	36%	36%	36%	4/4/2021
		At Salt Creek (large outlet)	4/4/2016	36%	36%	36%	4/4/2021
		Salt Creek Beach at Salt Creek service road	4/4/2017	36%	36%	36%	4/4/2021
		Salt Creek Beach at Dana Strand Road	4/4/2017	36%	36%	36%	4/4/2021
Lower San Juan (901.15)	Pacific Ocean Shoreline	at San Juan Creek	4/4/2016	44%	44%	48%	4/4/2021
	San Juan Creek	lower 1 mile	4/4/2018	44%	44%	47%	4/4/2021
	San Juan Creek Mouth	at mouth	4/4/2016	44%	44%	47%	4/4/2021
San Clemente (901.16)	Pacific Ocean Shoreline	at Poche Beach	4/4/2016	35%	35%	36%	4/4/2021
		Ole Hanson Beach Club Beach at Pico Drain	4/4/2016	35%	35%	36%	4/4/2021
		San Clemente City Beach (SCCB) at El Portal Street Stairs*	4/4/2017	35%	35%	36%	4/4/2021
		SCCB at Mariposa Street	4/4/2017	35%	35%	36%	4/4/2021
		SCCB at Linda Lane	4/4/2016	35%	35%	36%	4/4/2021
		SCCB at South Linda Lane*	4/4/2018	35%	35%	36%	4/4/2021
		SCCB at Lifeguard Headquarters	4/4/2017	35%	35%	36%	4/4/2021
		Under San Clemente Municipal Pier	4/4/2017	35%	35%	36%	4/4/2021
		SCCB at Trafalgar Canyon (Trafalgar Lane)	4/4/2018	35%	35%	36%	4/4/2021
		San Clemente State Beach (SCSB) at Riviera Beach	4/4/2016	35%	35%	36%	4/4/2021
		SCSB at Cypress Shores*	4/4/2017	35%	35%	36%	4/4/2021

* No historical monitoring station at this water segment, interim dry weather limitation not available
** Will be included upon WQIP adoption

Final Receiving Water Limitations

The final RWLs, expressed in allowable exceedance frequencies, are presented below in **Table 1.3**, and include Single Sample Maximum (SSM) and 30-Day geometric mean requirements for each FIB: Fecal Coliform (FC), Total Coliform (TC) and *Enterococcus* (ENT). A 22% exceedance frequency is allowed during wet weather days (defined as a day with >0.2" inches precipitation and 3 subsequent days) to account for reference conditions (defined as >93% watershed area being undisturbed) and distinct FIB sources, conveyance, and fate during infrequent storms in Southern California.

Table 1.3 Final Receiving Water Limitations (RWLs)

Constituent	Wet Weather Days[h]		Dry Weather Days	
	Single Sample Maximum (SSM) (MPN/100mL)[b,c]	Single Sample Maximum Allowable Exceedance Rate[d]	30-Day Geometric Mean (GM) (MPN/100mL)	30-Day Geometric Mean Allowable Exceedance Rate
Total Coliform[a]	10000	22%	1000	0%
Fecal Coliform	400	22%	200	0%
Enterococcus	61/104[e,f]	22%	35/33[g]	0

Notes:
a. Beach only
b. During wet weather days,only the SSM receiving water limitations are required to be achieved.
c. During dry weather days, the SSM and 30-day GM receiving water limitations are required to be achieved
d. The 22% SSM allowable exceedance frequency only applied to wet weather days. For dry weather days, the dry weather bacteria densities must be consistent with the SSM REC-1 water quality objectives in the Ocean Plan
e. For creeeks: A SSM of 104 MPN/100mL for Enterococcus may be applied as a receiving water limitation for creeks, instead of 61 MPN/100mL if one or more of the creeks addressed by these TMDLs is designated with a "moderately to lightly used area" or less frequent usage frequency in the Basin Plan. Otherwise, the SSM of 61 MPN/100mL must be used.
f. For beaches: a SSM of 104 MPN/100mL for Enterococcus is applied.
g. For beaches, it is 35 MPN/100mL. For Creeks, it is 33 MPN/100mL.
h. Wet weather days are defined as days with rainfall events of 0.2 inches or greater, plust the following 72 hours

2. MONITORING AND ASSESSMENT METHODS

2.1 Monitoring Locations, Frequencies and Methodologies

2.1.1 Dry Weather Monitoring

For beach segments, grab samples are collected weekly through the Unified Program and analyzed for FC, TC, and ENT. To increase inter-agency sampling efficiency, many monitoring stations used in the 2002 CWA 303(d) listing cycle were consolidated in 2015 with nearby stations from other monitoring programs. Certain historical stations were eliminated or may have been given a different station code. When possible, a station that has an extensive historical monitoring dataset is used when long-term comparisons are needed. In this transitional reporting period, monitoring locations were selected based on the following considerations: (subject to modification after WQIP approval):

1) When an historical station still exists in the current Unified Program, the historical station will be used as monitoring location to represent the beach segment. (e.g S-17, S6 etc.)

2) When historical stations are combined and renamed, the stations are often named by the street name near the storm drain followed by a letter "z", "d" or "u". They are called as Z point[2], down-coast[3] or up-coast[4] stations in the Unified Program. If the drain is not flowing to the ocean, a Z point station is used. If the creek flows to the ocean, a down-coast station is used.

3) When historical stations are combined in the Unified Program but the new station is not appropriate to represent the historical station, the monitoring point selected is the closest to the older station. For example, station SCM1u is the closest station to represent station "OSL25" for the surf zone of Monarch Beach at the Salt Creek outlet. Modification to the Unified Program has been proposed and approved by the Regional Board and will be reflected in the next annual report.

For creeks and creek mouths, samples are collected and analyzed for FC and ENT. Dry weather creek sampling is performed twice a year at Long Term Mass Emission stations (e.g ACJ01) and monthly at watershed assessment stations (e.g CTPJ01, L01-PCH) located upstream of the mouth. Creek mouths (SJC1 and ACM1) are monitored at least monthly during dry weather.

Figures 2.1(a)-(e) depict the dry weather monitoring points and their associated water segments sequentially from north to south.

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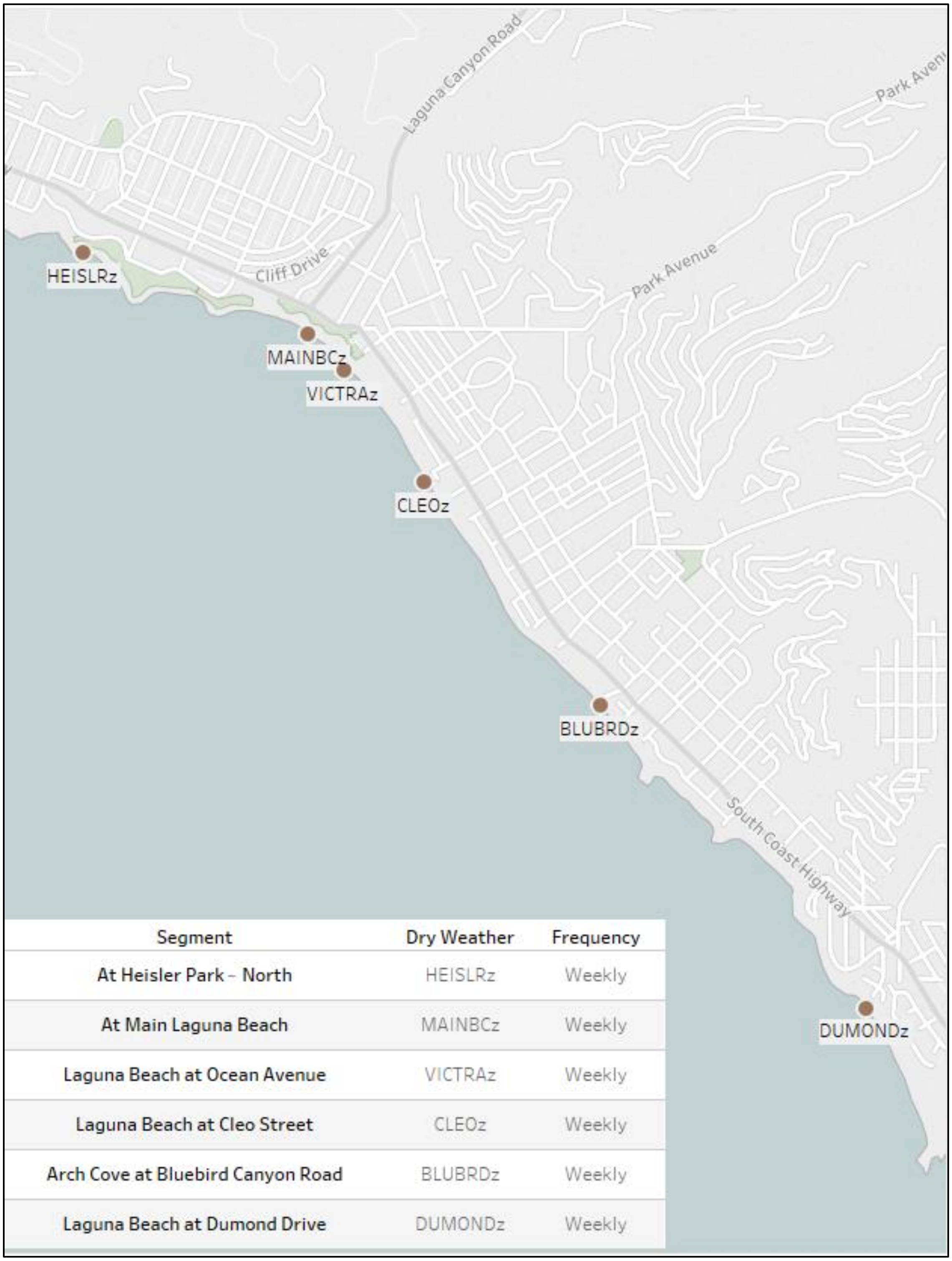
[2] Z point: A Z point is defined as the position along the shoreline where it appears that surface flow would enter the ocean if there were a surface flow) station will be used. It is coded with a "z" at the end of each drain's name, such as "MARIPOz".

[3] Down-coast station: A downcoast station is defined as seventy-five feet downcast from where the surface flow enters the ocean. It is coded with a "d" at the end of each drain's name, such as "MARIPOd".

[4] Up-coast station: An up coast station is defined as seventy-five feet up coast from where the surface flow enters the ocean. It is coded with a "u" at the end of each drain's name, such as "MARIPOu".

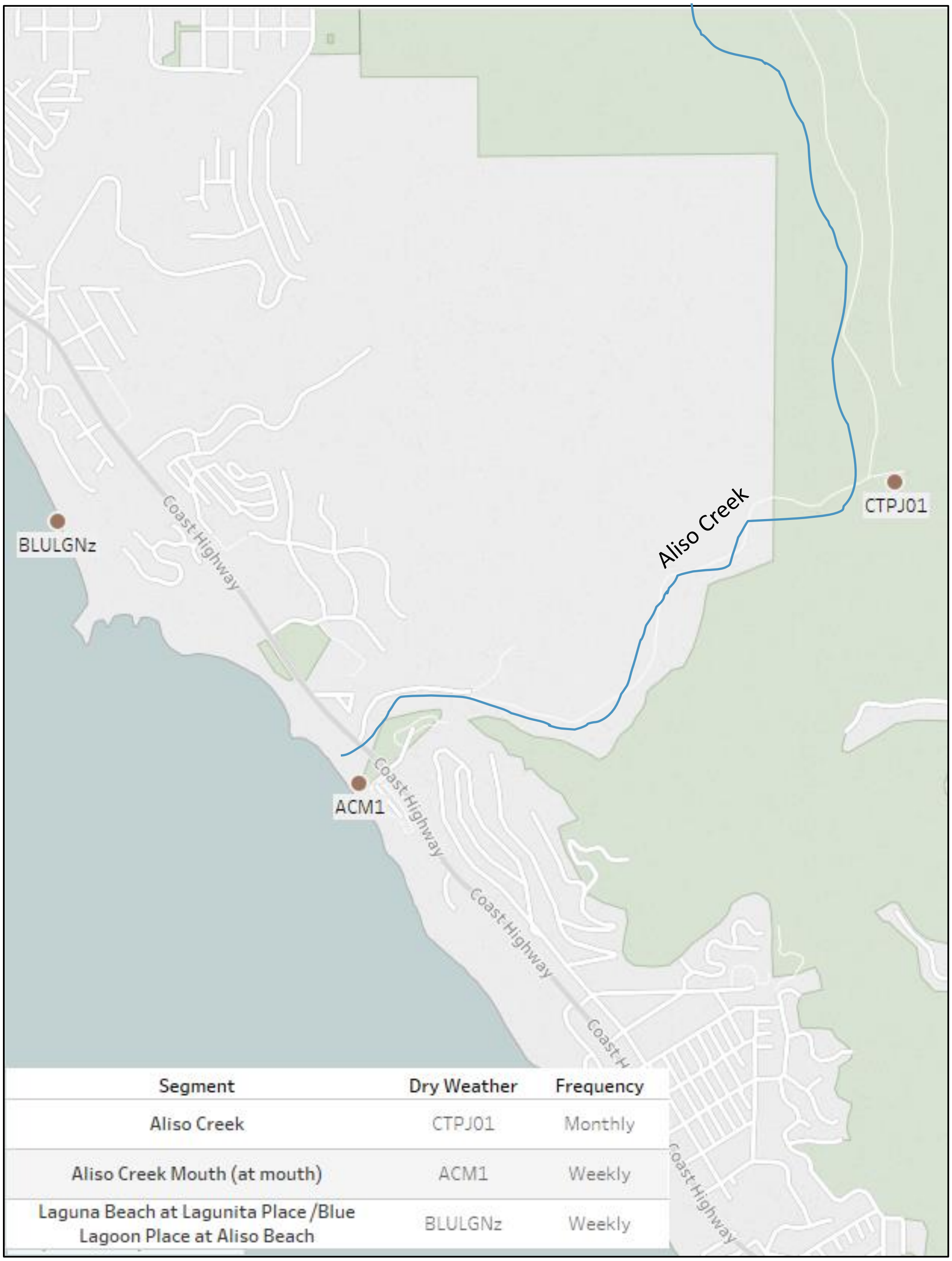
Figure 2.1(a) Dry Weather TMDL Monitoring Locations
(San Joaquin and Laguna HSA)



Segment	Dry Weather	Frequency
At Heisler Park – North	HEISLRz	Weekly
At Main Laguna Beach	MAINBCz	Weekly
Laguna Beach at Ocean Avenue	VICTRAz	Weekly
Laguna Beach at Cleo Street	CLEOz	Weekly
Arch Cove at Bluebird Canyon Road	BLUBRDz	Weekly
Laguna Beach at Dumond Drive	DUMONDz	Weekly

Monitoring locations and sampling frequencies may change upon approval of the WQIP.

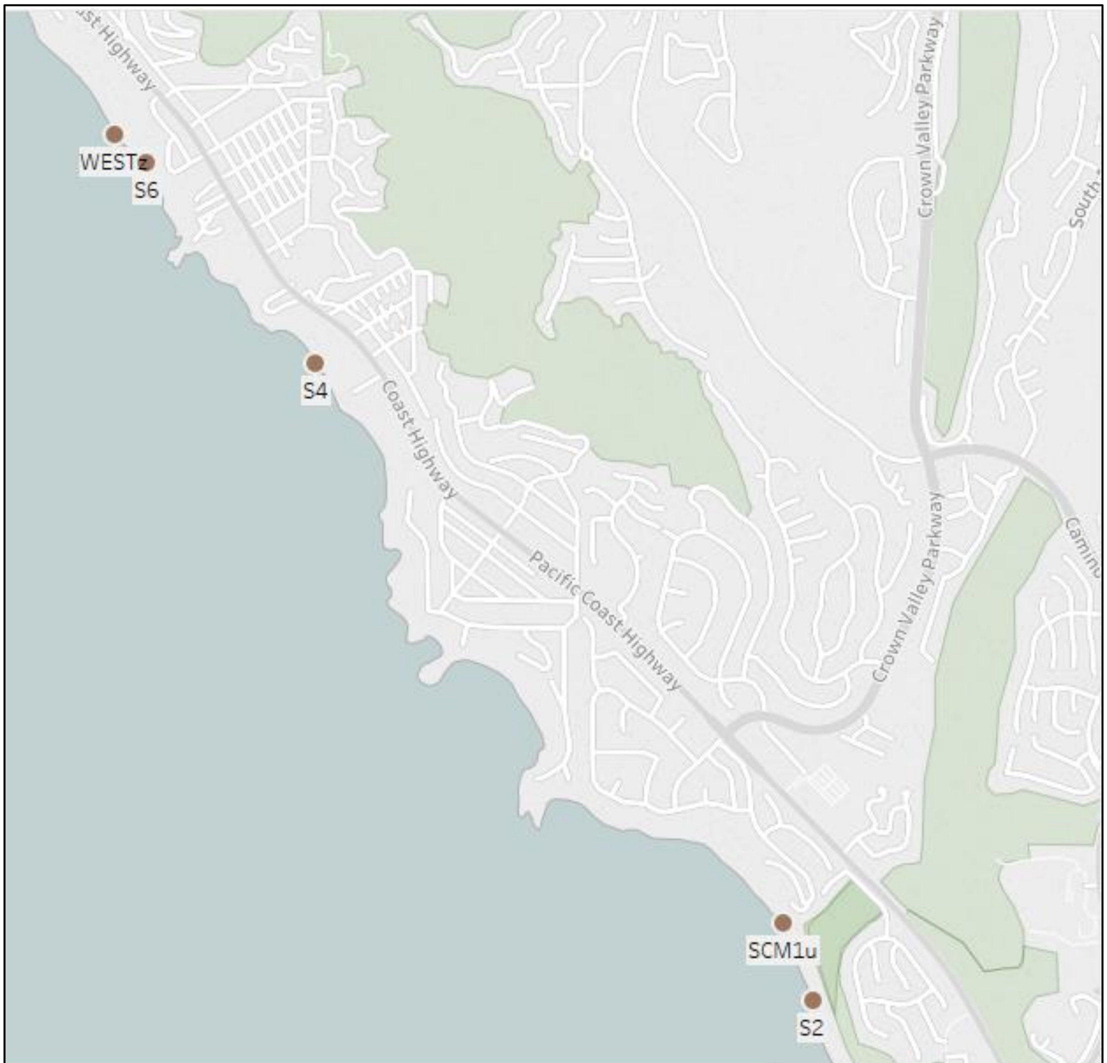
Figure 2.1(b) Dry Weather TMDL Monitoring Locations
(Aliso HSA)



Segment	Dry Weather	Frequency
Aliso Creek	CTPJ01	Monthly
Aliso Creek Mouth (at mouth)	ACM1	Weekly
Laguna Beach at Lagunita Place /Blue Lagoon Place at Aliso Beach	BLULGNz	Weekly

Monitoring locations and sampling frequencies may change upon approval of the WQIP.

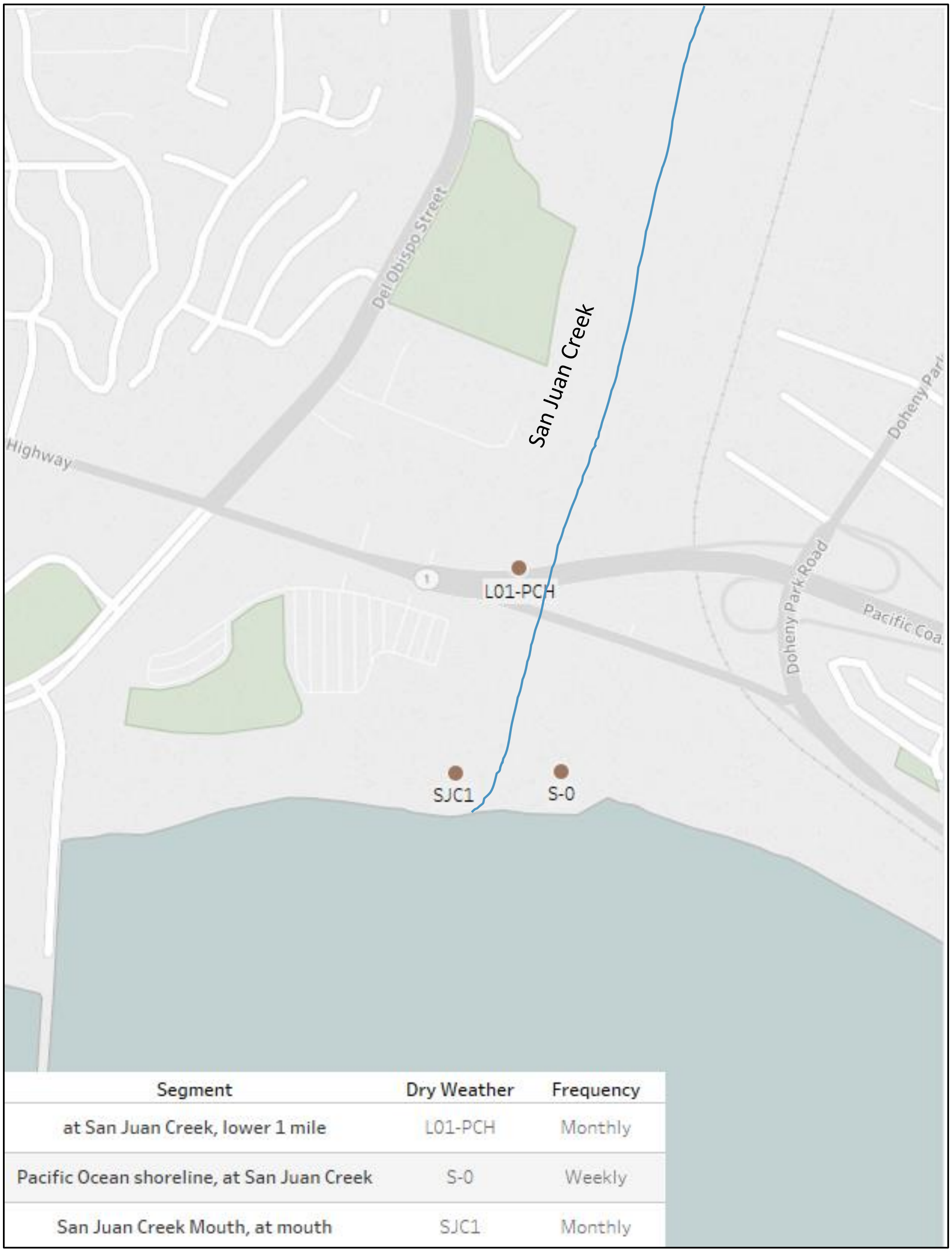
Figure 2.1(c) Dry Weather TMDL Monitoring Locations
(Dana Point HSA)



Segment	Dry Weather	Frequency
Aliso Beach at West Street	WESTz	Weekly
Aliso Beach at Table Rock Drive	S6	Weekly
1000 Steps Beach at Pacific Coast Hwy at Hospital (9th Ave)	S4	Weekly
At Salt Creek (large outlet)	SCM1u	Weekly
Salt Creek Beach at Salt Creek service road	S2	Weekly
Salt Creek Beach at Dana Strand Road	S1	Weekly

Monitoring locations and sampling frequencies may change upon approval of the WQIP.

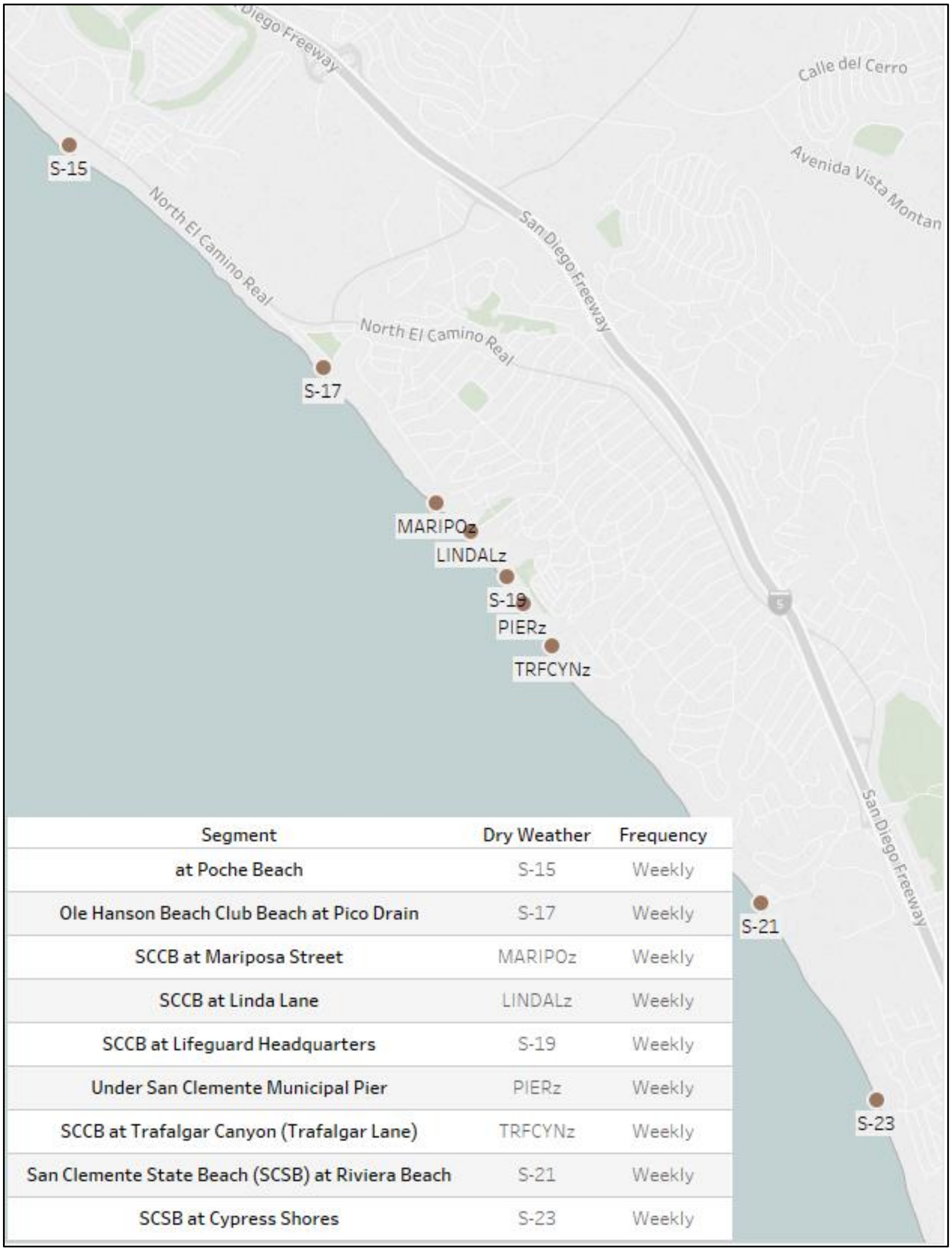
Figure 2.1(d) Dry Weather TMDL Monitoring Locations
(Lower San Juan HSA)



Segment	Dry Weather	Frequency
at San Juan Creek, lower 1 mile	L01-PCH	Monthly
Pacific Ocean shoreline, at San Juan Creek	S-0	Weekly
San Juan Creek Mouth, at mouth	SJC1	Monthly

Monitoring locations and sampling frequencies may change upon approval of the WQIP.

Figure 2.1(e) Dry Weather TMDL Monitoring Locations
(San Clemente HSA)



Segment	Dry Weather	Frequency
at Poche Beach	S-15	Weekly
Ole Hanson Beach Club Beach at Pico Drain	S-17	Weekly
SCCB at Mariposa Street	MARIPOz	Weekly
SCCB at Linda Lane	LINDALz	Weekly
SCCB at Lifeguard Headquarters	S-19	Weekly
Under San Clemente Municipal Pier	PIERz	Weekly
SCCB at Trafalgar Canyon (Trafalgar Lane)	TRFCYNz	Weekly
San Clemente State Beach (SCSB) at Riviera Beach	S-21	Weekly
SCSB at Cypress Shores	S-23	Weekly

Monitoring locations and sampling frequencies may change upon approval of the WQIP.

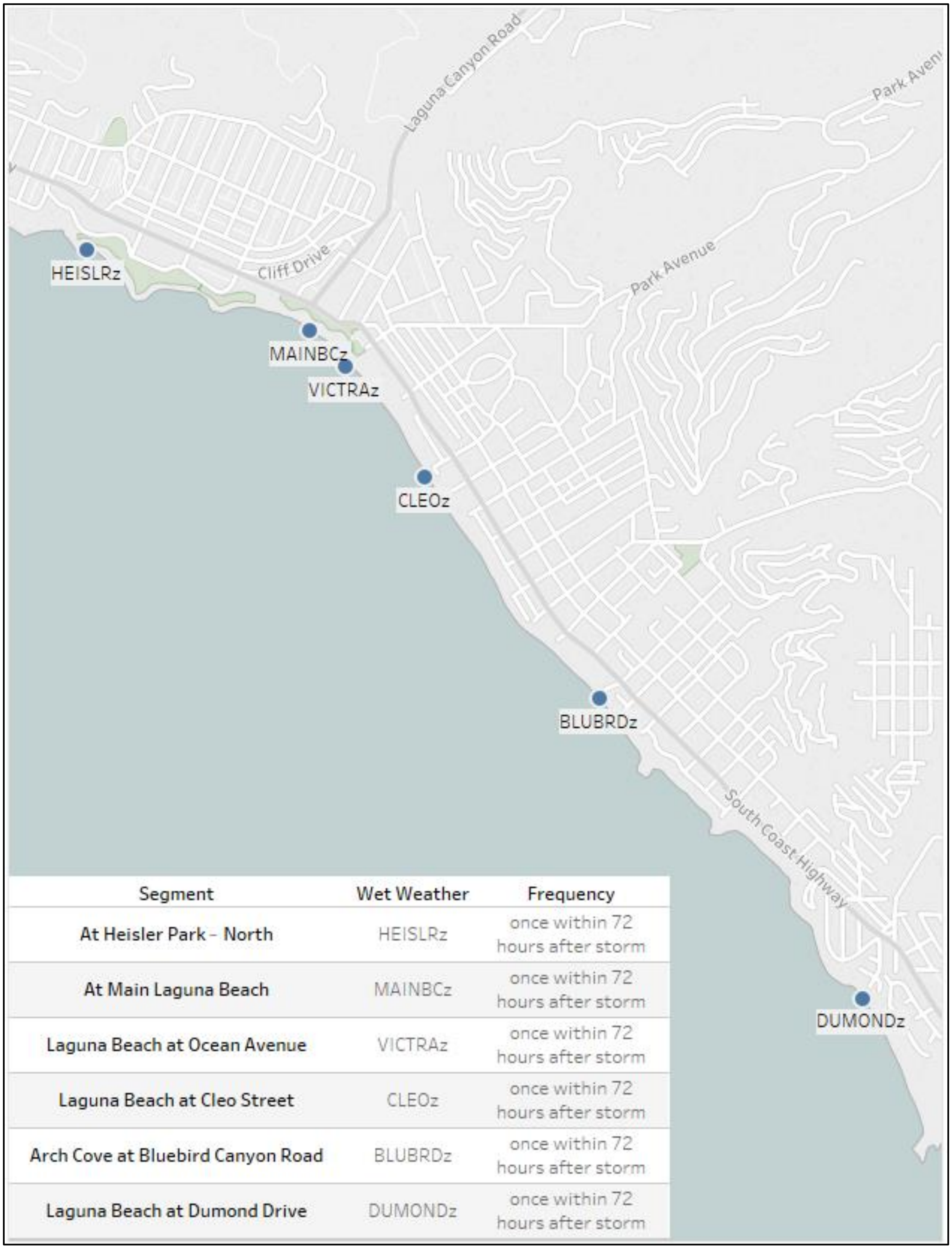
2.1.2 Wet Weather Monitoring

Wet weather sampling targets storms with greater than 0.2 inches of precipitation and is performed daily during the 72 hours following the end of the storm event. The first sample for each storm is collected within 24 hours after the storm event. A minimum of one storm event and a maximum of six storm events are monitored at each site during the wet season. To capture seasonal variation of the wet season, an effort is made to sample storms at the start of the wet season (October-November), in the middle (December-February), and towards the end of the wet season (March-April).

Wet weather sampling is highly dependent on rainfall patterns as well as safety and resource constraints. Based on the CLRP, targeted wet weather samples focus only on CWA 303(d) listed water bodies. For CWA 303(d) delisted water bodies, available data collected within 72 hours after the storm event through the weekly Unified Program are used to assess RWL attainment.

Figures 2.2(a)-(e) depict the wet weather monitoring stations and their associated water segments sequentially from north to south. Certain waterbodies have different wet weather monitoring stations from their dry weather stations due to safety concerns during storm sampling conditions and representativeness issues regarding the data collected. For example, creek flows may overwhelm Z point stations. Therefore, the downcoast location is more representative of beach conditions (e.g PIERd).

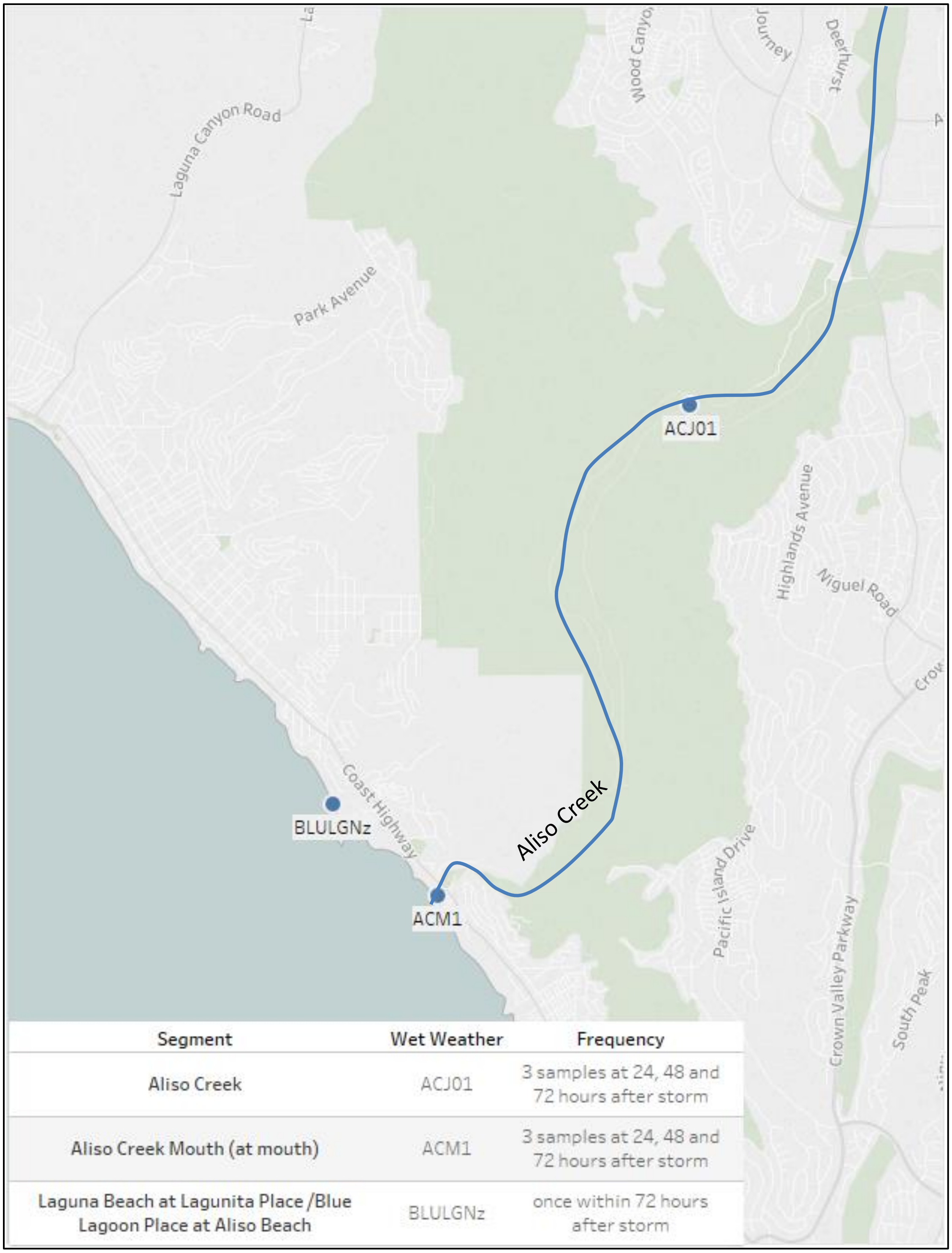
Figure 2.2(a) Wet Weather TMDL Monitoring Locations
(San Joaquin and Laguna HSA)



Segment	Wet Weather	Frequency
At Heisler Park - North	HEISLRz	once within 72 hours after storm
At Main Laguna Beach	MAINBCz	once within 72 hours after storm
Laguna Beach at Ocean Avenue	VICTRAz	once within 72 hours after storm
Laguna Beach at Cleo Street	CLEOz	once within 72 hours after storm
Arch Cove at Bluebird Canyon Road	BLUBRDz	once within 72 hours after storm
Laguna Beach at Dumond Drive	DUMONDz	once within 72 hours after storm

Monitoring locations and sampling frequencies may change upon approval of the WQIP.

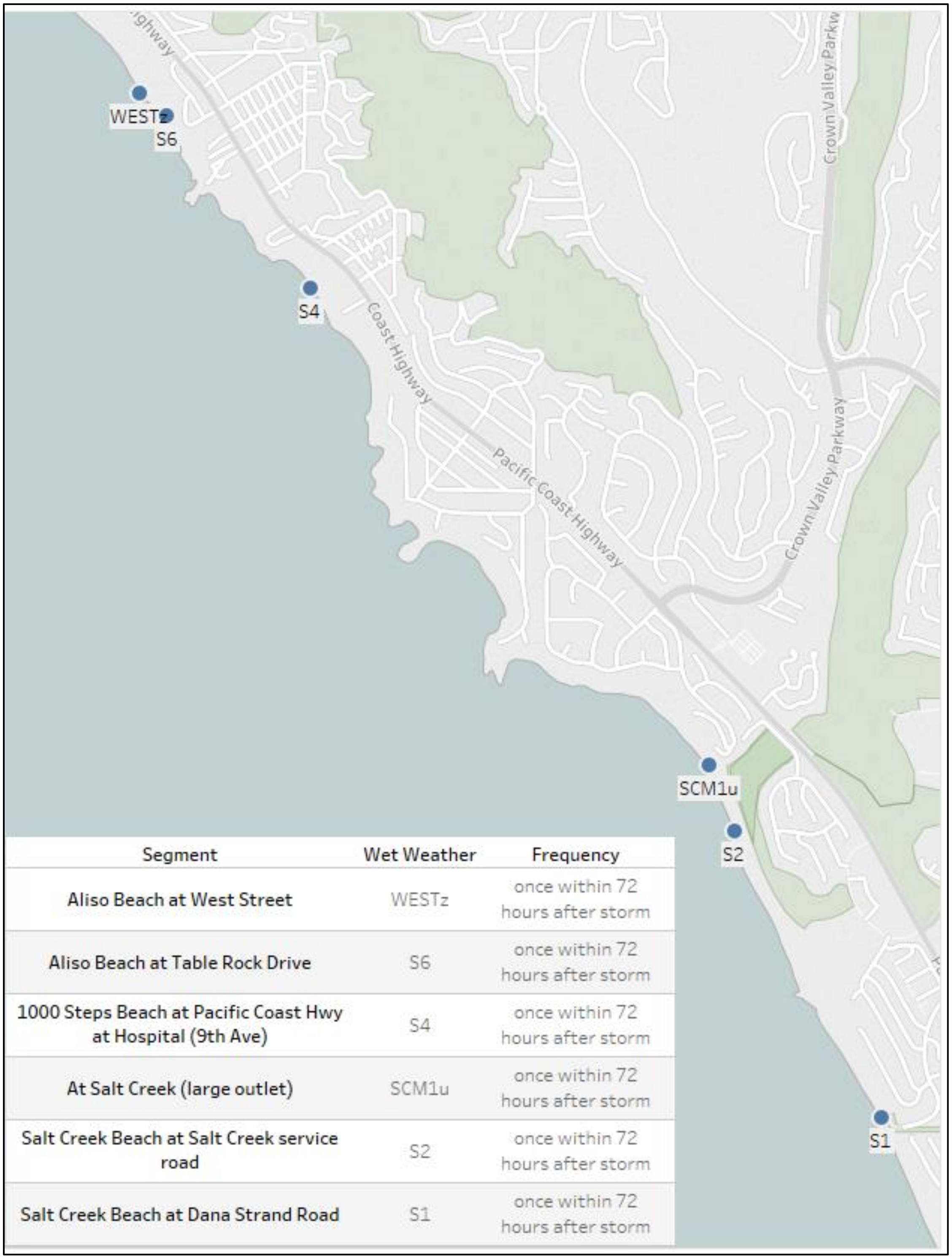
Figure 2.2(b) Wet Weather TMDL Monitoring Locations
(Aliso HSA)



Segment	Wet Weather	Frequency
Aliso Creek	ACJ01	3 samples at 24, 48 and 72 hours after storm
Aliso Creek Mouth (at mouth)	ACM1	3 samples at 24, 48 and 72 hours after storm
Laguna Beach at Lagunita Place /Blue Lagoon Place at Aliso Beach	BLULGNz	once within 72 hours after storm

Monitoring locations and sampling frequencies may change upon approval of the WQIP.

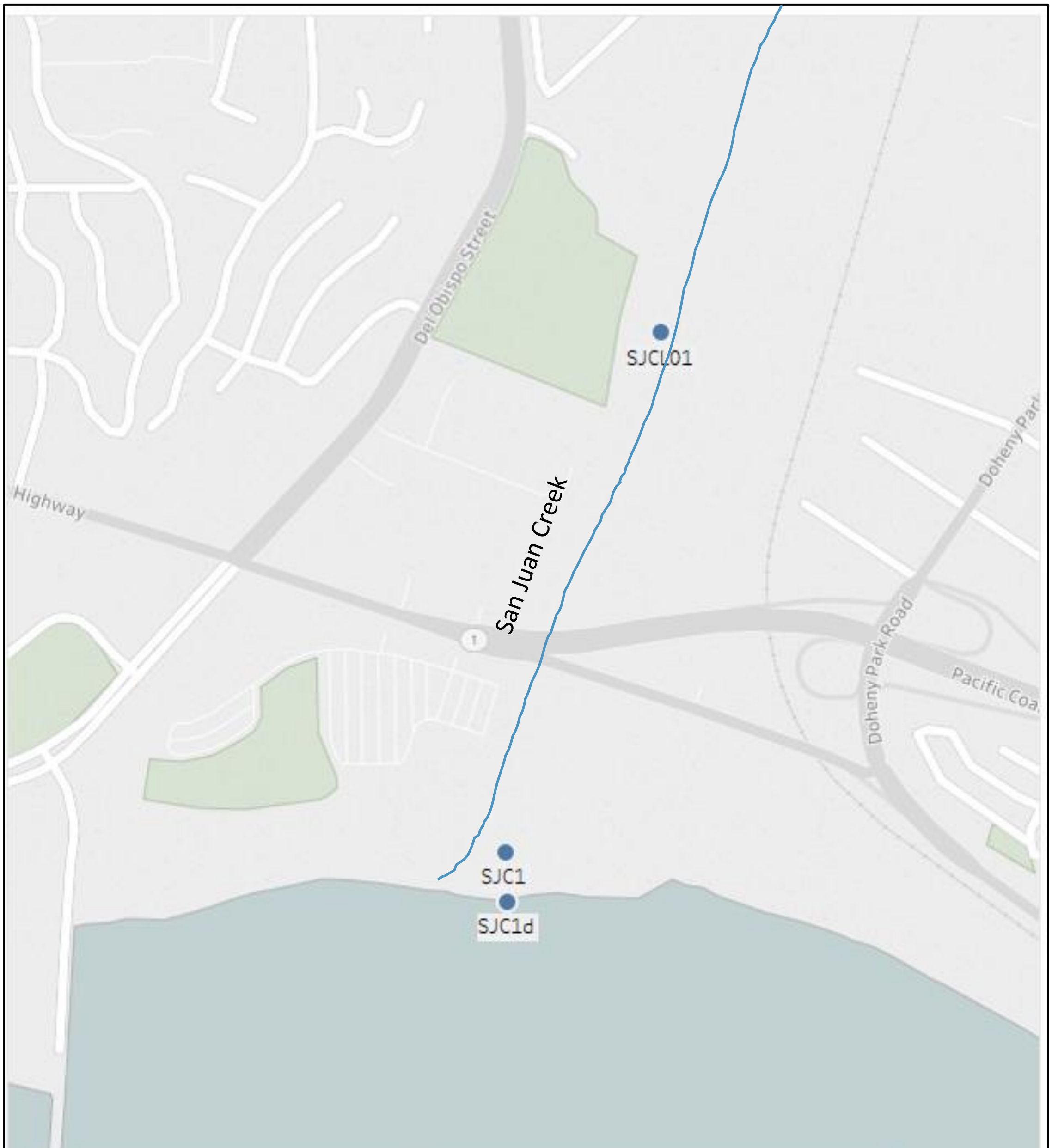
Figure 2.2(c) Wet Weather TMDL Monitoring Locations
(Dana Point HSA)



Segment	Wet Weather	Frequency
Aliso Beach at West Street	WESTz	once within 72 hours after storm
Aliso Beach at Table Rock Drive	S6	once within 72 hours after storm
1000 Steps Beach at Pacific Coast Hwy at Hospital (9th Ave)	S4	once within 72 hours after storm
At Salt Creek (large outlet)	SCM1u	once within 72 hours after storm
Salt Creek Beach at Salt Creek service road	S2	once within 72 hours after storm
Salt Creek Beach at Dana Strand Road	S1	once within 72 hours after storm

Monitoring locations and sampling frequencies may change upon approval of the WQIP.

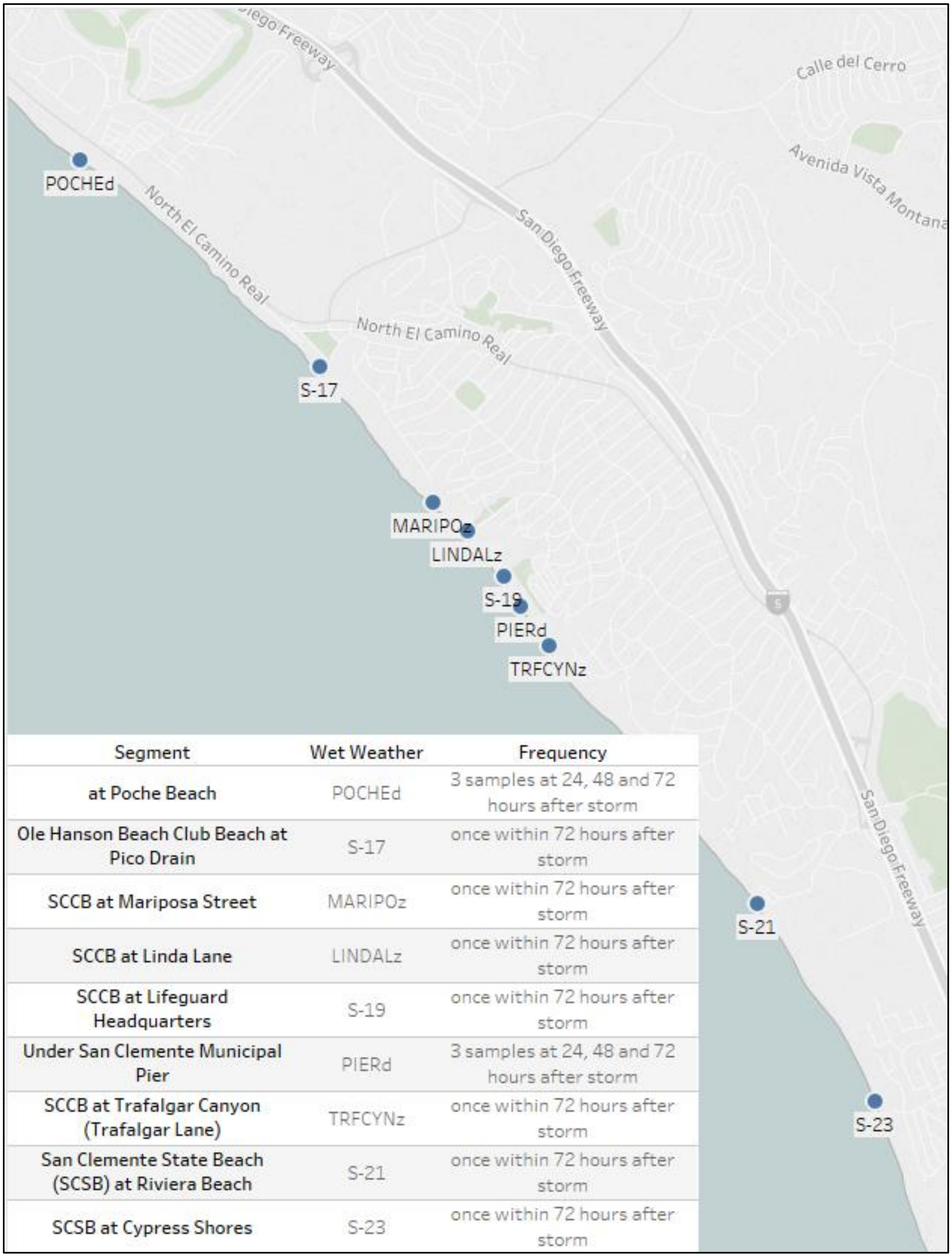
Figure 2.2(d) Wet Weather TMDL Monitoring Locations
(Lower San Juan HSA)



Segment	Wet Weather	Frequency
at San Juan Creek, lower 1 mile	SJCL01	3 samples at 24, 48 and 72 hours after storm
Pacific Ocean shoreline, at San Juan Creek	SJC1d	3 samples at 24, 48 and 72 hours after storm
San Juan Creek Mouth, at mouth	SJC1	3 samples at 24, 48 and 72 hours after storm

Monitoring locations and sampling frequencies may change upon approval of the WQIP.

Figure 2.2(e) Wet Weather TMDL Monitoring Locations
(San Clemente HSA)



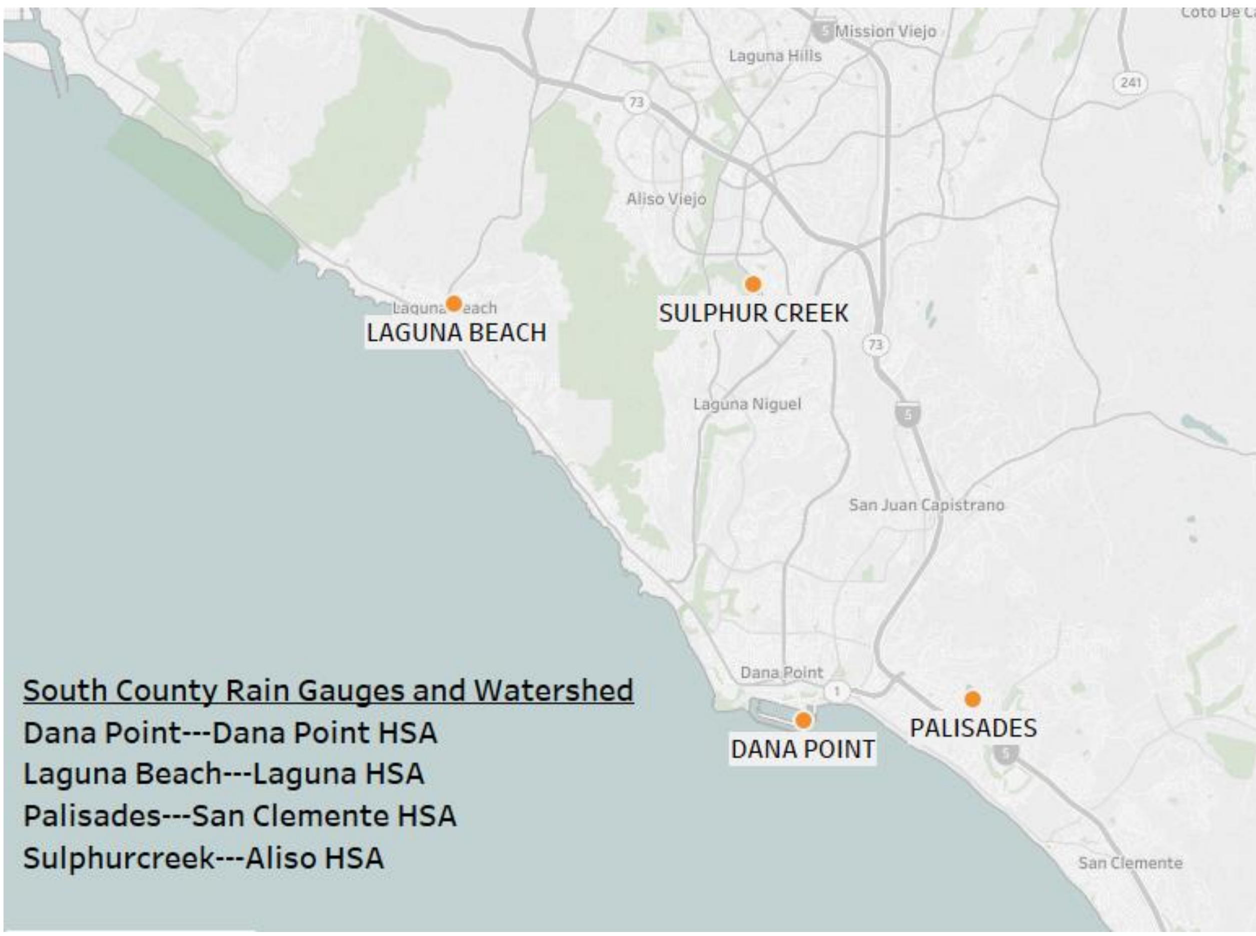
Segment	Wet Weather	Frequency
at Poche Beach	POCHEd	3 samples at 24, 48 and 72 hours after storm
Ole Hanson Beach Club Beach at Pico Drain	S-17	once within 72 hours after storm
SCCB at Mariposa Street	MARIPOz	once within 72 hours after storm
SCCB at Linda Lane	LINDALz	once within 72 hours after storm
SCCB at Lifeguard Headquarters	S-19	once within 72 hours after storm
Under San Clemente Municipal Pier	PIERd	3 samples at 24, 48 and 72 hours after storm
SCCB at Trafalgar Canyon (Trafalgar Lane)	TRFCYNz	once within 72 hours after storm
San Clemente State Beach (SCSB) at Riviera Beach	S-21	once within 72 hours after storm
SCSB at Cypress Shores	S-23	once within 72 hours after storm

Monitoring locations and sampling frequencies may change upon approval of the WQIP.

2.1.3 Precipitation

Figure 2.3 depicts the locations of the rain gages throughout south Orange County that were used in this report. Wet weather samplings are initiated based on Orange County Automated Local Evaluation in Real Time (ALERT) rain gauges when a 0.2 inch or more of rain is observed at any of the rain gauges listed below. Total wet weather days are calculated by adding the rainy days with the 72 hours post the last rainy day of each storm event. Rainy days were determined when any of the daily rainfall accumulation records of the four stations had a value of more than 0.2 inch. As the four stations located across south Orange County share similar rainfall patterns, the use of maximum rainfall captures all rainy days. A manual check has also been conducted to check exceptions as a quality control procedure.

Figure 2.3 Rain Gauge Locations



2.2 Assessment Methods

Dry weather 30-day geometric means and wet weather single sample maximum (SSM) exceedance frequencies are calculated, as described in the Bacteria TMDL and the Fifth Term Permit. The results from the calculations are used to compare the interim and final RWLs in **Tables 1.2 and 1.3**. The wet weather 30-day geometric mean is, however, not applicable for RWLs assessment.

2.2.1 Dry Weather Geometric Mean

The 30-day geometric means were calculated for water bodies listed in the TMDL. The methodology is consistent with the Ocean Plan and Basin Plan (i.e. 5 or more sample in a 30-day period). The exceedance frequency is calculated by dividing the number of geometric means that exceed the geometric means RWLs in **Table 1.2** by the total number of geometric means calculated during the dry season.

When a rainfall over 0.2 inches occurred during the dry season, samples collected within 72 hours of the rainfall event were excluded from the dry weather calculations as these are considered wet weather samples.

2.2.2 Wet Weather Single Sample Maximum

The wet weather SSM exceedance rate is calculated as follows:

1. If wet weather samples are not on a daily basis (i.e. storm days and 72 hours afterwards), the bacteria data for missing wet weather days will be replaced by the highest bacteria data among the samples collected;
2. If any storm events are not sampled, the bacteria density for each wet weather day is assumed to be equal to the average of the highest bacteria densities reported from all storm events sampled during the wet season; and
3. The SSM exceedance frequency is calculated by dividing the number of wet weather days that exceed the SSM receiving water limitations in **Table 1.2**, including the days with assumed exceedances as described above, by the total number of wet weather days during the wet season.

For CWA 303(d) listed water segments, most wet weather samples were collected through the CLRP monitoring program, which provides a robust dataset for wet weather conditions. For delisted beach segments, data collected through the weekly Unified Program that fell within 72 hours of the rainfall events were used.

2.2.3 Wet Weather Geometric Mean

The data collected for dry weather during the wet season were used in addition to the data collected for wet weather to calculate the wet weather 30-day geometric mean. The exceedance frequency of the wet weather 30-day geometric mean was calculated by dividing the number of geometric means that exceed the geometric mean by the total number of geometric means calculated from samples collected during the wet season.

3. MONITORING SUMMARY

This section summarizes the monitoring events for the reporting period, including the number of samples, flow conditions, hydrology and key observations. Analytical results and hydrologic data are presented in **Attachment A** and **Attachment B**.

3.1 Dry Weather Sampling

Weekly beach sampling was performed through the Unified Program on a fixed schedule. Monthly creek visits were conducted as part of the CLRP monitoring program and additional samples collected by the Aliso Creek 13225 Directive Monitoring Program were also included in the calculation of the 30-day geometric mean. **Table 3.1** presents the total number of samples and total number of 30-day geometric mean excluding wet weather days. Samples collected during dry season were used in dry weather 30-day geometric mean calculation according to the method described in **Section 2.2.1.** Those collected during the wet season were used in calculating the wet weather 30-day geometric mean according to the method described in **Section 2.2.3**.

Table 3.1 Dry Weather Total Number of Samples and Number of geometric means

Watershed Management Area	Segment	Station	2017	
			# of Samples	# of GMs
San Joaquin Hills and Laguna Beach HSA	Cameo Cove at Irvine Cove Drive -- Riviera Waya	*No Station*		
	At Heisler Park -- North	HEISLRz	22	22
	At Main Laguna Beach	MAINBCz	22	22
	Laguna Beach at Ocean Avenue	VICTRAz	22	22
	Laguna Beach at Cleo Street	CLEOz	22	22
	Arch Cove at Bluebird Canyon Road	BLUBRDz	23	23
	Laguna Beach at Dumond Drive	DUMONDz	22	22
Aliso HSA	Laguna Beach at Lagunita Place /Blue Lagoon Place at Aliso Beach	BLULGNz*	13	5
	Aliso Creek Mouth (at mouth)	ACM1	22	21
	Aliso Creek	CTPJ01	23	17
DanaPoint HSA	Aliso Beach at West Street	WESTz	22	21
	Aliso Beach at Table Rock Drive	S6	22	21
	1000 Steps Beach at Pacific Coast Hwy at Hospital (9th Ave)	S4	22	21
	At Salt Creek (large outlet)	SCM1u	31	31
	Salt Creek Beach at Salt Creek service road	S2	22	22
	Salt Creek Beach at Dana Strand Road	S1	22	22
Lower San Juan HSA	San Juan Creek Mouth, at mouth	SJC1	2	0
	at San Juan Creek, lower 1 mile	L01-PCH	2	0
	Pacific Ocean shoreline, at San Juan Creek	S-0	32	27
San Clemente HSA	at Poche Beach	S-15	22	22
	Ole Hanson Beach Club Beach at Pico Drain	S-17	21	17
	San Clemente City Beach (SCCB) at El Portal Street Stairs	*No Station*		
	SCCB at Mariposa Street	MARIPOz	20	15
	SCCB at Linda Lane	LINDALz	22	20
	SCCB at South Linda Lane	*No Station*		
	SCCB at Lifeguard Headquarters	S-19	22	22
	Under San Clemente Municipal Pier	PIERz	34	34
	SCCB at Trafalgar Canyon (Trafalgar Lane)	TRFCYNz	22	22
	San Clemente State Beach (SCSB) at Riviera Beach	S-21	22	22
	SCSB at Cypress Shores	S-23	22	22

* This location has been unsafe when high tide occurs. Samples were only collected when it was safe for the samplers.

3.1.1 Creek and Creek Mouth

Aliso Creek and Creek Mouth

During the reporting period, monthly visits were performed according to the CLRP at Aliso Creek watershed assessment station CTPJ01 during dry weather conditions. In addition, 20 samples from CTPJ01 were also collected through the Aliso Creek 13225 Directive Monitoring Program from August 1 to September 30 each year. Samples from these two programs were combined and used in the 30-Day geometric mean calculation. A total of 22 and 23 samples excluding wet weather days were included for CTPJ01 and ACM1 respectively.

San Juan Creek and Creek Mouth

During the reporting period, monthly monitoring was performed at the lowest 1 mile of San Juan Creek from Stonehill Drive to Pacific Coast Highway according to CLRP and a voluntary weekly observational survey was performed to document the creek's flowing condition until August 2017. After a large storm season, the Creek was flowing intermittently from May to the first week of July and flow stopped after the second week of July. (see **Figure 3.1** below). Occasionally ponded water was observed in the creek at various spots and it appeared to be associated with rising groundwater. During the dry season, only one outfall had observed flowing to the channel bed but the discharge infiltrated into San Juan Creek bed and did not reach the ocean. Observational data shown out of the 15 visits, the creek berm was only open during one visit in early May. Therefore, a true creek mouth was not formed during this reporting year. The weekly observation data can be found in **Attachment C**. Due to limit data from the CLRP and creek's flow being intermit, dry weather 30-Day geometric means were available for San Juan Creek and the creek mouth for this reporting year.

Figure 3.1 Examples of Flowing Conditions at San Juan Creek (Left: May 18, 2017 upstream of PCH, Right: August 21, 2017 downstream of Stonehill Drive)

3.2 Wet Weather Sampling

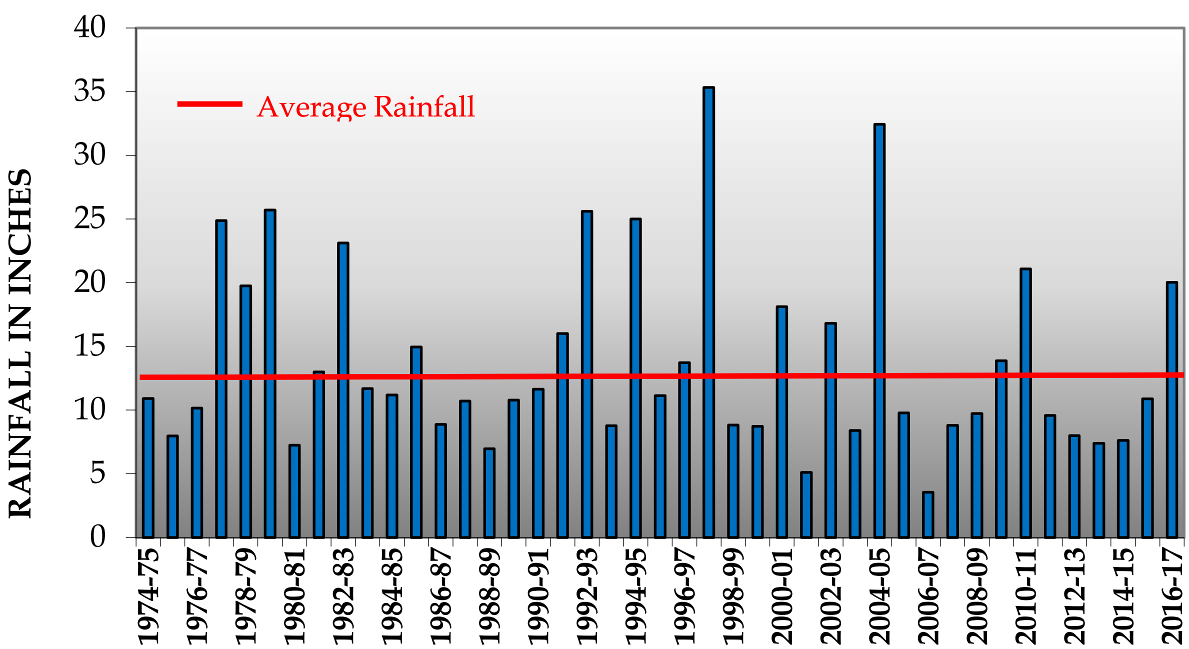
3.2.1 Precipitation

Reporting year 2016-17 storm season was much wetter than average as presented in **Figure 3.2.** An average of 17 inches (compared to 6 inches) of rain occurred across south Orange County. During the reporting year, the south Orange County rain gauges received a range of 16.41 to 19.13 inches of rainfall (**Table 3.2**) with 65 wet days during wet season (# of Wet Days), compared to 48 days during reporting year 2015-16. A full rainfall record can be found in **Attachment B**.

Table 3.2 2016-17 Rainfall Total

Station	Rainfall Total (inches)			
	2016		2017	
	Wet Season	Dry Season	Wet Season	Dry Season
DANA POINT	5.16	0.46	16.41	0.93
EL TORO	6.89	0.35	17.55	0.62
LAGUNA BEACH	5.34	0.44	15.96	0.37
PALISADES	4.27	0.58	15.67	0.85
SULPHUR CREEK	8.25	0.41	19.13	0.91

Figure 3.2 Historical Rainfall Conditions at Sulphur Creek Dam Station



3.2.2 Sampling Coverage

Table 3.3 presents an overview of wet weather sampling by showing the total number of wet weather days that were sampled (# of Sampled Days) divided by "# of Wet Days" (sampling coverage).

During this reporting year, 4 targeted storms were sampled at the CWA 303(d) listed TMDL water bodies stations: ACJ01, ACM1, ACM1d, SJC1, SJCL01, SJC1d, POCHEd and PIERd in addition to the weekly sampling at TMDL beach segments resulting in a wet weather sampling coverage of 18to 29percent at those locations. The 4 targeted storms occurred from October 25-27, November 21-23, January 6-8, and February 8-10. For most delisted beach segments, a 3-12percent sampling coverage was achieved.

Data were used in wet weather SSM exceedance frequency assessment according to the method described in **Section 2.2.2** and were aggregated with wet season dry weather data for wet weather 30-day geometric means exceedances frequency assessment according to the method described in **Section 2.2.3**.

Table 3.3 Wet Weather Sampling Coverage

Watershed Management Area	Segment	Station	Sampling Coverage: Number of Sampled Days (Days) Sampling Coverage (%)
San Joaquin Hills and Laguna Beach HSA	Arch Cove at Bluebird Canyon Road	BLUBRDz	6 9%
	At Heisler Park North	HEISLRz	6 9%
	At Main Laguna Beach	MAINBCz	6 9%
	Laguna Beach at Cleo Street	CLEOz	6 9%
	Laguna Beach at Dumond Drive	DUMON..	6 9%
	Laguna Beach at Ocean Avenue	VICTRAz	6 9%
Aliso HSA	Aliso Creek	ACJ01	12 18%
	Aliso Creek Mouth (at mouth)	ACM1	16 25%
	Laguna Beach at Lagunita Place /Blue Lagoon Place at Aliso Beach	BLULGNz	5 8%
Dana Point HSA	1000 Steps Beach at Pacific Coast Hwy at Hospital (9th Ave)	S4	8 12%
	Aliso Beach at Table Rock Drive	S6	8 12%
	Aliso Beach at West Street	WESTz	8 12%
	At Salt Creek (large outlet)	SCM1u	6 9%
	Salt Creek Beach at Dana Strand Road	S1	12 18%
	Salt Creek Beach at Salt Creek service road	S2	6 9%
Lower San Juan HSA	at San Juan Creek, lower 1 mile	SJCL01	12 18%
	Pacific Ocean shoreline, at San Juan Creek	SJC1d	19 29%
	San Juan Creek Mouth, at mouth	SJC1	12 18%
San Clemente HSA	at Poche Beach	POCHEd	16 25%
	Ole Hanson Beach Club Beach at Pico Drain	S-17	4 6%
	San Clemente State Beach (SCSB) at Riviera Beach	S-21	4 6%
	SCCB at Lifeguard Headquarters	S-19	5 8%
	SCCB at Linda Lane	LINDALz	2 3%
	SCCB at Mariposa Street	MARIPOz	2 3%
	SCCB at Trafalgar Canyon (Trafalgar Lane)	TRFCYNz	4 6%
	SCSB at Cypress Shores	S-23	3 5%
	Under San Clemente Municipal Pier	PIERd	13 20%

4. WATER QUALITY ASSESSMENT

This section summarizes water quality assessment results for the dry weather 30-day geometric means, wet weather SSM and wet weather 30-day geometric means assessed according to the method described in **Section 2**. Exceedance frequencies for both dry weather 30-day geometric mean and wet weather SSM were compared against the applicable RWLs to determine whether the interim and final RWLs have been achieved as described in **Section 1**.

4.1 Dry Weather 30-Day geometric means

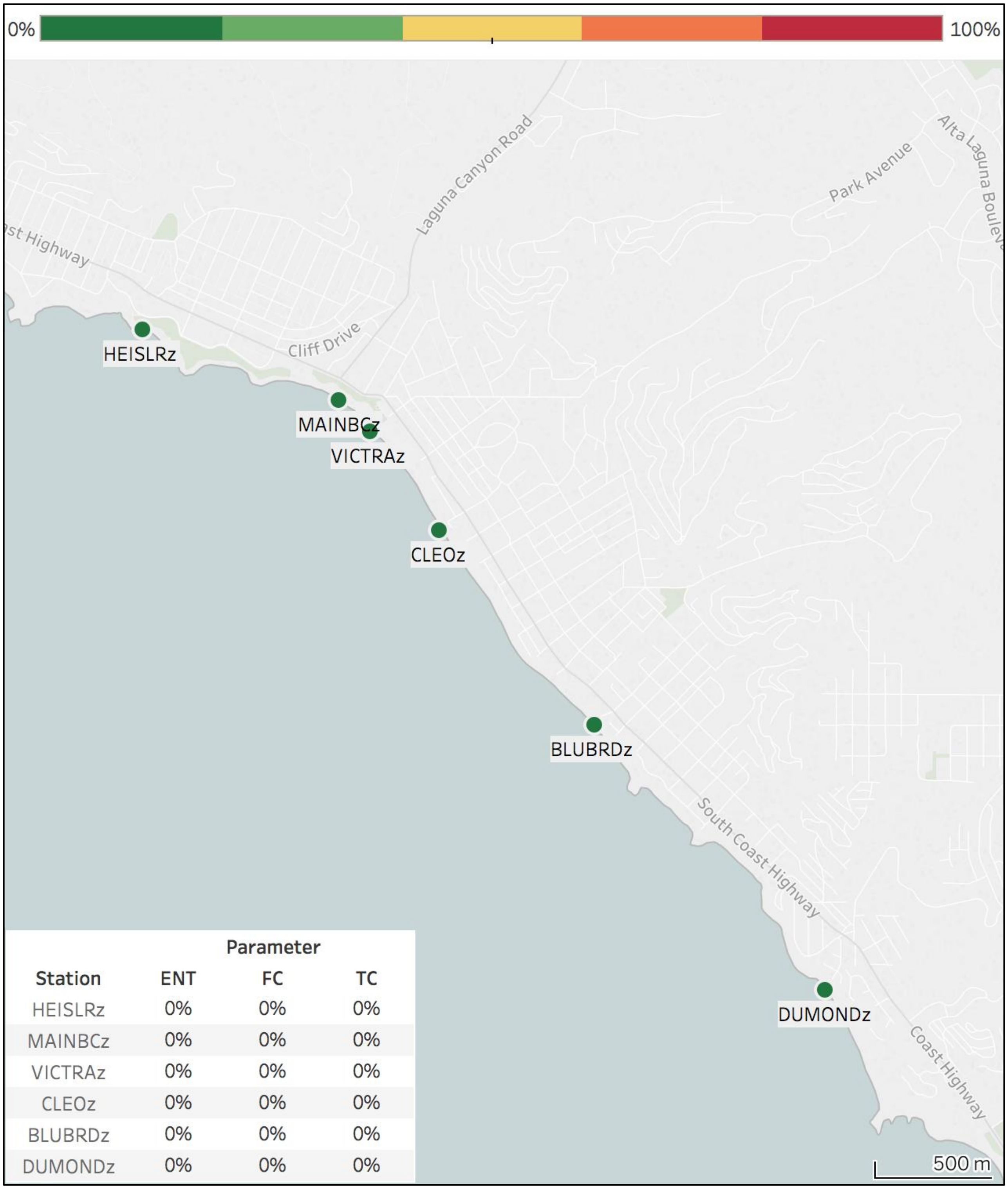
Figures 4.1(a)-(e) depict the dry weather 30-day geometric mean exceedance frequencies for the Bacteria TMDL water bodies during the 2017 dry season. To provide an overview of the FIB conditions for each hydrologic subarea, the color graded points in each figure indicates the average exceedance frequencies for the three FIB parameters: TC, FC and ENT.

Among the 27 monitored water segments, 22 have met the final RWLs which include the delisted segments and Poche Beach. Laguna Beach at Pier has limited exceedance of 3% for ENT. The 30 day geomean exceedance rate at San Juan Creek and Creek mouth is not available as monitoring frequency is conducted on a monthly basis and flow was observed to be intermittent. For reporting year 2016-17, Aliso Creek (ENT, TC) and Aliso Creek mouth (ENT, FC) were found to have elevated bacteria levels.

Aliso Creek and creek mouth: The ponded water behind the sand berm (Aliso Creek mouth, ACM1) continues to have high exceedances (65% exceedances for FC and 100% exceedance for ENT). Although ACM1 is isolated from the ocean during the dry season (16 out of 23 visits from May 2017-September 2017) and the beach bacteria level (ACM1z) remained low, the bacteria level at ACM1z still fluctuate with ACM1 due to higher flow during this past storm season. **(Figure 4.2)** Additionally, exceedance levels at ACM1 were consistently higher than at CTPJ01 (0% exceedance for FC and 41% exceedance for ENT) located 1¼ miles upstream of the ACM1. CTPJ01 is located downstream of major storm drains and tributaries, indicating there are potential sources between the two stations such as bacteria regrowth, and droppings from birds that congregate at the Creek mouth**.**

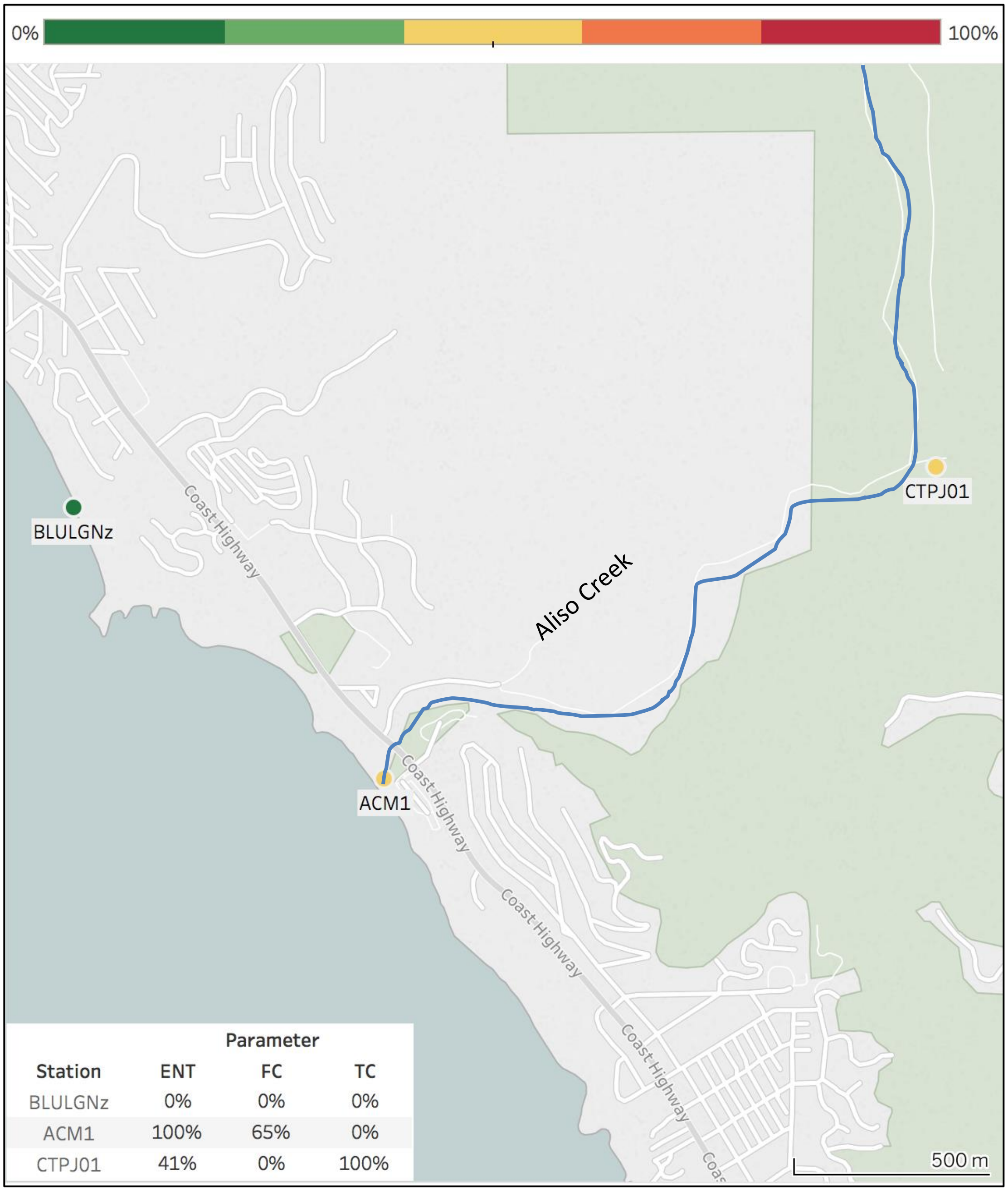
San Juan Creek and creek mouth: The beach station (S-0) has 0% exceedances due to the sand berm being closed and the creek being dry more than half of the 2017 dry season, as discussed in **Section 3.1.1**. No 30-day geometric mean assessments were available and therefore the comparisons of interim and final RWLs were not possible. Similar to Aliso Creek, the pond behind the sand berm was constantly impacted by bird congregation. During the weekly visits from May to August, 2017, the total bird population at the creek mouth area especially the pond behind the sand berm ranged from 50-563, with an average population of 167. (**Attachment C**)

Figure 4.1(a) Dry Weather 30-Day geometric means Assessment (San Joaquin and Laguna HSA)



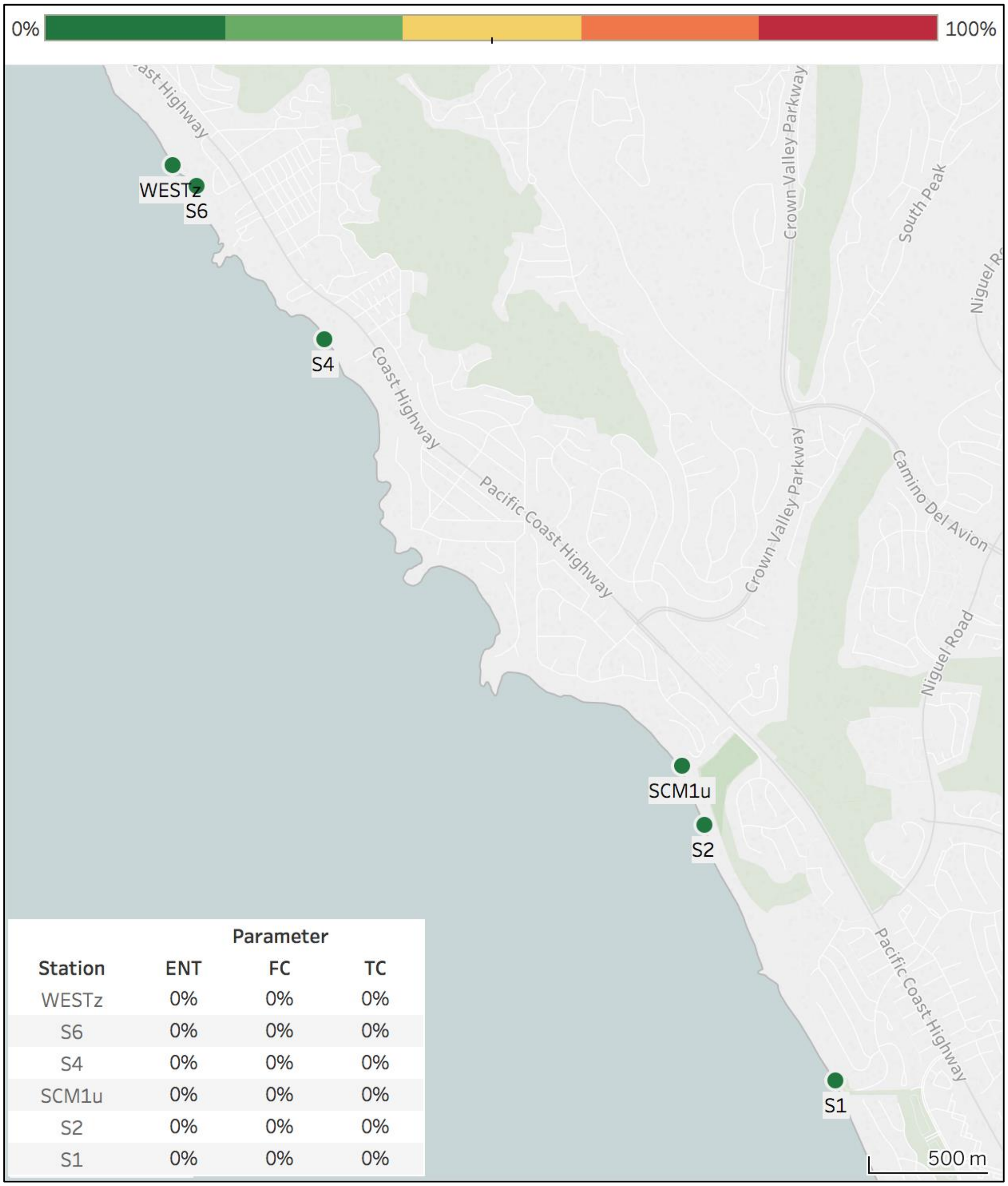
Station	Parameter ENT	FC	TC
HEISLRz	0%	0%	0%
MAINBCz	0%	0%	0%
VICTRAz	0%	0%	0%
CLEOz	0%	0%	0%
BLUBRDz	0%	0%	0%
DUMONDz	0%	0%	0%

Figure 4.1(b) Dry Weather 30-Day geometric means Assessment (Aliso HSA)



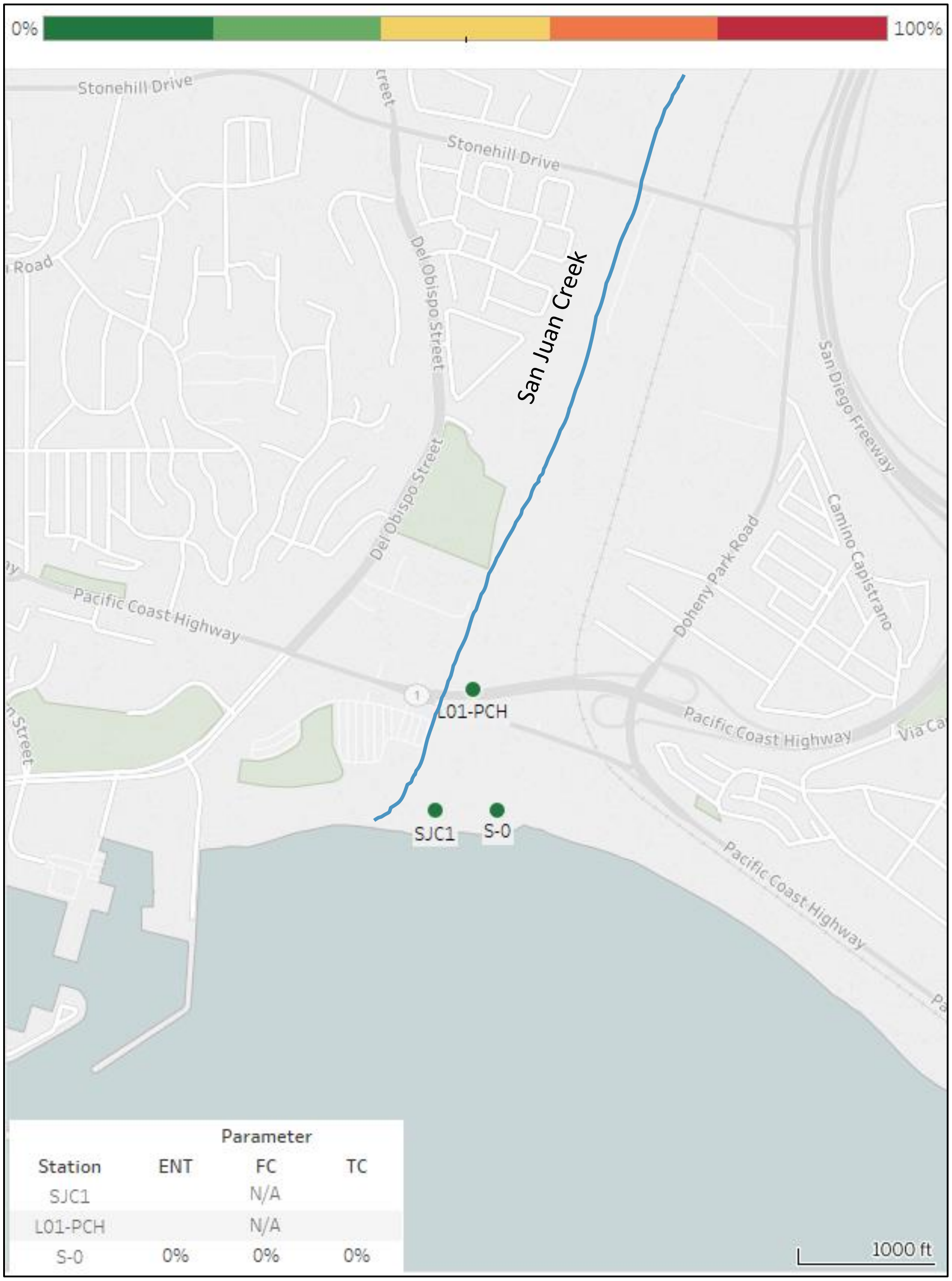
	Parameter		
Station	ENT	FC	TC
BLULGNz	0%	0%	0%
ACM1	100%	65%	0%
CTPJ01	41%	0%	100%

Figure 4.1(c) Dry Weather 30-Day geometric means Assessment (Dana Point HSA)



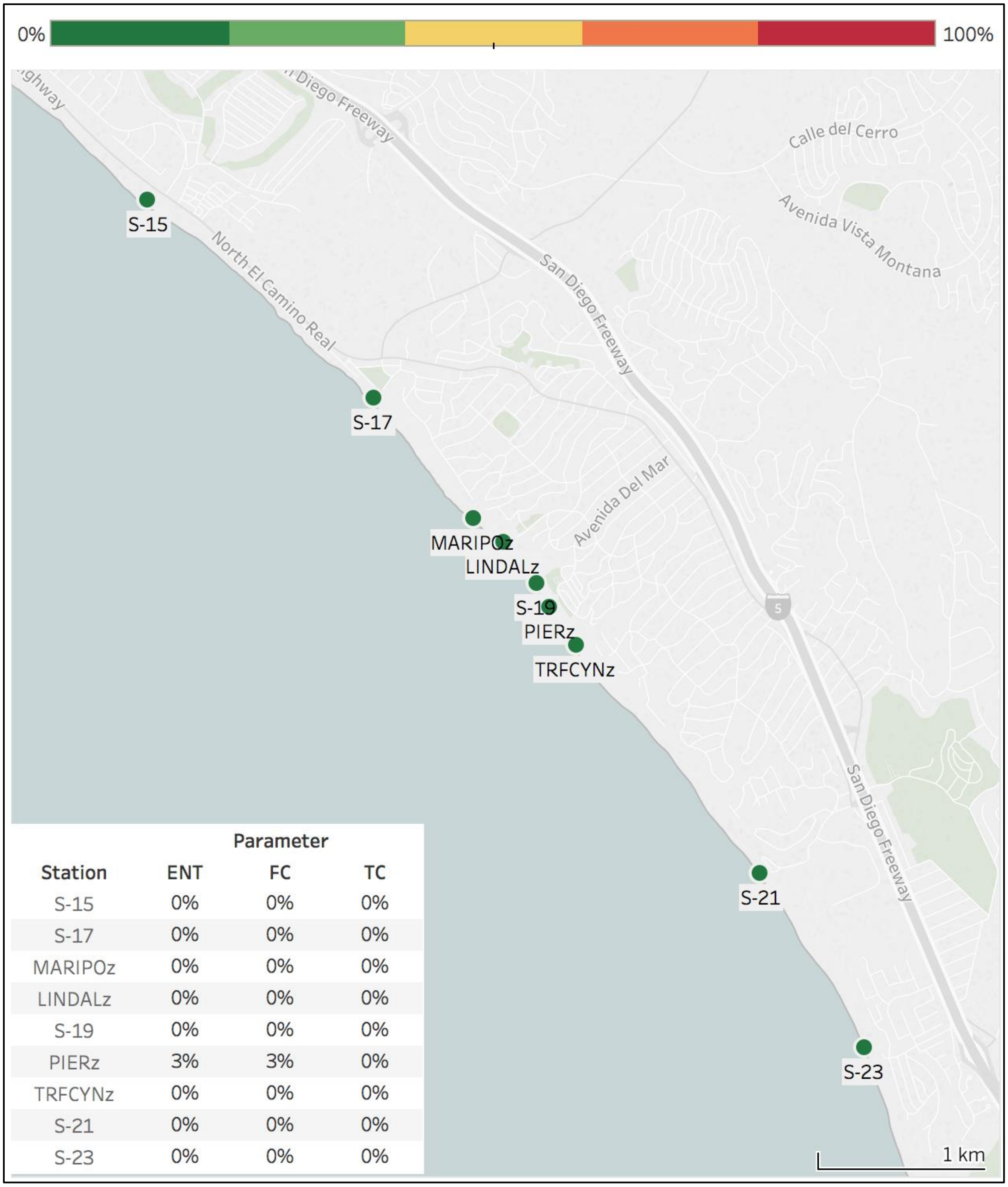
	Parameter		
Station	ENT	FC	TC
WESTz	0%	0%	0%
S6	0%	0%	0%
S4	0%	0%	0%
SCM1u	0%	0%	0%
S2	0%	0%	0%
S1	0%	0%	0%

**Figure 4.1(d) Dry Weather 30-Day geometric means Assessment
(Lower San Juan HSA)**



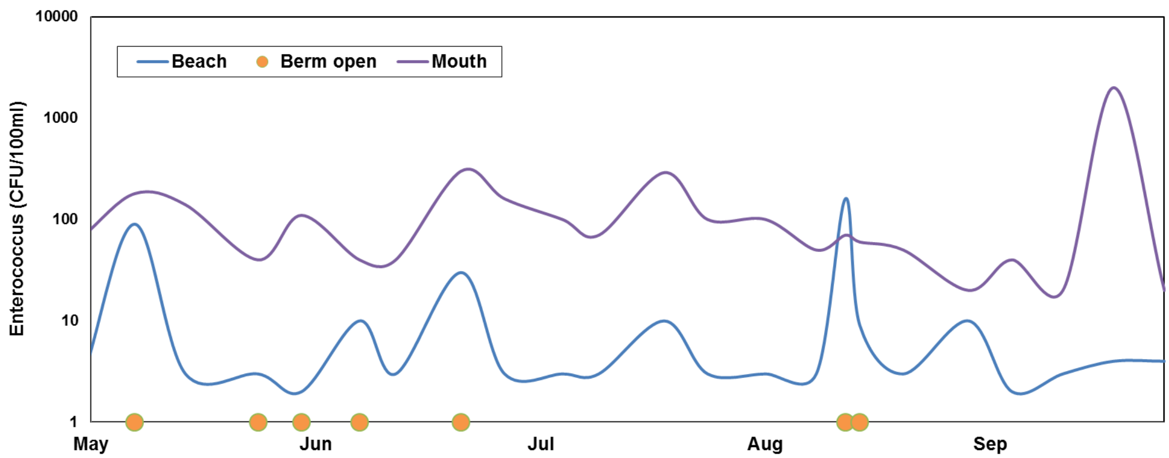
Station	ENT	Parameter FC	TC
SJC1		N/A	
L01-PCH		N/A	
S-0	0%	0%	0%

Figure 4.1(e) Dry Weather 30-Day geometric means Assessment (San Clemente HSA)



	Parameter		
Station	ENT	FC	TC
S-15	0%	0%	0%
S-17	0%	0%	0%
MARIPOz	0%	0%	0%
LINDALz	0%	0%	0%
S-19	0%	0%	0%
PIERz	3%	3%	0%
TRFCYNz	0%	0%	0%
S-21	0%	0%	0%
S-23	0%	0%	0%

Figure 4.2 Dry Season Beach Bacteria Level vs Creek Mouth



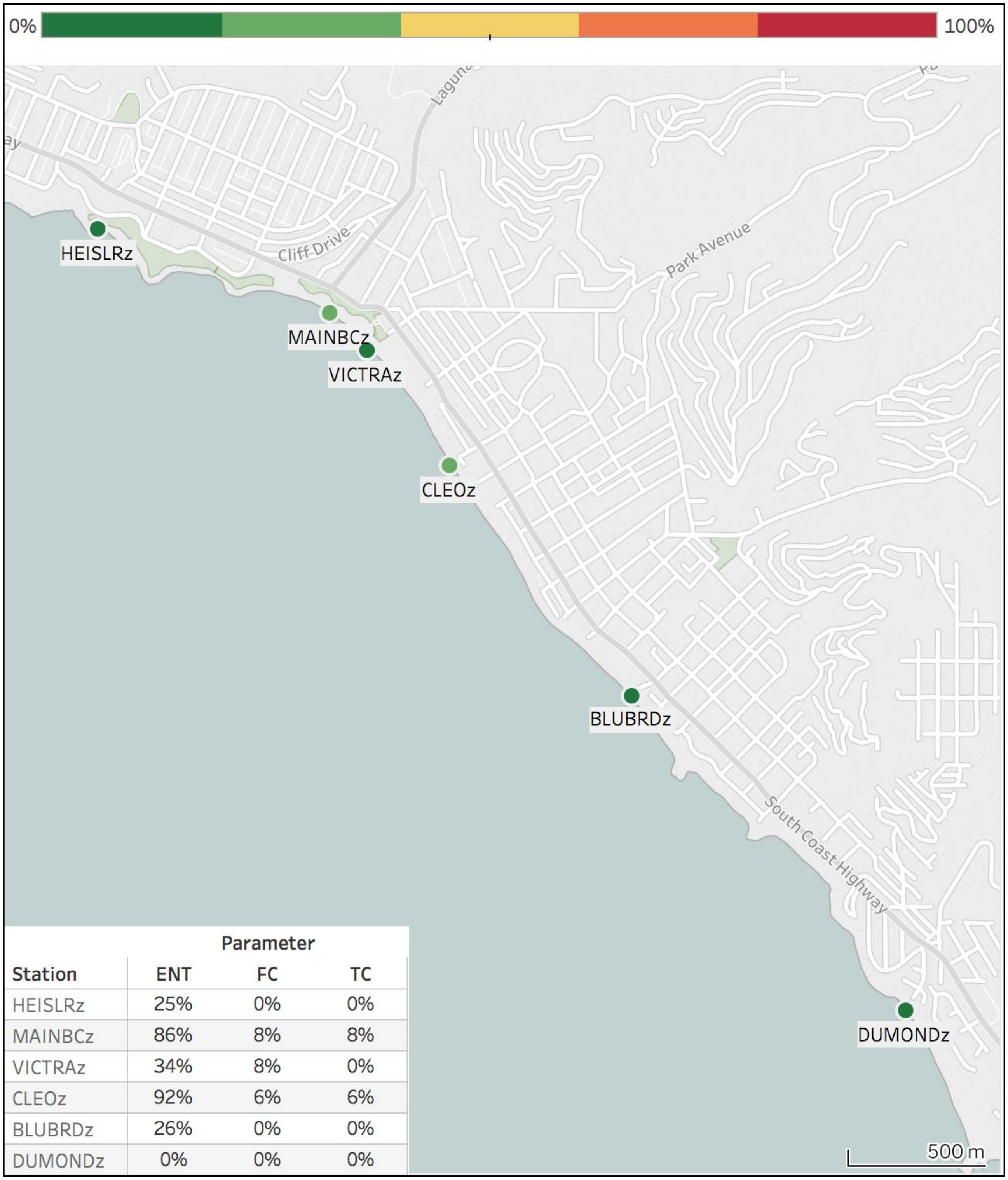
4.2 Wet Weather SSM

Figures 4.4(a)-(e) depict the wet weather SSM exceedance frequencies for the Bacteria TMDL water bodies during the 2016-17 wet season. To provide an overview of the FIB exceedances for each hydrologic subarea, the figures show average exceedance frequencies for the three FIB parameters: TC, FC and ENT.

Among the 27 monitored water segments, 15 met the final RWLs, which are mostly delisted segments and POCHEd and PIERd. The stations that have elevated bacteria levels are include HEISLRz, MAINBCz, VICTRAz ,CLEOz, BLUBRDz, ACJ01, ACM1, SCJL01, SJC1d, SCJ1, MARIPOz and TRFCYNz.

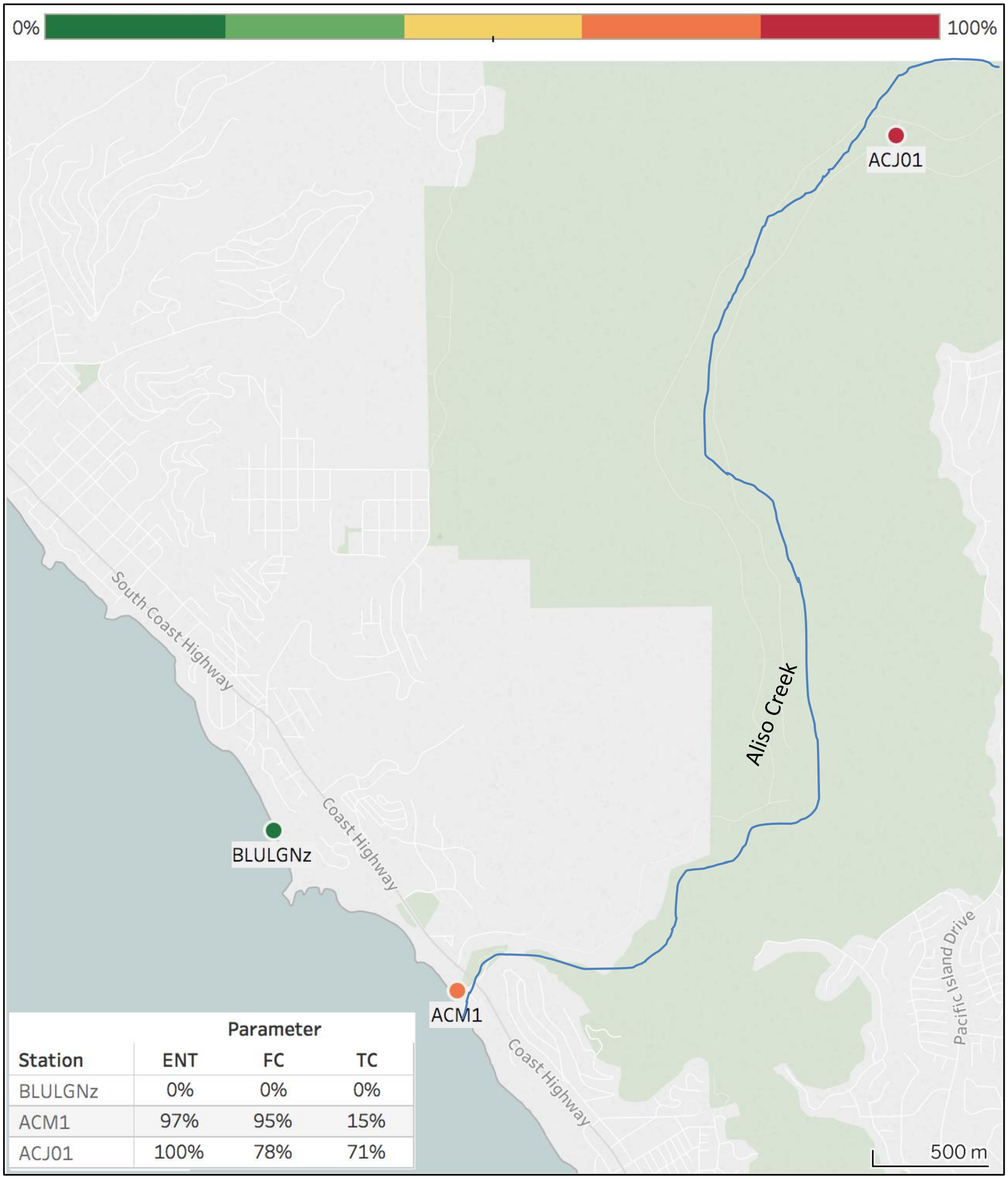
A number of delisted water bodies at Laguna Beach and San Clemente City Beach have shown elevated bacteria levels this year compared to 2015-16. Potential reasons for such fluctuation could be limited sample size (2-6 samples per station) and a more intense storm season (average of 17 inches compare to 6 inches last year). Additionally, the high exceedances rates were for ENT which can come from nature sources such as disturbed soil or other debris transported by intense stormwater flow. Monitoring will continue to be conducted in future monitoring years to provide more information on the overall condition of those stations.

Figure 4.4(a) Wet Weather SSM Assessment (San Joaquin and Laguna HSA)



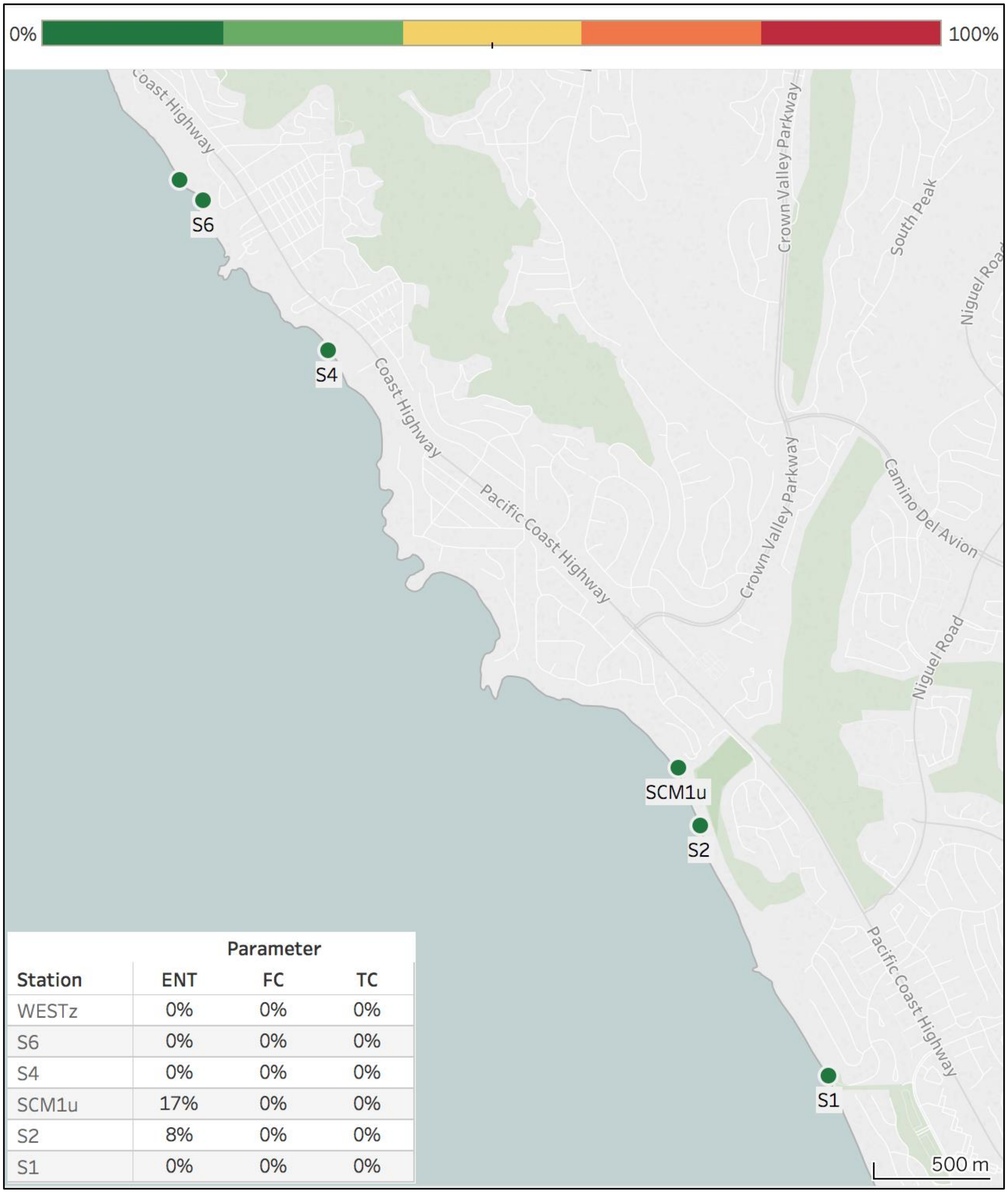
Station	Parameter ENT	FC	TC
HEISLRz	25%	0%	0%
MAINBCz	86%	8%	8%
VICTRAz	34%	8%	0%
CLEOz	92%	6%	6%
BLUBRDz	26%	0%	0%
DUMONDz	0%	0%	0%

Figure 4.4(b) Wet Weather SSM Assessment
(Aliso HSA)



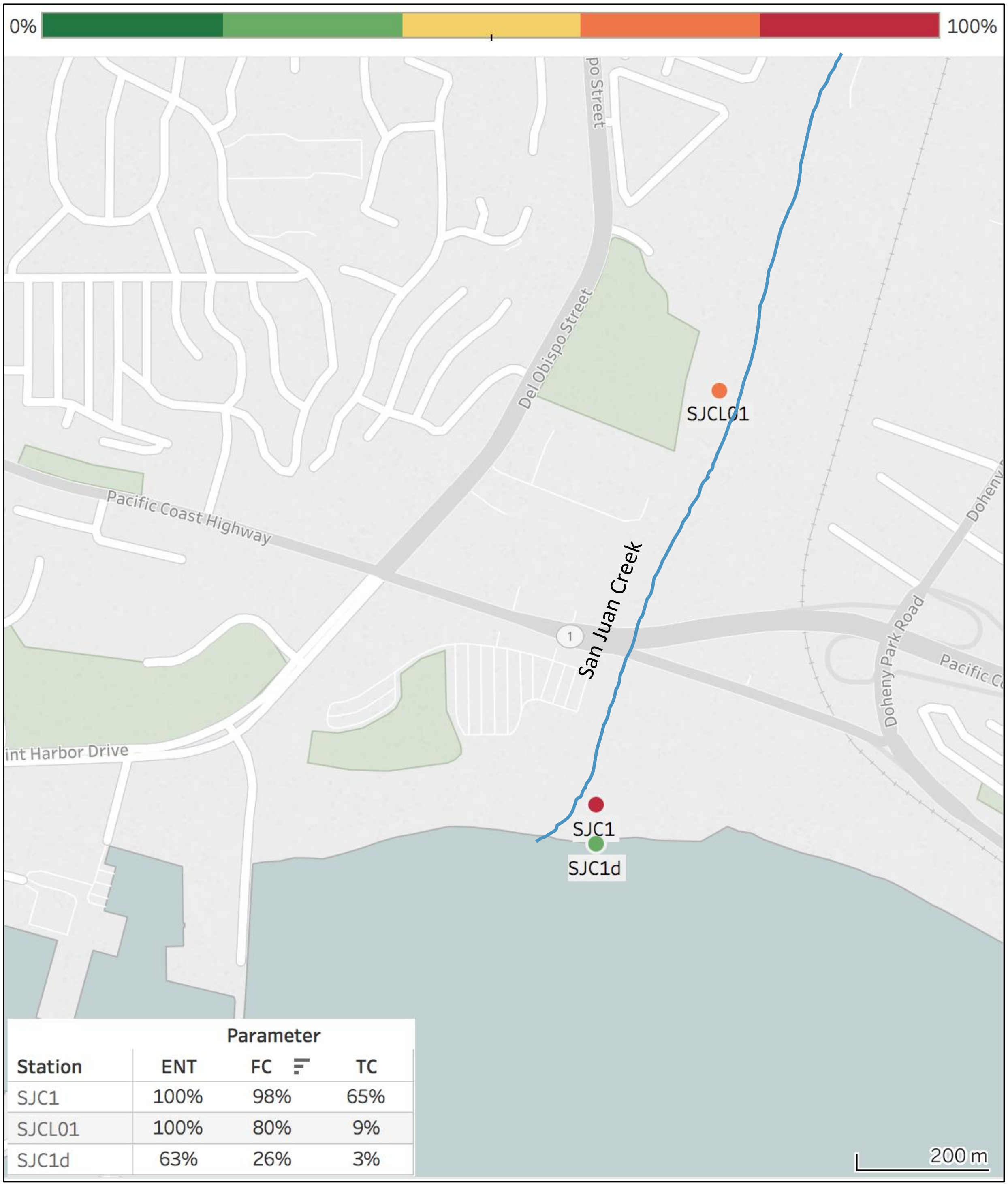
Station	Parameter		
	ENT	FC	TC
BLULGNz	0%	0%	0%
ACM1	97%	95%	15%
ACJ01	100%	78%	71%

Figure 4.4(c) Wet Weather SSM Assessment
(Dana Point HSA)



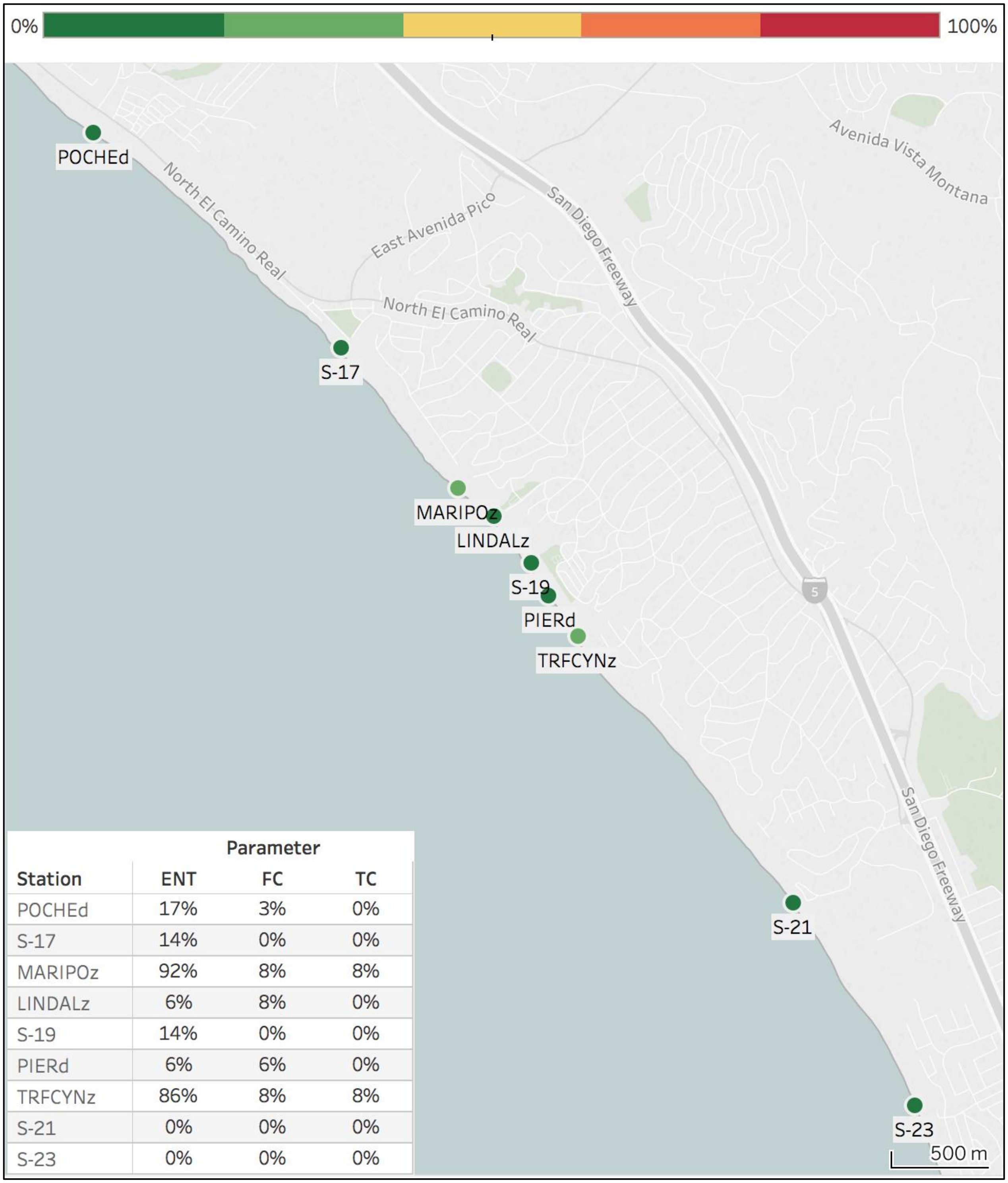
	Parameter		
Station	ENT	FC	TC
WESTz	0%	0%	0%
S6	0%	0%	0%
S4	0%	0%	0%
SCM1u	17%	0%	0%
S2	8%	0%	0%
S1	0%	0%	0%

Figure 4.4(d) Wet Weather SSM Assessment
(Lower San Juan HSA)



	Parameter		
Station	ENT	FC	TC
SJC1	100%	98%	65%
SJCL01	100%	80%	9%
SJC1d	63%	26%	3%

Figure 4.4(e) Wet Weather SSM Assessment
(San Clemente HSA)



	Parameter		
Station	ENT	FC	TC
POCHEd	17%	3%	0%
S-17	14%	0%	0%
MARIPOz	92%	8%	8%
LINDALz	6%	8%	0%
S-19	14%	0%	0%
PIERd	6%	6%	0%
TRFCYNz	86%	8%	8%
S-21	0%	0%	0%
S-23	0%	0%	0%

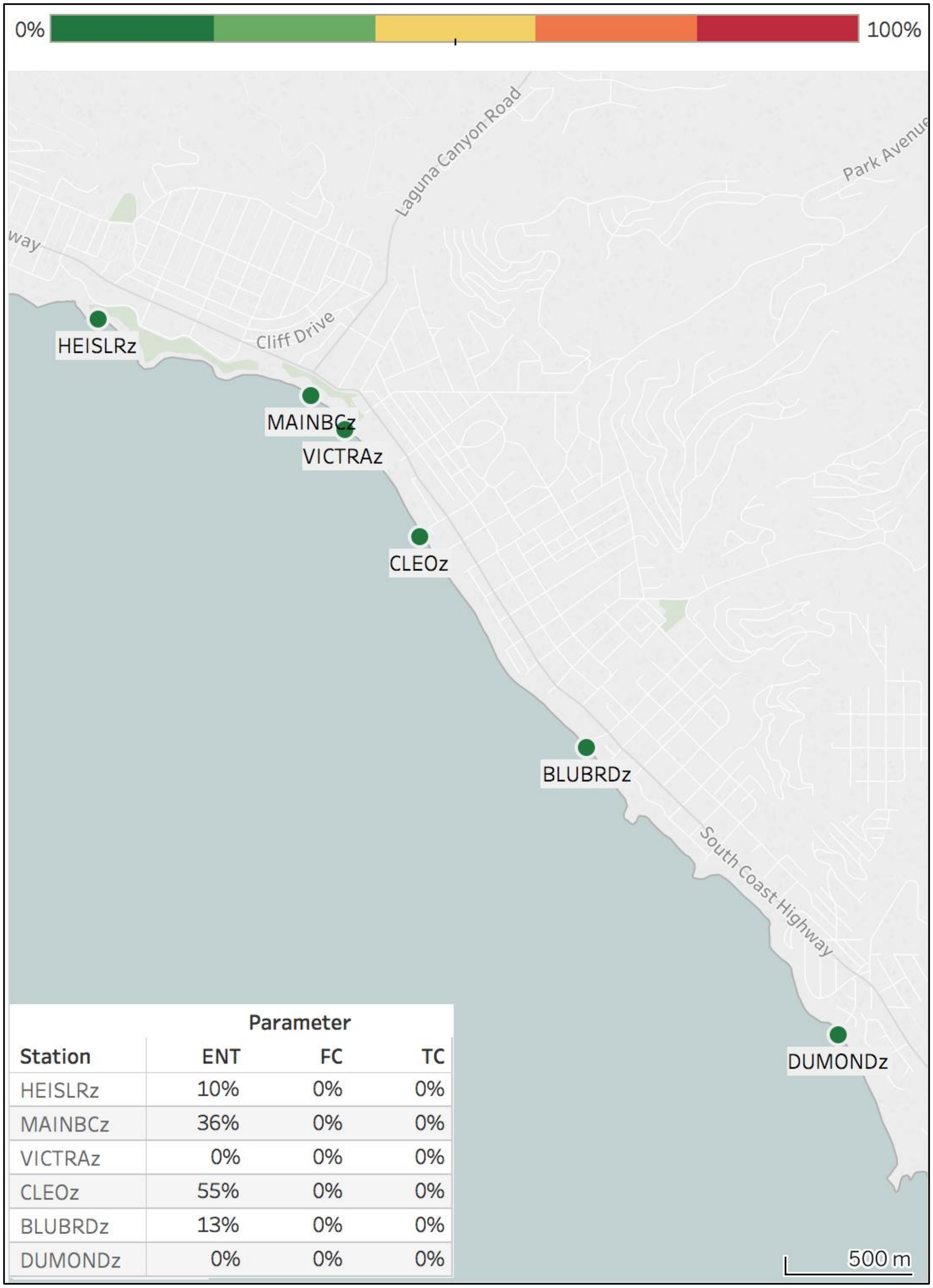
4.3 Wet Weather 30-Day Geometric Means

Figures 4.5(a)-(e) depict wet weather 30-day geometric mean exceedance frequencies for the Bacteria TMDL water bodies during the 2016-17 wet season. To provide an overview of the FIB exceedance condition for each hydrologic subarea, the figures show an average exceedance frequency for the three FIB parameters: TC, FC and ENT.

Among the 25 monitored water segments, 12 consistently showed no exceedances of the wet weather 30-Day geometric mean, and 2 stations (PIERd and POCHEd) did not get enough samples to calculate the 30-Day geometric mean due to limited sample size.

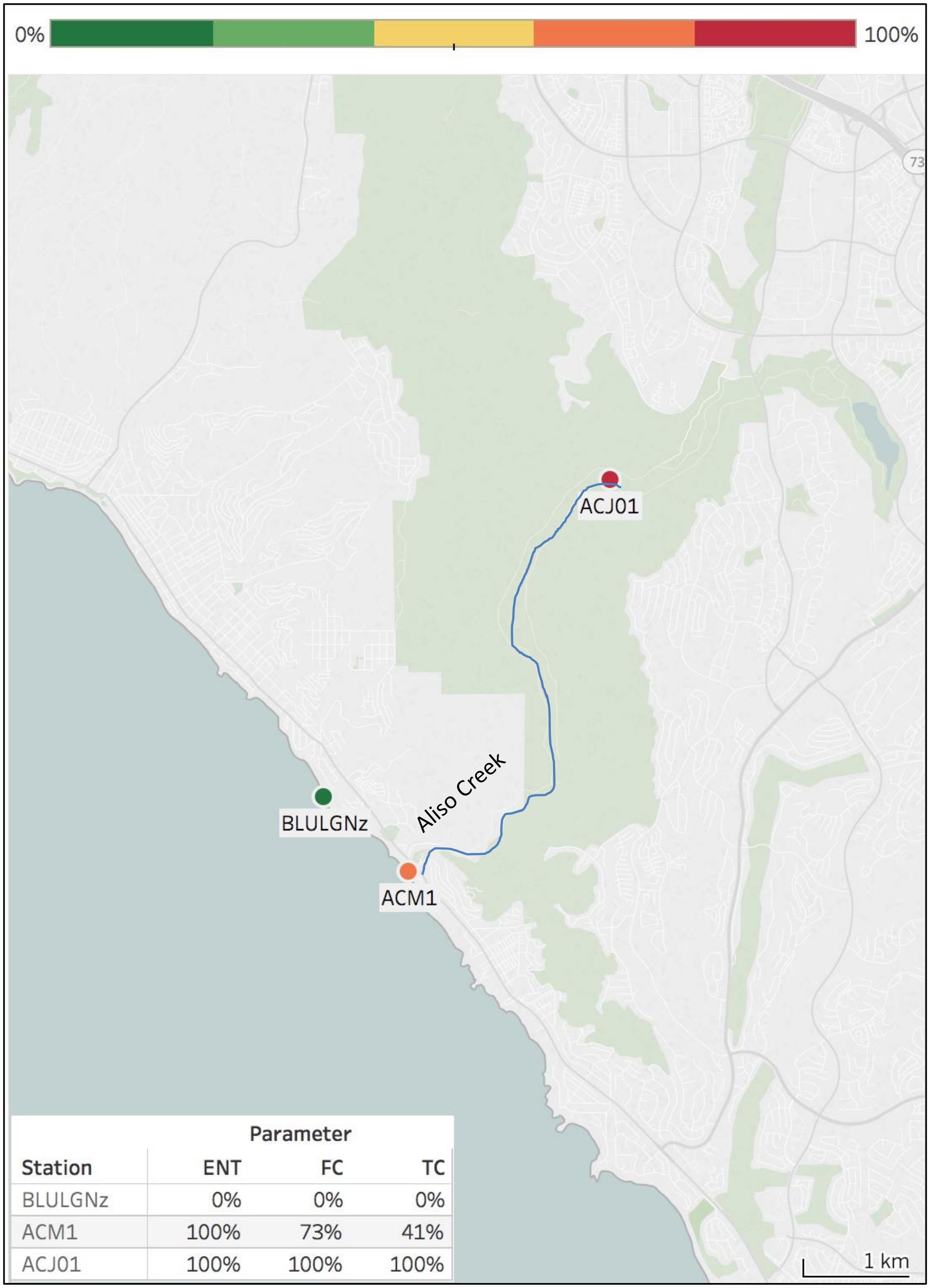
It is critical to point out the permit requires the use of wet and dry weather data to calculate the wet weather 30-day geometric mean. The mixing of wet weather data directly leads to most of the exceedances presented in the figures. It is also important to note that wet weather 30-day geometric mean do not apply to any of the RWLs. Therefore, in order to provide a better understanding to the watershed condition and align with the RWLs, it is recommended that, in future permits, such assessment requirements should be replaced with *wet season dry weather 30-day geometric means*.

Figure 4.5(a) Wet Weather 30-Day geometric means Assessment (San Joaquin and Laguna HSA)



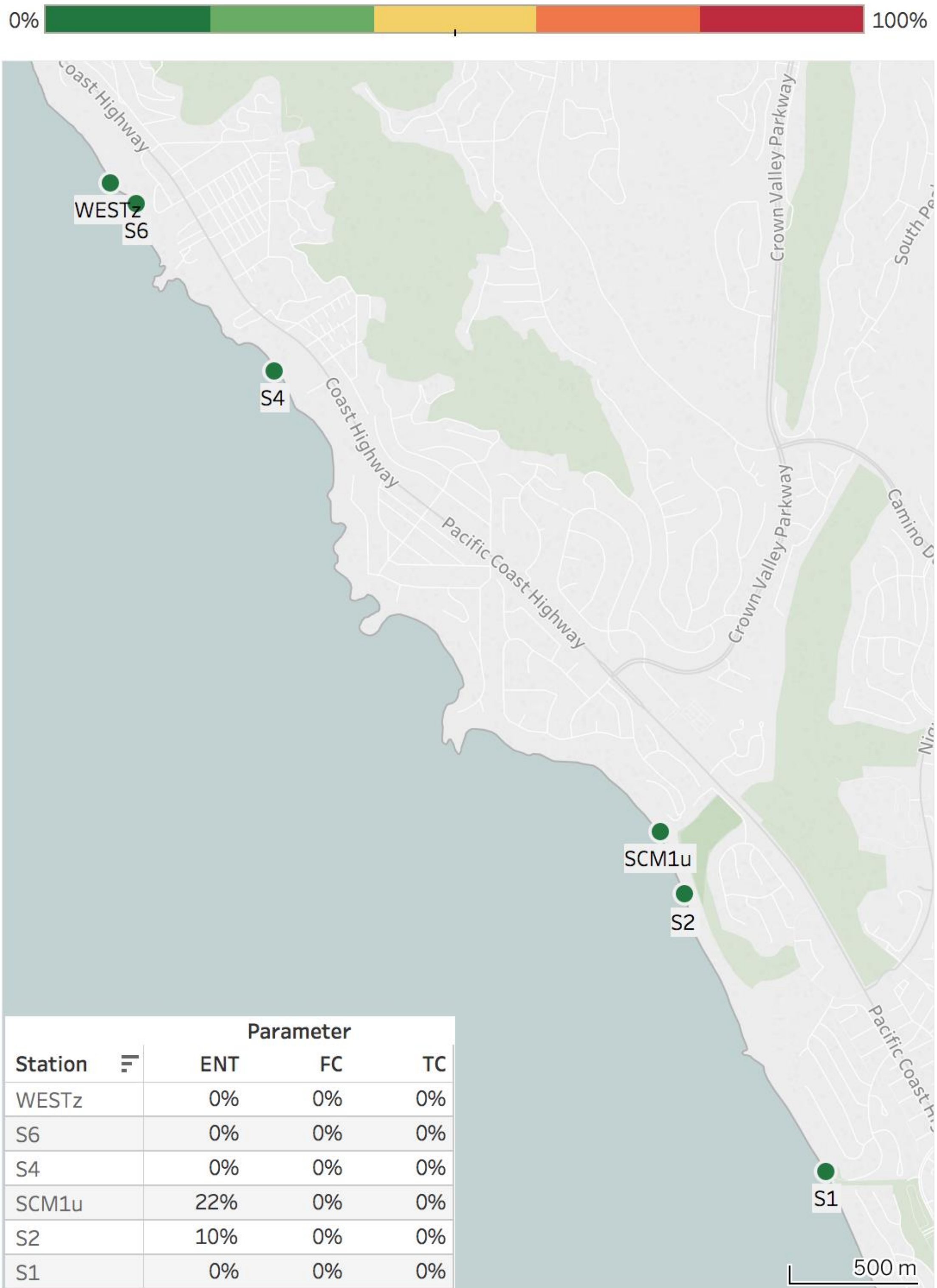
Station	ENT	FC	TC
	Parameter		
HEISLRz	10%	0%	0%
MAINBCz	36%	0%	0%
VICTRAz	0%	0%	0%
CLEOz	55%	0%	0%
BLUBRDz	13%	0%	0%
DUMONDz	0%	0%	0%

Figure 4.5(b) Wet Weather 30-Day geometric means Assessment
(Aliso HSA)



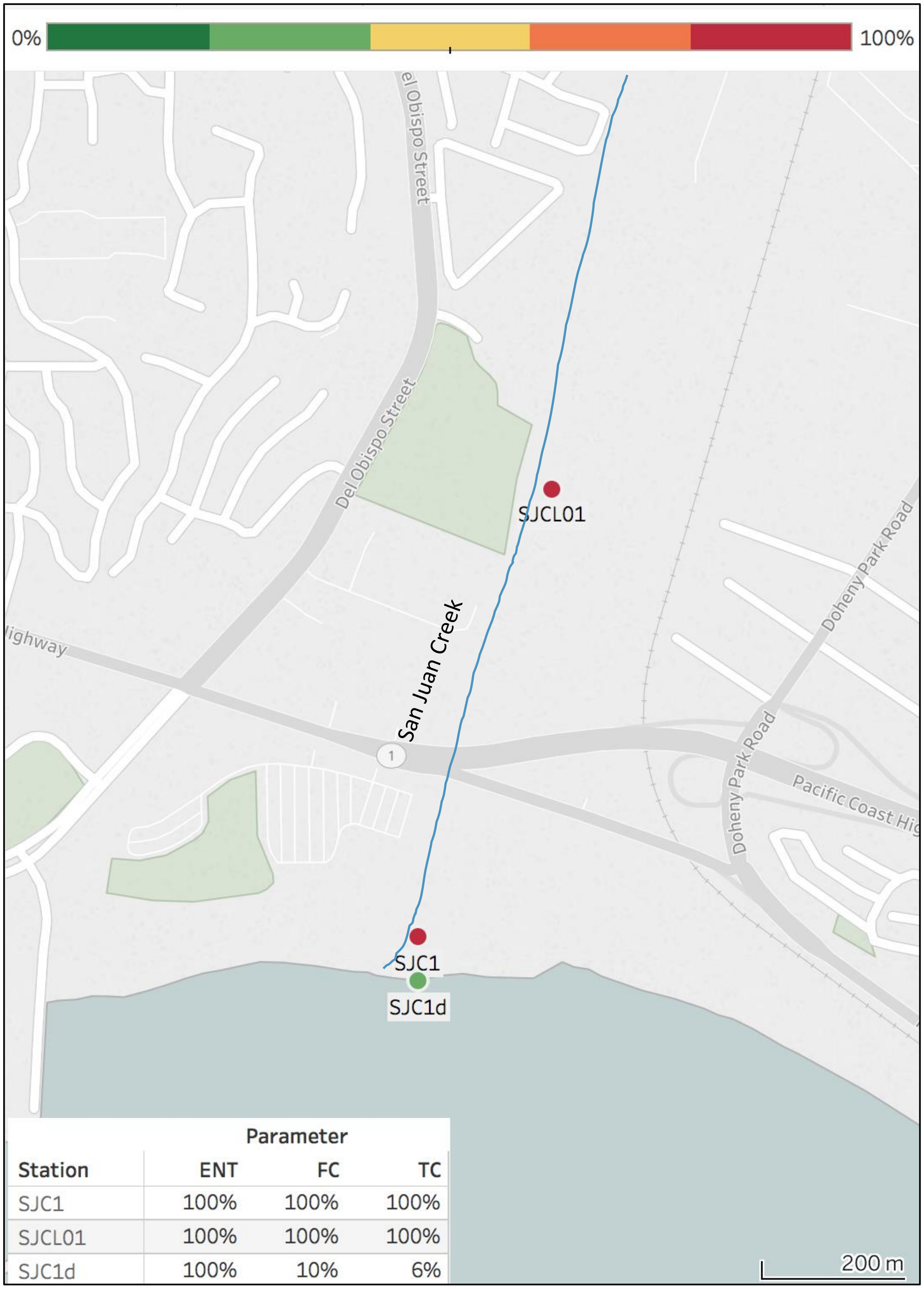
Station	Parameter ENT	FC	TC
BLULGNz	0%	0%	0%
ACM1	100%	73%	41%
ACJ01	100%	100%	100%

Figure 4.5(c) Wet Weather 30-Day geometric means Assessment
(Dana Point HSA)



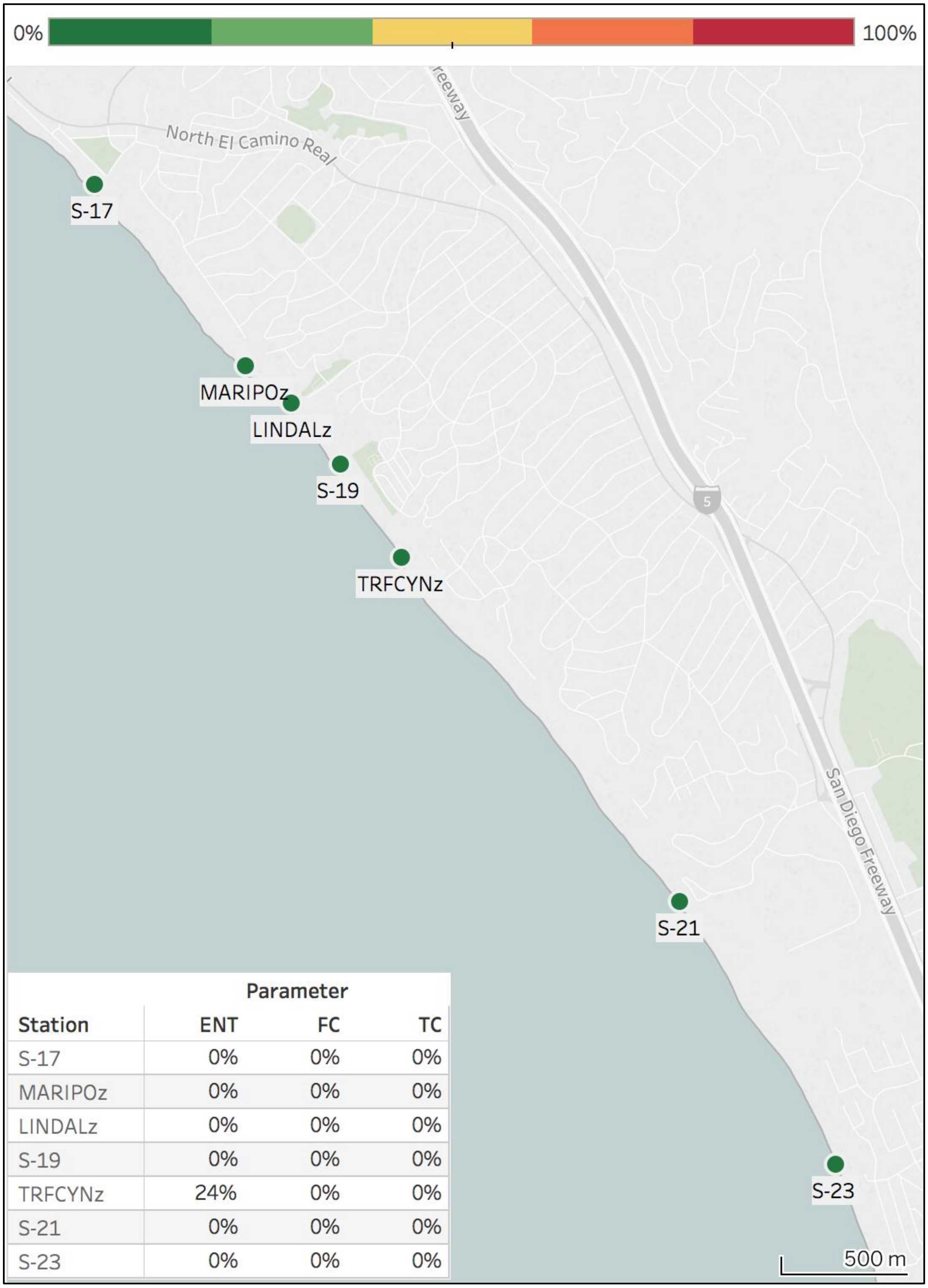
Station	Parameter ENT	FC	TC
WESTz	0%	0%	0%
S6	0%	0%	0%
S4	0%	0%	0%
SCM1u	22%	0%	0%
S2	10%	0%	0%
S1	0%	0%	0%

Figure 4.5(d) Wet Weather 30-Day geometric means Assessment (Lower San Juan HSA)



	Parameter		
Station	ENT	FC	TC
SJC1	100%	100%	100%
SJCL01	100%	100%	100%
SJC1d	100%	10%	6%

Figure 4.5(e) Wet Weather 30-Day geometric means Assessment (San Clemente HSA)



Station	ENT	FC	TC
S-17	0%	0%	0%
MARIPOz	0%	0%	0%
LINDALz	0%	0%	0%
S-19	0%	0%	0%
TRFCYNz	24%	0%	0%
S-21	0%	0%	0%
S-23	0%	0%	0%

4.4 Interim and Final RWLs Attainment

Exceedance frequencies for both dry weather 30-day geometric means and wet weather SSM were compared against the interim and final targets. Wet weather 30-day geometric means were not applicable for RWLs comparisons. **Table 4.1** summarizes the interim and final RWLs attainment status.

CWA 303(d) delisted water bodies and Poche Beach met final RWLs for dry weather during the dry season, while other CWA 303(d) listed water bodies did not meet final RWLs. Interim dry weather RWLs were included in the proposed WQIP and therefore their attainments will be assessed upon the approval of the WQIP.

During the 2016-17 reporting year, 15 water bodies (compared to 19 in 2015-16) out of the 27 monitored stations met the final wet weather RWLs and 16 met the interim wet weather RWLs. Wet weather RWL attainment remains a challenge for CWA 303(d) listed water bodies and some delisted water bodies. It is critical to recognize that wet weather RWLs attainment is highly influenced by rainfall pattern and available sample size, which varies from year to year. Therefore, attainment of RWL should not be considered the sole representation of the site condition.

Table 4.1 TMDL and RWLs Summary

Hydrologic Subarea	Water Body	Segment	Dry Weather: Interim Dry Weather Compliance Date	Dry Weather: Meet Interim Dry Weather Limitation?	Dry Weather: Final Dry Weather Compliance Date	Dry Weather: Meet Final Dry Weather Limitation? (2017)	Wet Weather: Interim Wet Weather Compliance Date	Wet Weather: Meet Interim Wet Weather Limitation? (2017)	Wet Weather: Final Wet Weather Compliance Date	Wet Weather: Meet Final Wet Weather Limitation? (2017)
San Joaquin Hills(901.11) and Laguna Beach(901.12)	Pacific Ocean Shoreline	Cameo Cove at Irvine Cove Drive -Riviera Waya	4/4/2016	NA**	4/4/2021	Y	4/4/2021	N	4/4/2031	N
		At Heisler Park -- North	4/4/2016				4/4/2021			
	Pacific Ocean Shoreline	At Main Laguna Beach	4/4/2016			Y	4/4/2021	N		N
		Laguna Beach at Ocean Avenue	4/4/2016			Y	4/4/2021	Y		N
		Laguna Beach at Cleo Street	4/4/2016			Y	4/4/2021	N		N
		Arch Cove at Bluebird Canyon Road	4/4/2016			Y	4/4/2021	Y		N
		Laguna Beach at Dumond Drive	4/4/2016			Y	4/4/2021	Y		Y
Aliso (901.13)	Pacific Ocean Shoreline	Laguna Beach at Lagunita Place /Blue Lagoon Place at Aliso Beach	4/4/2016			Y	4/4/2021	Y		Y
	Aliso Creek	Aliso Creek	4/4/2018			N	4/4/2021	N		N
	Aliso Creek Mouth	at mouth	4/4/2018			N	4/4/2021	N		N
DanaPoint(901.14)	Pacific Ocean Shoreline	Aliso Beach at West Street	4/4/2016			Y	4/4/2021	Y		Y
		Aliso Beach at Table Rock Drive	4/4/2016			Y	4/4/2021	Y		Y
		1000 Steps Beach at Pacific Coast Hwy at Hospital (9th Ave)	4/4/2016			Y	4/4/2021	Y		Y
		At Salt Creek (large outlet)	4/4/2016			Y	4/4/2021	Y		Y
		Salt Creek Beach at Salt Creek service road	4/4/2017			Y	4/4/2021	Y		Y
		Salt Creek Beach at Dana Strand Road	4/4/2017			Y	4/4/2021	Y		Y
Lower San Juan (901.15)	Pacific Ocean Shoreline	at San Juan Creek	4/4/2016			NA*	4/4/2021	N		N
	San Juan Creek	lower 1 mile	4/4/2018			NA*	4/4/2021	N		N
	San Juan Creek Mouth	at mouth	4/4/2016			NA*	4/4/2021	N		N
San Clemente (901.16)	Pacific Ocean Shoreline	at Poche Beach	4/4/2016			N	4/4/2021	Y		Y
		Ole Hanson Beach Club Beach at Pico Drain	4/4/2016			Y	4/4/2021	Y		Y
		San Clemente City Beach (SCCB) at El Portal Street Stairs	4/4/2017				4/4/2021			
		SCCB at Mariposa Street	4/4/2017			Y	4/4/2021	N		N
		SCCB at Linda Lane	4/4/2016			Y	4/4/2021	Y		Y
		SCCB at South Linda Lane	4/4/2018				4/4/2021			
		SCCB at Lifeguard Headquarters	4/4/2017			Y	4/4/2021	Y		Y
		Under San Clemente Municipal Pier	4/4/2017			N	4/4/2021	Y		Y
		SCCB at Trafalgar Canyon (Trafalgar Lane)	4/4/2018			Y	4/4/2021	N		N
		San Clemente State Beach (SCSB) at Riviera Beach	4/4/2016			Y	4/4/2021	Y		Y
		SCSB at Cypress Shores	4/4/2017			Y	4/4/2021	Y		Y

*Analysis not applicable due to creek flow being intermit

** Interim RWLs will not be available until WQIP adoption. The assessment against interim RWLs will be presented in future WQIP annual reports.

APPENDIX F
BABY BEACH TOTAL MAXIMUM DAILY LOAD

BABY BEACH INDICATOR BACTERIA TOTAL MAXIMUM DAILY LOAD

ANNUAL PROGRESS REPORT FY 2016-17

PREPARED BY WATERSHED PARTNERS:

COUNTY OF ORANGE
&
CITY OF DANA POINT

January 31, 2018

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EXECUTIVE SUMMARY

To address high bacteria concentrations at Baby Beach (and at other impaired harbor and bay beaches in Shelter Island) the San Diego Regional Water Quality Control Board adopted Total Maximum Daily Loads (TMDLs) for Indicator Bacteria, Baby Beach in Dana Point Harbor and Shelter Island Shoreline Park in San Diego Bay (Resolution No. R9-2008-0027) in June 2008. The TMDLs were later incorporated into the Fifth Term Municipal Separate Storm Sewer Systems (MS4s) Permit Order No. R9-2013-0001 as amended by No. R9-2015-0001 and R9-2015-0100. Attachment E Specific Provision 5.b.(2)(c) of Order R9-2013-0001 requires the County of Orange and the City of Dana Point to implement best management practices (BMPs) to achieve the interim and final TMDL compliance requirements.

Bacteria source investigation and control efforts at Baby Beach have occurred since an initial Beach closing in 1996 and have continued to the present. Baby Beach water quality has improved significantly through the bacteria source investigation and implementation of BMPs to address suspected bacteria sources. Data analysis for the 2016-17 reporting period (October 1 – September 30) indicates:

1) Dry weather final TMDL targets have been achieved for Total Coliform and Fecal Coliform. No dry weather exceedances of the 30-day geometric mean target occurred for both indicators during the reporting period. There was no exceedance of the single sample maximum numeric target for Total Coliform and only 2% exceedance of the numeric target for Fecal Coliform. Exceedances of the *Enterococcus* numeric targets in receiving waters occurred for both the 30-day geometric mean and single sample maximum. However, with the implementation of the dry weather diversion BMP, the MS4 did not discharge to the receiving water, which demonstrates compliance.

2) Wet weather interim TMDL targets have been achieved for Total Coliform, Fecal Coliform and *Enterococcus*. There were no wet weather exceedances of the Total Coliform numeric target and only 5% exceedance of the Fecal Coliform numeric target during the reporting period. The wet weather interim TMDL compliance milestone of 31.1% load reduction was met for *Enterococcus* this reporting period, with a 44% exceedance rate reduction compared to the baseline period.

A microbial source identification special study that began in 2012 continued in 2016-17. A subset of Baby Beach samples, which exceeded numeric targets, was tested for genetic markers. Twenty-five percent of the samples in the receiving waters tested positive for canine markers while only 5% of the samples tested positive for human markers. Human sources of bacteria from the MS4, including sewer exfiltration were eliminated as potential sources of the human markers after a number of sewer repairs were completed in November 2015.

The coordinated watershed-wide effort which include monitoring, special studies, and load reduction BMPs have resulted in reduced overall loadings of indicator bacteria by 100% and 72 % during dry weather and wet weather conditions, respectively. Load reduction efforts have exceeded the requirements of the TMDL (see **Table 2.1** and **Table 2.2** in Section 2).

1.0 INTRODUCTION

Baby Beach (Beach) is a small man-made beach located in Dana Point Harbor in the City of Dana Point, California (see **Figure 1.1**). Approximately 600 feet wide (700 feet of shoreline) and nestled below the bluffs of Dana Point in the innermost corner of the Harbor, the Beach is owned and operated by the County of Orange.

This sixth annual progress report provides a summary of Best Management Practices (BMP) efforts (**Section 3**), the Total Maximum Daily Load (TMDL) monitoring program (**Section 4**), an analysis of bacterial water quality (**Section 5**), and the TMDL Work Plan (**Section 6**). The Work Plan addresses the remaining Fecal Indicator Bacteria (FIB) exceedances and was developed utilizing *The California Microbial Source Identification Manual: A Tiered Approach to Identifying Fecal Pollution Sources to Beaches* (SCCWRP, 2013).

Figure 1.1: Aerial Photo of Dana Point Harbor

1.1 Historical Context

Routine testing of bacterial water quality at the Beach began in 1995. In August 1996, high FIB concentrations in beach waters prompted health officials to close the Beach. An extensive 11-month investigation and source control effort included:

- Video camera inspections of nearby sewer lines,
- Inspections of plumbing at harbor restrooms,
- Testing of groundwater at 15 monitoring wells,
- Analysis of runoff from bluff top neighborhoods,
- Installation of plugs in storm drains to the Beach,
- Reduction of irrigation and fertilizer use at adjacent park areas,
- Increased cleanup of animal excrement in the park area,
- Installation of signage to discourage the feeding of birds, and
- Removal of an old abandoned septic tank.

The source of high bacteria levels remained unknown in spite of these efforts. The Beach was reopened on July 1, 1997; however, high bacteria counts remained a recurring problem. In 2000, health risk advisory signs were posted at the Beach again for a period of 54 days. As a result, the Beach was placed on the 2002 Clean Water Act (CWA) 303(d) list of impaired waterbodies (CWA 303 (d) list) for indicator bacteria. In 2004, the San Diego Regional Water Quality Control Board (San Diego Regional Board) began development of the TMDLs to address the high bacteria concentrations at the Beach and other impaired harbor and bay beaches in the San Diego Region.

On June 11, 2008, the San Diego Regional Board adopted the TMDLs to address elevated bacteria concentrations at Baby Beach in Dana Point Harbor and Shelter Island Shoreline Park in San Diego Bay (Resolution No. R9-2008-0027). The Office of Administrative Law (OAL) approved the TMDLs in September 15, 2009.

During the 2008-2010 CWA 303(d) listing cycle, previous "indicator bacteria" listings were divided into separate listings for three bacterial indicators: Total Coliform, Fecal Coliform, and *Enterococcus*. As a result, the Beach was listed in the 2010 CWA 303(d) list as impaired by Total Coliforms and *Enterococcus*. The 2010 Total Coliform listing was based upon the water quality objective associated with shellfish harvesting (SHEL) beneficial use, not contact recreation (REC-1).

On February 11, 2015, the San Diego Regional Board adopted the Fifth Term Permit Order No. R9-2013-0001 as amended by Order No. R9-2015-0001 and R9-2015-0100 in November 18, 2015 incorporating south Orange County into the regional stormwater permit. The Fifth Term Permit incorporated the waste load allocations (WLAs) prescribed in the Baby Beach TMDL (see **Section 3** of this report) as well as monitoring and other requirements for the Beach.

1.2 Water Quality Improvement

Bacteria source investigation and control efforts have continued at the Beach since the initial 1996 Beach closure. Although a definitive source of high bacteria levels has not been identified, there has been a significant improvement in water quality at the Beach through the implementation of multiple BMPs.

As a testament to this improvement, the number of days per year the Beach waters have been posted for high bacteria concentrations has declined considerably. The Orange County Health Care Agency (HCA) uses Beach Mile Days (BMD) as a metric of bacterial water quality to reflect both the extent of Beach frontage as well as the time period affected. In 2000, 12.78 BMD was posted at the Beach, out of a maximum 16.61 BMD possible. By 2009, this had dropped to 0.23 BMD. For the 2016-17 reporting period, 0.49 BMD were posted at the Beach (B.Wong, personal communication, 2018).

Additionally, the Beach was delisted for Fecal Coliform from the 2010 303(d) list and is proposed for delisting for *Enterococcus* from the 2014/2016 303(d) list. The Heal the Bay Annual Beach Report Card has given the Beach good scores over the past five years. Scores for the Beach sites for the 2016-17reporting period were "B" to "A+" during summer dry weather and "A" to "A+" during winter dry weather (www.healthebay.org). Winter wet weather grades were "C" to "B", which was comparable to the rest of Orange County beaches, where 44% of beaches earning A or B grades.

1.3 Watershed Setting

A 43.4 acre watershed drains to the Beach as shown in **Figure 1.2**. The Beach is surrounded by mixed land uses including commercial food and lodging, open space, and residential areas. The County's Youth & Group Facility is located to the east and the Ocean Institute to the west of the Beach. The areas immediately adjacent to the Beach are parking lots and a grass picnic park. Visitors consist of Beach goers, picnic groups, kayakers, stand up paddle boarders, day camp students from the Ocean Institute, sailing students from the Youth & Group Facility, and dog walkers (although dogs are not allowed on the Beach). Sea birds are common on the shoreline.

Two storm drains discharge directly to the Beach at the west and east ends of the Beach. The west end drains runoff from the hillside to the west of the Harbor including surrounding roadways, commercial development, residential areas, and undeveloped open space. The east end drains runoff from a small parking lot near the Beach. Another small drain near the Beach discharges runoff from the Ocean Institute.

Figure 1.2: The Baby Beach Watershed & Associated Land Use

2.0 WASTE LOAD ALLOCATIONS/SCHEDULE

Attachment E of Order R9-2013-0001 requires the County of Orange and the City of Dana Point to implement BMPs capable of achieving the interim and final waste load allocations (WLAs) in discharges to the Beach as described in **Table 2.1** and **2.2** below per the schedule provided in **Table 2.3**:

Table 2.1: Interim Indicator Bacteria Waste Load Allocations

	WASTE LOAD ALLOCATIONS (WLAs)		WASTE LOAD REDUCTIONS	
BACTERIAL INDICATOR	DRY WEATHER (BILLION MPN*/DAY)	WET WEATHER (BILLION MPN*/30 DAYS)	% REDUCTION REQUIRED DRY WEATHER	% REDUCTION REQUIRED WET WEATHER
Total Coliform	4.93	3,254	45.2	0
Fecal Coliform	0.59	112	41.4	0
Enterococcus(2012)	0.42	301	48.1	0
Enterococcus(2016)	0.03	207	96.2	31.1

*MPN is functionally equivalent to CFU

Table 2.2: Final Indicator Bacteria Waste Load Allocations

	WASTE LOAD ALLOCATIONS (WLAs)		WASTE LOAD REDUCTIONS	
BACTERIAL INDICATOR	DRY WEATHER (BILLION MPN*/DAY)	WET WEATHER (BILLION MPN*/30 DAYS)	% REDUCTION REQUIRED DRY WEATHER	% REDUCTION REQUIRED WET WEATHER
Total Coliform	0.86	3,254	90.4	0
Fecal Coliform	0.17	112	82.7	0
Enterococcus	0.03	114	96.2	62.2

Table 2.3: TMDL Waste Load Reduction Milestones

ACTION	DATE/MILESTONE	ACTUAL DATE
Meet 50% waste load reductions	3 years after effective date for dry weather	September 15, 2012*
	7 years after effective date for wet weather	September 15, 2016*
Meet 100% waste load reductions	5 years after effective date for dry weather	December 31, 2014**
	10 years after effective date for wet weather	December 31, 2019**

*The effective date of the TMDL was September 15, 2009.
** The Order R9-2013-0001 specifies that the WLAs are to be met by the end of the year.

The WLAs are established at levels that will result in full attainment of water quality standards (numeric targets). For this reason, the San Diego Regional Board expects that once the WLA reductions above have been achieved, the numeric targets in **Table 2.4** will be met.

Table 2.4: Final Indicator Bacteria Numeric Targets

BACTERIAL INDICATOR	30-DAY GEOMETRIC MEAN	SINGLE SAMPLE MAX (MPN/100ML)
	DRY WEATHER ONLY	**DRY & WET WEATHER**
Total Coliform	1,000	10,000
Fecal Coliform	200	400
Enterococcus	35	104

Attachment E, Specific Provision 5.b (3) of the Fifth Term Permit states for final TMDL compliance determination, the responsible Permittees can demonstrate compliance with any of the following methods:

1) There is no direct discharge from the MS4s to the receiving water; or
2) No exceedance of the final receiving water limitations (**Table 2.4**) in the receiving water at, or downstream of the MS4 outfalls; or
3) No exceedance of the final effluent limitations at the MS4 outfalls; or
4) Pollutant loads discharging from the MS4 outfalls do not exceed limits (**Table 2.2**); or
5) Pollutant load reductions for discharges from the MS4 outfalls are greater than or equal to limits specified in **Table 2.2;** or
6) Show that exceedances of the final receiving water limitations (see **Table 2.4**) are due to loads from other sources and pollutant loads from the Permittee's MS4s are not causing or contributing to the exceedances; or
7) Develop and implement the Water Quality Improvement Plan (WQIP) as specified.

3.0 SUMMARY OF BEST MANAGEMENT PRACTICES (BMPs)

3.1 BMP Implementation Timeline

Improving the water quality of the Beach has been a high priority for the County of Orange, including Dana Point Harbor, and the City of Dana Point. After years of efforts, recent water quality improvements suggest that the comprehensive approach of special studies, operational changes, and structural improvements has been successful in reducing overall FIB exceedances. The myriad of efforts has been implemented in a collaborative manner by various stakeholders, including County departments: OC Public Works (OCPW), OC Health Care Agency (HCA), OC Community Resources (OCCR which includes OC Parks and OC Dana Point Harbor); and the City of Dana Point. A chronological list of BMPs implemented at the Beach and throughout the watershed is provided as **Attachment B** (https://ocgov.box.com/v/201617-TMAR-Datasets).

3.2 Future BMP Efforts

As described in **Section 6** of this report, there has been notable improvement in water quality at the Beach since 2002 and significant progress made toward achieving TMDL WLAs. The Permittees have allocated considerable resources to identify sources and implement BMPs that have improved water quality. Though structural and source control BMPs are in place, there are still occasional exceedances of TMDL numeric targets for FIB at the Beach. As a result, the County of Orange and City of Dana Point will utilize *The California Microbial Source Identification Manual: A Tiered Approach to Identifying Fecal Pollution Sources to Beaches* produced by the Southern California Coastal Water Research Project (SCCWRP) to address these exceedances. Continued operation of existing BMPs coupled with additional source investigations were carried out during the 2016-17 following the work plan outlined in **Section 6**.

4.0 TMDL MONITORING PROGRAM

The Beach Indicator Bacteria TMDL Monitoring Program (TMDL Monitoring Program) was submitted by the County of Orange and City of Dana Point to the San Diego Regional Board on December 16, 2010. The TMDL Monitoring Program includes elements of several agency programs within the Harbor, as described below. As part of each year's TMDL Annual Progress Report, the TMDL monitoring program is reevaluated to determine if the program is effective in assessing TMDL compliance and ensuring the protection of REC-1 beneficial uses at the Beach.

Samples for fecal indicator bacteria are collected at 11 locations throughout Dana Point Harbor (see **Figure 4.1)**. County of Orange staff has been collecting the samples at these locations including 4 locations along the Beach (BDP12, BDP13, BDP14, and BDP15) as part of the Unified Beach Water Quality Monitoring and Assessment Program in south Orange County. County staff collected additional samples at the Beach location BDP14 for targeted wet weather sampling. A summary of the existing Dana Point Harbor bacteria monitoring sites and frequencies and the Baby Beach TMDL Monitoring Program is provided in **Table 4.1**.

Samples are collected at ankle depth water, using 250 ml sterile plastic containers that are pre-supplied by HCA laboratory, which performs the sample analysis. They are transported in ice (cool to <10C) within the recommended holding time of 6 hours. A trip blank is collected and submitted with each batch of samples for quality control purposes.

Data for the Beach monitoring sites for 2016-17 are provided in **Attachment A** to this report (https://ocgov.box.com/v/201617-TMAR-Datasets) and an updated water quality assessment of the Beach waters is provided in **Section 5**. No changes to the monitoring program are proposed for 2017-18.

Figure 4.1: Fecal Indicator Bacteria Sample Collection Sites

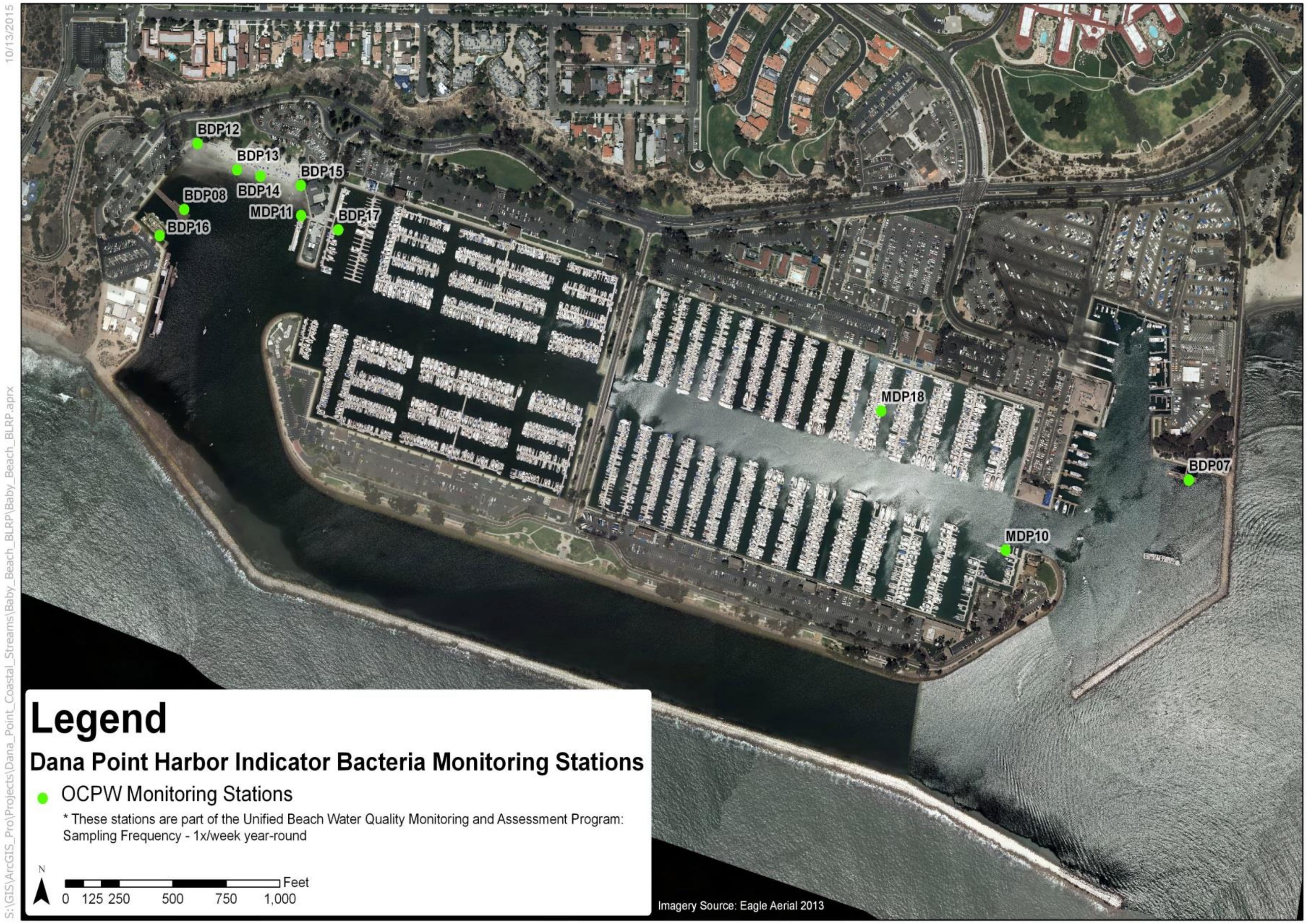


Table 4.1: Dana Point Harbor Bacteria Monitoring Sites and Frequencies

	Monitoring Sites	Frequency	Samples/Year
Existing Monitoring Programs			
Unified Program	BDP12, BDP13, BDP14, BDP15, BDP16, BDP17, BDP08, MDP11, MDP10, MDP18, BDP07	1x/Week Year-round	572 (includes 208 at Baby Beach)
Baby Beach TMDL Monitoring Program			
Targeted Wet Weather Monitoring	BDP14	Up to 3x/Year following storm events >= 0.2 inch of rain	3

5.0 WATER QUALITY ASSESSMENT AND CONCLUSIONS

5.1 Introduction

The following sections assess water quality at the Beach relative to the receiving water concentration-based TMDL targets and examine conditions at the Beach pre- and post-TMDL development and during the reporting period.

5.2 Assessment Criteria and Baby Beach Monitoring

5.2.1 Data Analysis Methodology

The Beach water quality has been monitored at four monitoring stations along the Beach (BDP12, BDP13, BDP14, and BDP15). The period from November 1996 through October 2002 represents the pre-TMDL baseline conditions at the Beach ("baseline years") and the period since November 2002 is referred to as the "progress years" or "progress period".

Due to the close proximity of the Beach monitoring sites, data from all four sites were aggregated for this assessment. Geometric means were only calculated if at least five samples were collected within any running 30-day period. Dry and wet weather data were analyzed separately for TMDL compliance assessment purposes.

5.2.2 Storm Sampling

The Baby Beach Indicator Bacteria TMDLs consider wet weather as storm events of at least 0.20 inches of rain in a single day and a period of 72 hours (3 days) following such events. A review of rain data from the County of Orange's Palisades Reservoir rain gauge, located near Dana Point Harbor, found that from 1996 to 2017, there was an average of 15 days a year that had at least 0.20 inches of rain. Comparatively, the current reporting period had 23 such days compared to 9 days during the 2015-16 reporting period.

After five years of below average rainfall, 16.52 inches was recorded at Palisades Reservoir during the reporting period, which is above the annual average of 12.41 inches.

Wet weather samples were collected at BDP14 during three storm events: November 11-21, 2016; January 8, 2017; and February 8-10, 2017. Two additional events, October 25-27, 2016 and January 6-7, 2017, were sampled; however, rainfall depth at the Palisades Reservoir rain gauge did not register enough rainfall for the results to be considered wet weather. The samples results were included in the dry weather analysis. Five regular weekly sampled days within the reporting period also met the TMDL wet weather criteria giving good coverage of wet weather water quality this reporting period.

5.3 Baby Beach Data Analysis – Total Coliform

Total Coliform exceedances remained low for both wet and dry weather. **Table 5.1** provides a summary of Total Coliform exceedances comparing baseline, progress periods, and the 2016-17 reporting year for dry weather. **Table 5.2** provides a summary of Total Coliform exceedances for wet weather.

Table 5.1: Baby Beach Dry Weather Total Coliform Exceedances

	Single Sample Maximum			30-Day Geometric Mean		
	Baseline Years 1996-2002	**Progress Years 2002-17**	**Reporting Period 2016-17**	**Baseline Years 1996-2002**	**Progress Years 2002-17**	**Reporting Period 2016-17**
# of Samples/ Geomeans	1214	2803	180	850	1751	130
Exceedances	10	12	0	12	11	0
Exceedance Rate	< 1%	< 1%	0%	1%	< 1%	0%

5.3.1 Total Coliform Results for Dry Weather

Dry weather Total Coliform data at the Beach monitoring sites are depicted in **Figures 5.1** and **5.2**. Box plots were constructed to display the distribution of bacterial data in each figure. Each box displays the median and first and third quartiles, whiskers represent the 10^{th} and 90^{th} percentile, and dots represent outliers. Running 30-day geometric means of concentrations are depicted in **Figure 5.1** while **Figure 5.2** depicts individual sample concentrations. Compared to baseline years, an overall declining trend in Total Coliform concentrations is visible in **Figure 5.1**. Additionally, **Figure 5.1** shows that there has been no exceedance of the geometric mean numeric target for REC-1 since 2005. **Figure 5.2** shows no exceedance of the single sample standard this reporting period, therefore compliance has been demonstrated. These appear to be the result of the implementation of the dry weather diversion BMPs in 2005.

Figure 5.1: Total Coliform 30-Day Geometric Mean Comparing Baseline Period with Progress Years (Dry Weather)

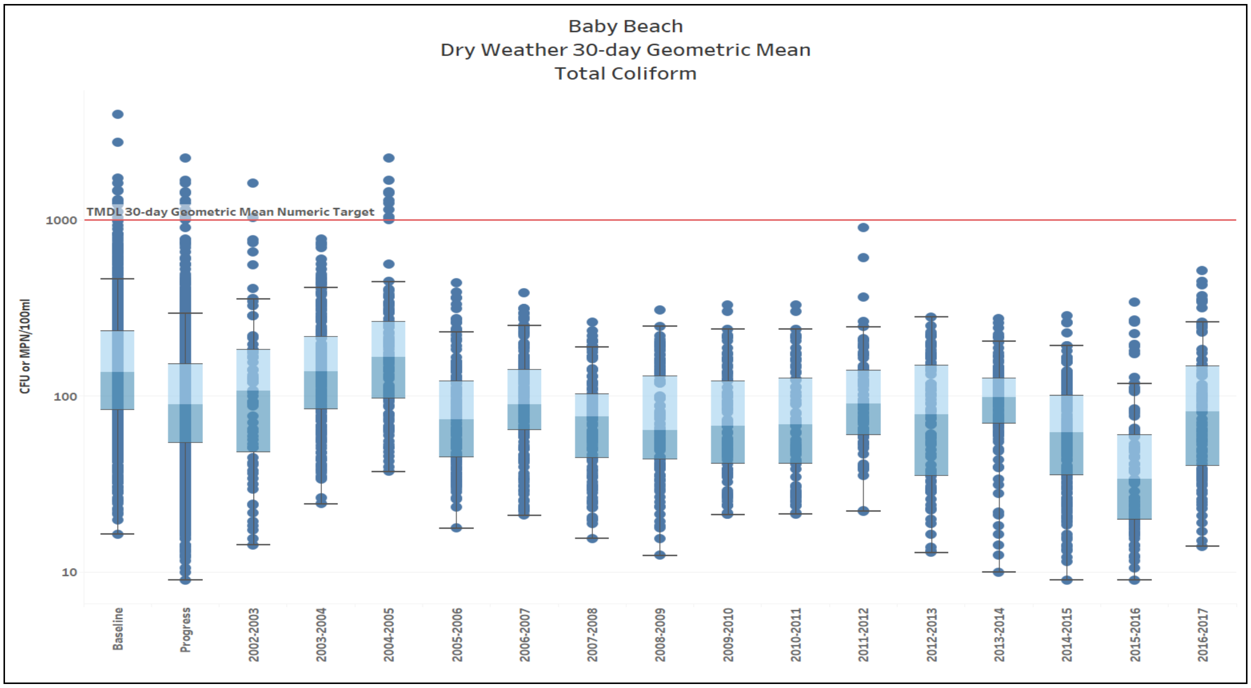
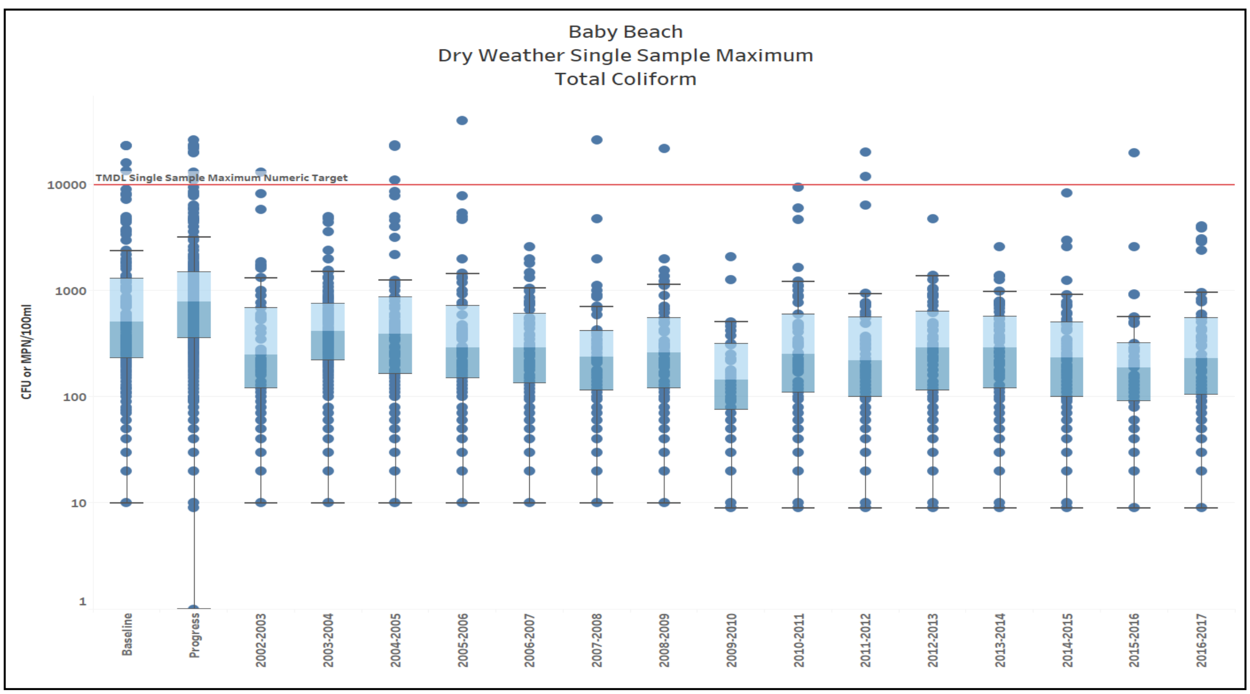


Figure 5.2: Total Coliform Single Sample Concentrations Comparing Baseline Period with Progress Years (Dry Weather)



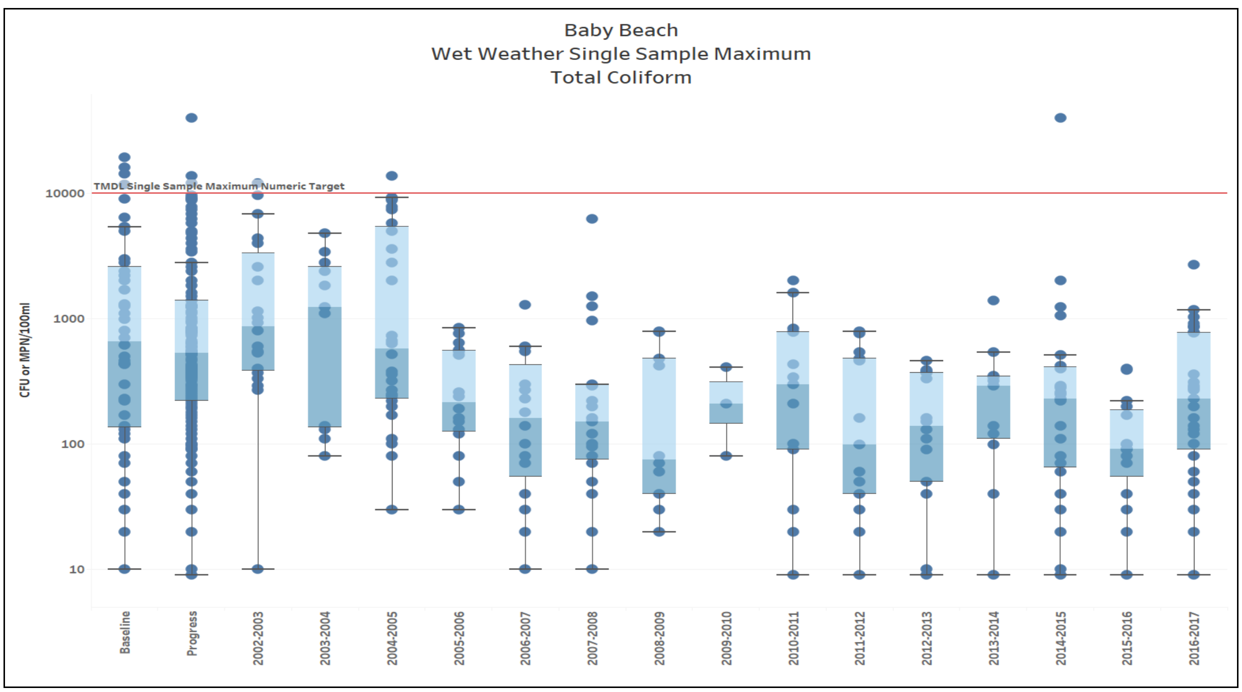
5.3.2 Total Coliform Results for Wet Weather

There was no exceedance of the wet weather numeric target for Total Coliform during the 2016-17 reporting period (**Table 5.2**). The interim wet weather compliance milestone was met. Wet weather Total Coliform concentrations at the Beach monitoring sites are depicted in **Figure 5.3**. As with dry weather samples, an overall declining trend in concentrations is visible on the graph and values are significantly below the numeric target for wet weather.

Table 5.2: Baby Beach Wet Weather Total Coliform Exceedances

	Single Sample Maximum		
	Baseline Years 1996-2002	**Progress Years 2002-17**	**Reporting Period 2016-17**
# of Samples	148	341	34
Exceedances	6	3	0
Exceedance Rate	4%	<1%	0%

Figure 5.3: Total Coliform Single Sample Concentrations Comparing Baseline Period with Progress Years (Wet Weather)

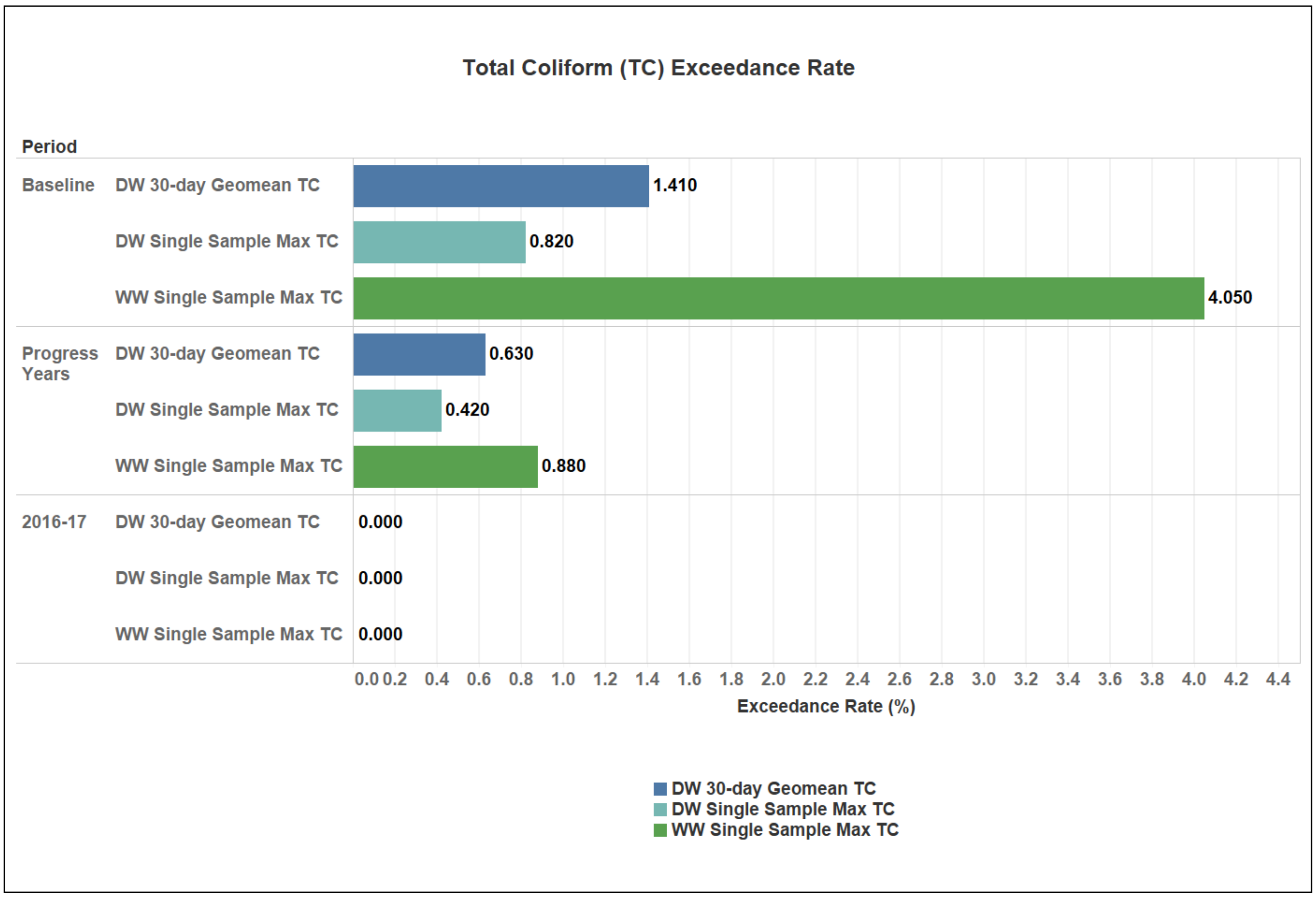


5.3.3 Total Coliform – Overall Exceedance and Concentration Discussion

Overall Exceedance Rates

The exceedance rate for Total Coliform continues to be low for both dry and wet weather conditions (**Figure 5.4**). The dry weather single sample maximum and 30-day geometric mean were not exceeded during the reporting period; therefore, compliance was demonstrated. The implementation of the dry weather diversion BMP in 2005 (see **Attachment B**, item number **19**), eliminated discharge from the MS4 during dry weather. There was no wet weather single sample maximum exceedance this reporting period, thus the interim wet weather compliance milestone has been met.

Figure 5.4: Total Coliform Exceedance Rate Comparing Baseline Period with Progress Years and Current Reporting Year



5.4 Baby Beach Data Analysis – Fecal Coliform

Fecal Coliform exceedances have significantly declined since the baseline period during both wet and dry weather. Summary of Fecal Coliform exceedances comparing baseline, progress periods, and the 2016-17 reporting year for dry weather is presented in **Table 5.3** and wet weather in **Table 5.4**.

Table 5.3: Baby Beach Dry Weather Fecal Coliform Exceedances

	Single Sample Maximum			30-Day Geometric Mean		
	Baseline Years 1996-2002	Progress Years 2002-17	Reporting Period 2016-17	Baseline Years 1996-2002	Progress Years 2002-17	Reporting Period 2016-17
# of Samples/ Geomeans	1353	2799	182	1002	1847	118
Exceedances	299	140	4	264	30	0
Exceedance Rate	22%	5%	2%	26%	2%	0%

5.4.1 Fecal Coliform Results for Dry Weather

Dry weather fecal coliform concentrations at the Beach monitoring sites are graphed in **Figure 5.5** and **Figure 5.6**. Box plots were constructed to display the statistical distribution of bacterial data. Dry weather exceedance rates during the progress period continued to be low. Exceedance of the single sample maximum was the same as the previous reporting period, as presented in **Figure 5.6**. The 30-day geometric mean numeric target was met since there were no exceedances during dry weather (**Figure 5.5**). Current dry weather exceedance rates for Fecal Coliform are more than 90% below baseline years. Moreover, with the implementation of the dry weather diversion BMP, there is no dry weather discharge from the MS4 and the percent load reduction has been achieved.

Figure 5.5: Fecal Coliform 30-Day Geometric Mean Comparing Baseline Period with Progress Years (Dry Weather)

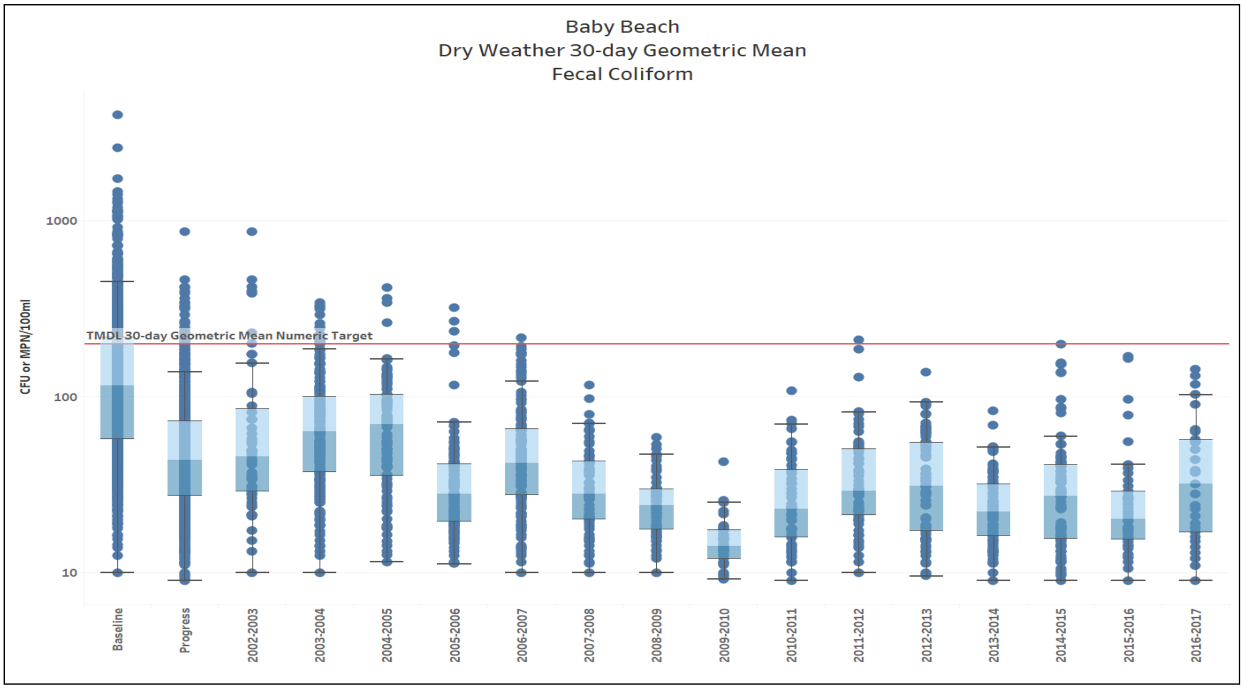
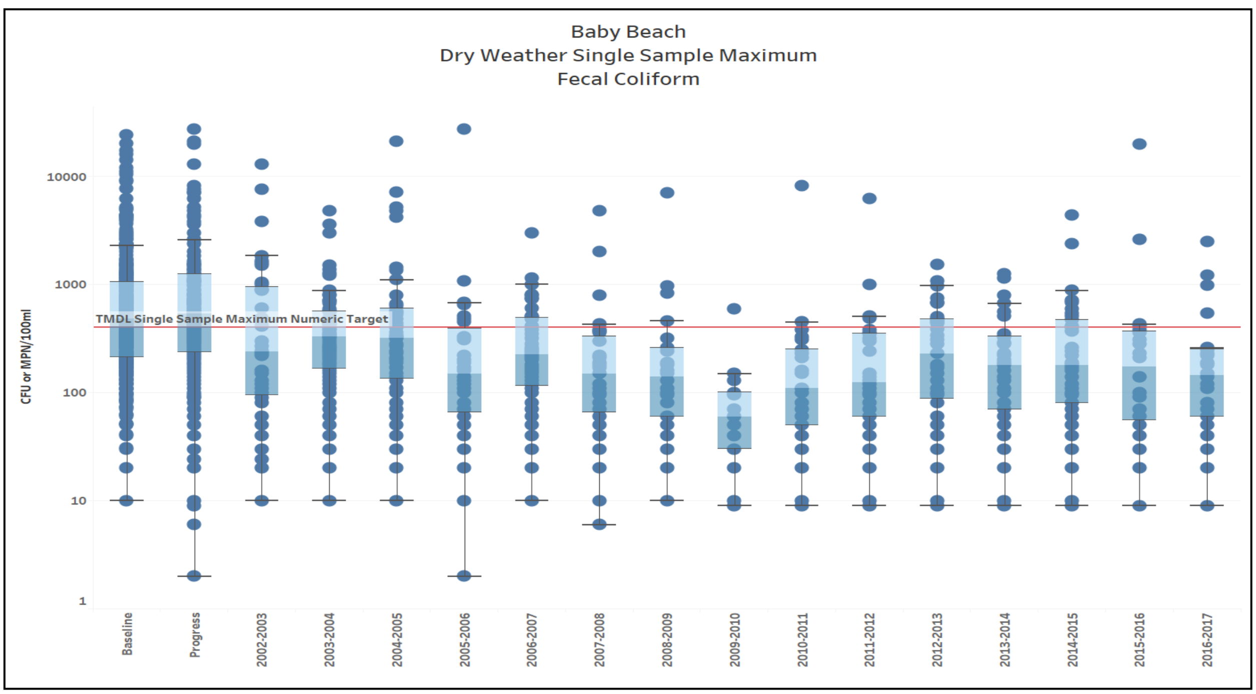


Figure 5.6: Fecal Coliform Single Sample Concentrations Comparing Baseline Period with Progress Years (Dry Weather)



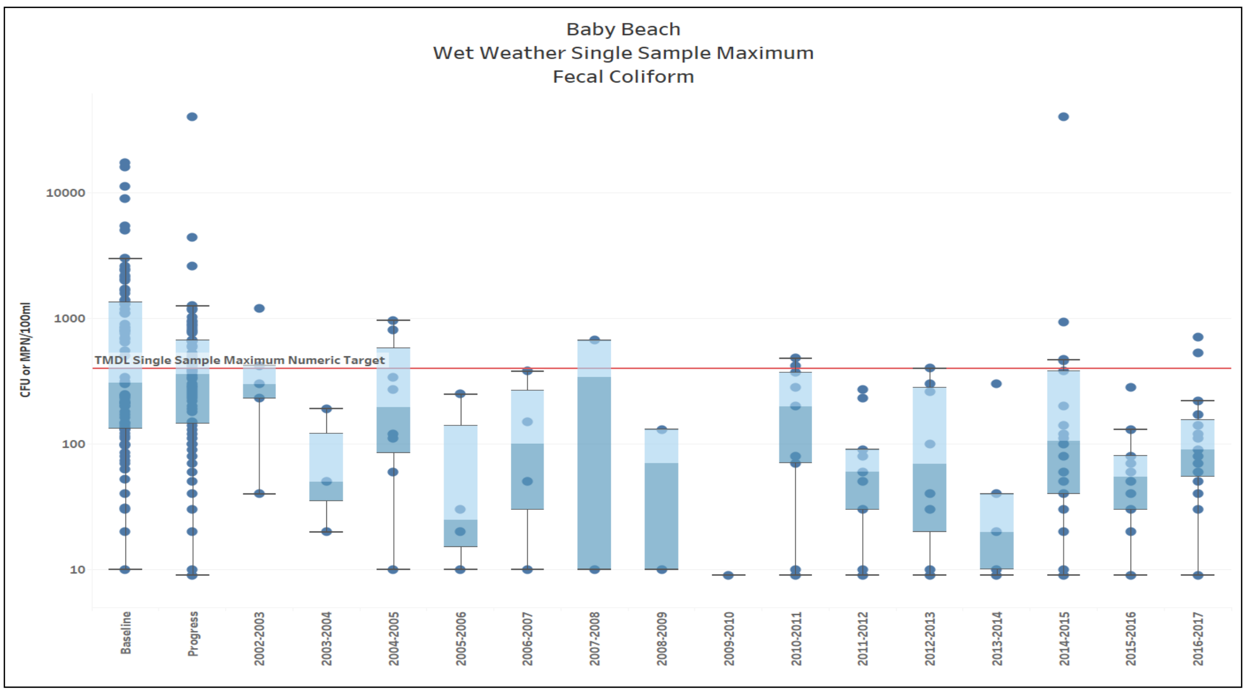
5.4.2 Fecal Coliform Results for Wet Weather

There were two wet weather Fecal Coliform single sample exceedances during the reporting period as presented in **Table 5.4**. The exceedance rate has steadily declined from 32% in baseline years, to 10% in the progress years and 5% in the current reporting period. The interim wet weather compliance milestone was met.

Table 5.4: Baby Beach Wet Weather Fecal Coliform Exceedances

	Single Sample Maximum		
	Baseline Years 1996-2002	Progress Years 2002-17	Reporting Period 2016-17
# of Samples	155	318	35
Exceedances	50	34	2
Exceedance Rate	32%	10%	5%

Figure 5.7: Fecal Coliform Single Sample Concentrations Comparing Baseline Period with Progress Years (Wet Weather)

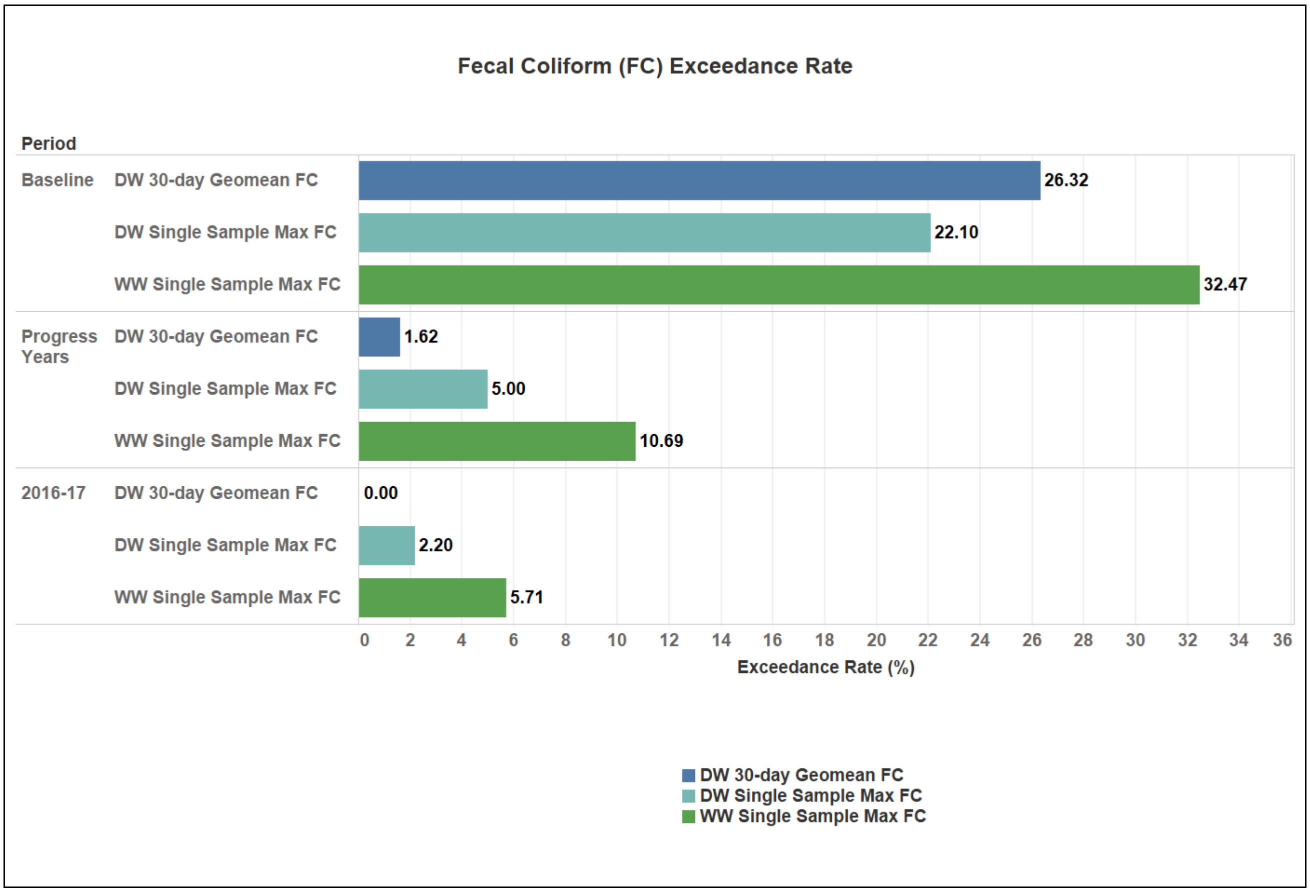


5.4.3 Fecal Coliform – Overall Exceedance and Concentration Discussion

Overall Exceedance Rates

The exceedance rate for Fecal Coliform has decreased considerably since the baseline period for both dry and wet weather conditions (**Figure 5.8**). No exceedances of the dry weather 30-day geometric mean occurred during the reporting period for Fecal Coliform. The dry weather single sample maximum exceedance rate was only 2%. Furthermore, with the implementation of the dry weather diversion BMPs, dry weather percent load reduction TMDL targets have been achieved. The interim wet weather compliance milestone was also met, with only 5% exceedance of the single sample maximum.

Figure 5.8: Fecal Coliform Single Sample Concentrations Exceedance Rate Comparing Baseline Period with Progress Years and Current Reporting Year



5.5 Baby Beach Data Analysis – *Enterococcus*

Enterococcus exceedances have significantly declined since the baseline period for both wet and dry weather conditions. Summary of *Enterococcus* exceedances comparing baseline, progress periods, and the 2016-17 reporting year for dry weather is presented in **Table 5.5** and wet weather in **Table 5.6**.

Table 5.5: Baby Beach Dry Weather *Enterococcus* Exceedances

	Single Sample Maximum			30 Day Geometric Mean		
	Baseline Years 1996-2002	Progress Years 2002-17	Reporting Period 2016-17	Baseline Years 1996-2002	Progress Years 2002-17	Reporting Period 2016-17
# of Samples/ Geomeans	785	2797	182	586	1845	118
Exceedances	202	347	13	292	388	22
Exceedance Rate	26%	12%	7%	50%	21%	19%

5.5.1 *Enterococcus* Results for Dry Weather

Dry weather *Enterococcus* data are plotted in **Figure 5.9** and **Figure 5.10**. Box plots were constructed to display the distribution of bacterial data. **Figure 5.9** presents the exceedance of the 30-day geometric mean numeric target**,** and **Figure 5.10** presents the single sample maximum exceedances. Single sample maximum exceedances have increased during the 2016-17 reporting year compared to 2015-216 reporting year. From the exceedances, 6 of the13 were rain influenced samples and collected while a rain advisory was out. However, the Palisades Reservoir rain gauge did not register enough rainfall for the results to be considered wet weather, thus the samples were included in the database for dry weather. Source investigations (**Section 5.6**.) and routine sanitary surveys (**Section 6.3**) continued this year to help identify the cause of the exceedances.

Even though *Enterococcus* occasional exceedances continue to occur during dry weather, rates for the progress period continued to decline. The single sample maximum exceedance rate for 2002-16 was 13%; it decreased to 12% for 2002-17. The geometric mean exceedance rate for 2002-16 was 23%; it decreased to 21% for 2002-17.

Figure 5.9: ***Enterococcus*** **30-Day Geometric Means Comparing Baseline Period with Progress Years (Dry Weather)**

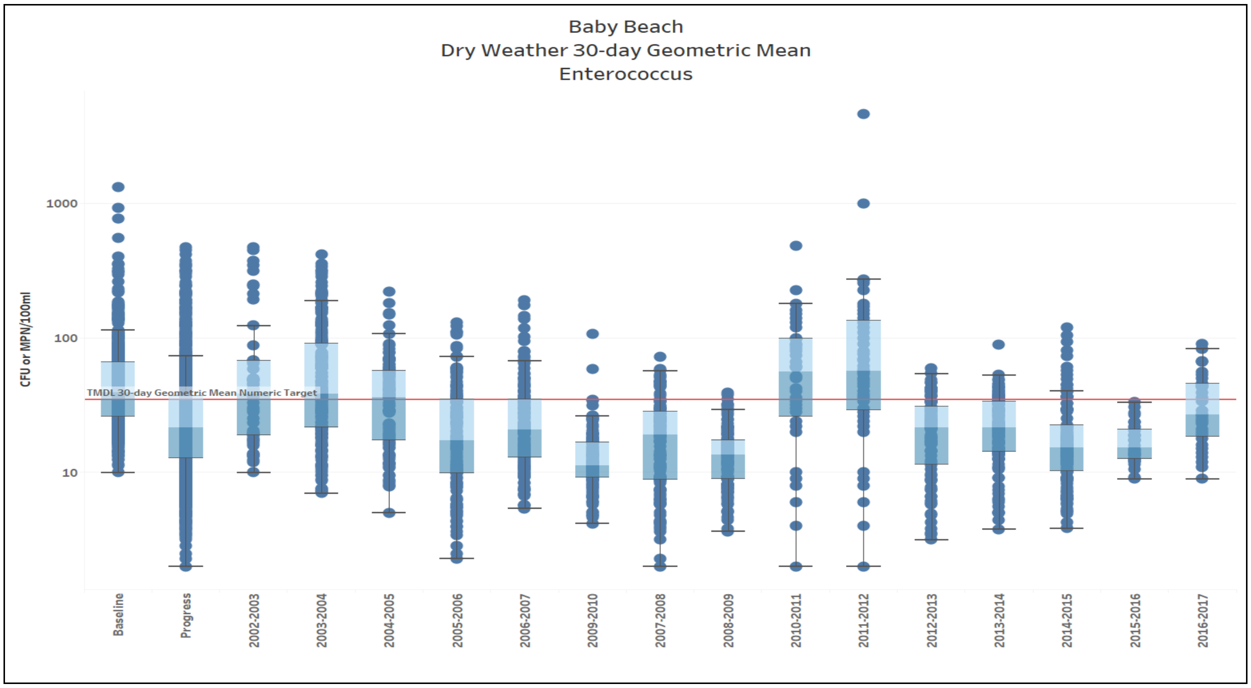
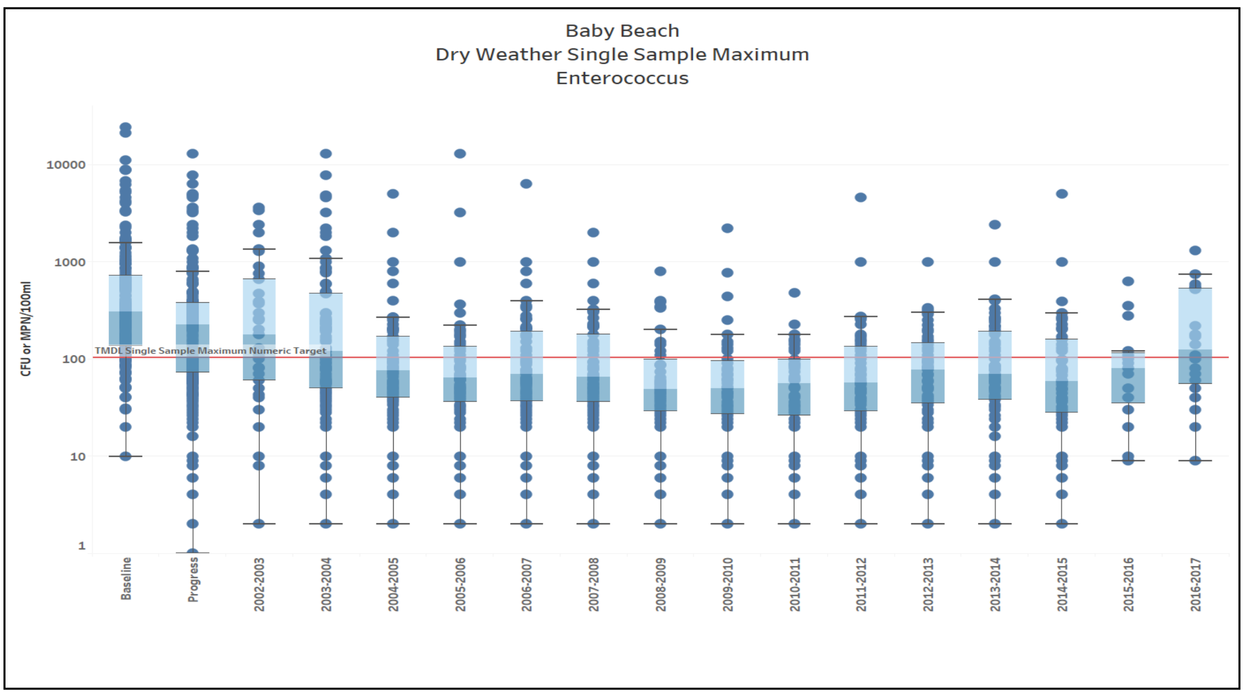


Figure 5.10: ***Enterococcus*** **Single Sample Concentrations Comparing Baseline Period with Progress Years (Dry Weather)**



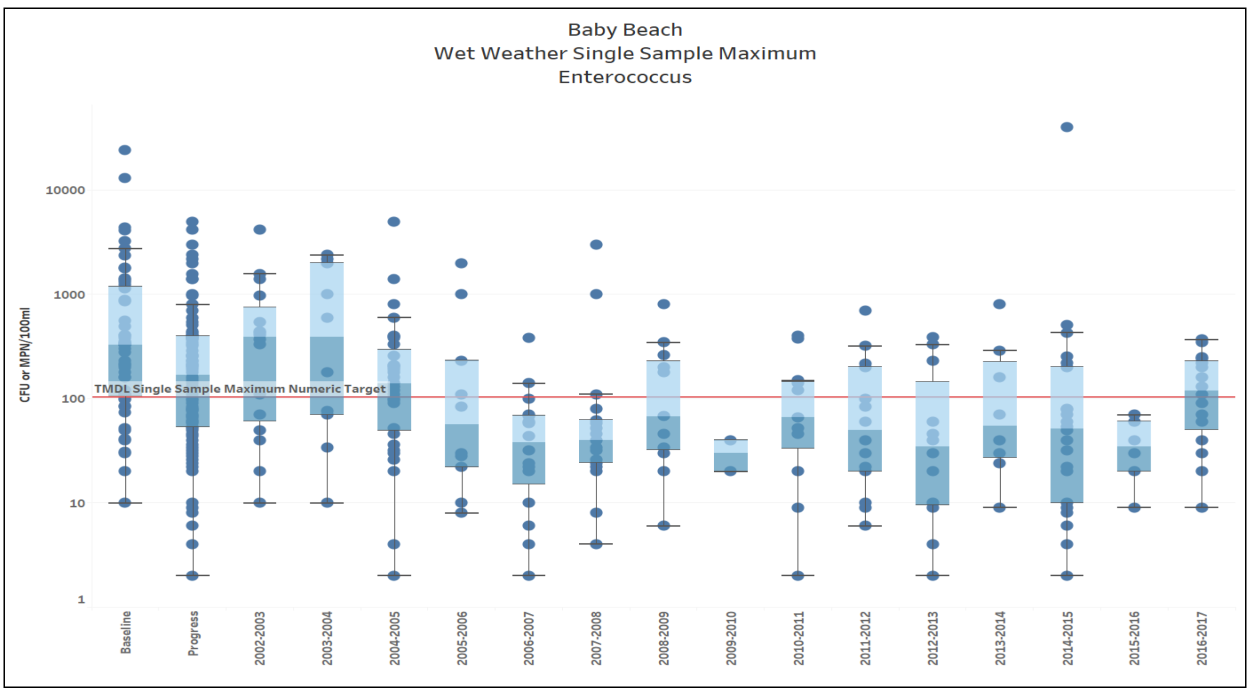
5.5.2 *Enterococcus* Results for Wet Weather

While exceedances of wet weather *Enterococcus* numeric targets still occurred, significant progress has been made and interim percent load reduction targets have been achieved (**Table 5.6, Figure 5.11**). The data shows a 44% percent exceedance rate reduction form baseline years, which exceeds the interim wet weather compliance milestone of 31.1% (see **Table 2.1**).

Table 5.6: Baby Beach Wet Weather *Enterococcus* Exceedances

	Single Sample Maximum		
	Baseline Years 1996-2002	Progress Years 2002-17	Reporting Period 2016-17
# of Samples	74	319	36
Exceedances	41	93	11
Exceedance Rate	55%	29%	31%

Figure 5.11*:* *Enterococcus* Single Sample Concentrations Comparing Baseline Period with Progress Years (Wet Weather)

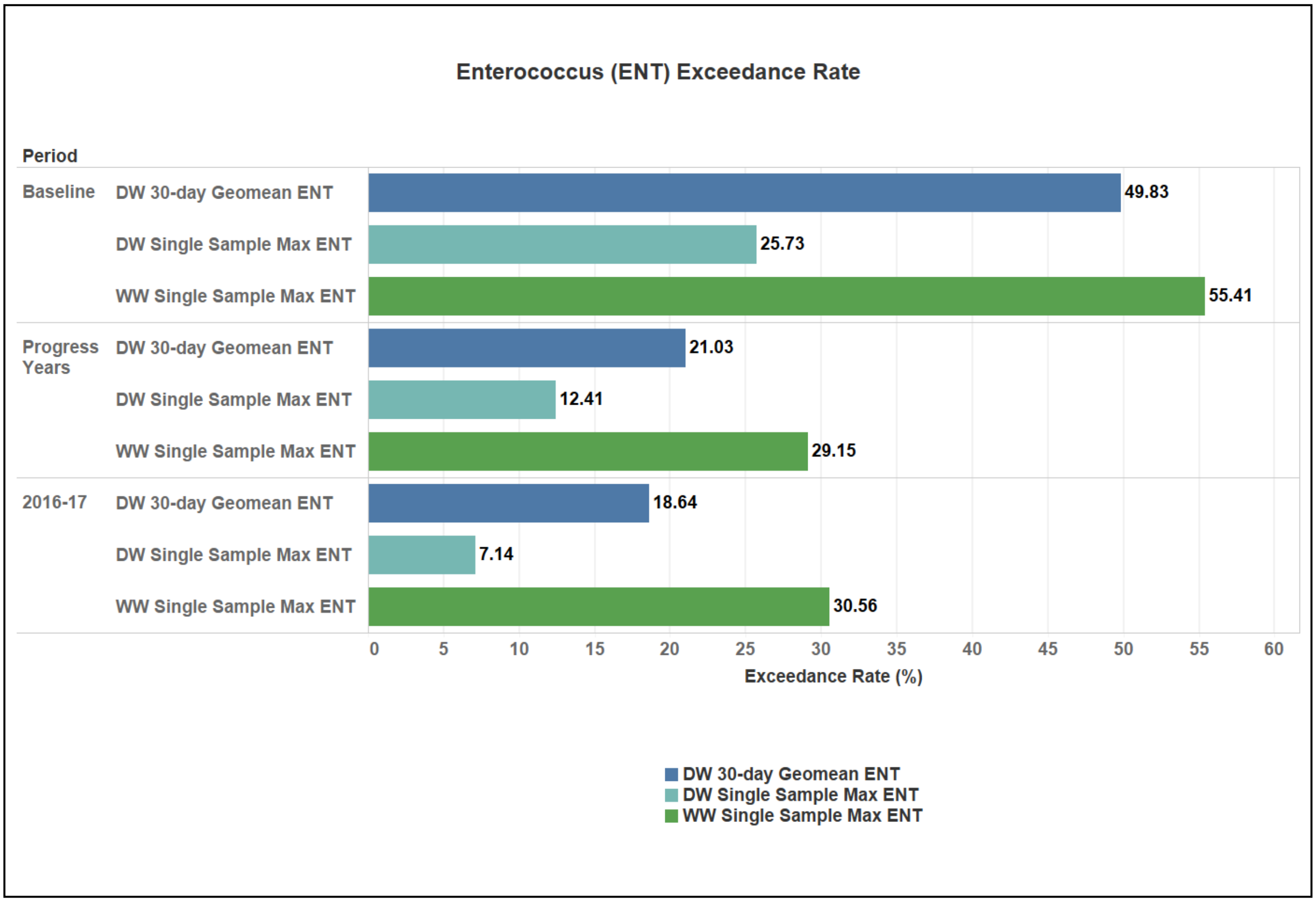


5.5.3 *Enterococcus* – Overall Exceedance and Concentration Discussion

Overall Exceedance Rates

The exceedance rate for *Enterococcus* has decreased significantly since the baseline period for both dry and wet weather conditions (**Figure 5.12)**. Exceedance of the *Enterococcus* numeric targets are still occurring for both the 30-day geometric mean and single sample maximum. With the implementation of the dry weather diversion BMPs, there is no discharge (and associated pollutant loading) from the MS4 during the dry season to the Beach, thus the required compliance demonstration for the MS4 during the dry season has been achieved. The interim wet weather compliance milestone of 31.1% load reduction was met this reporting period, with the 44% exceedance rate reduction compared to baseline period.

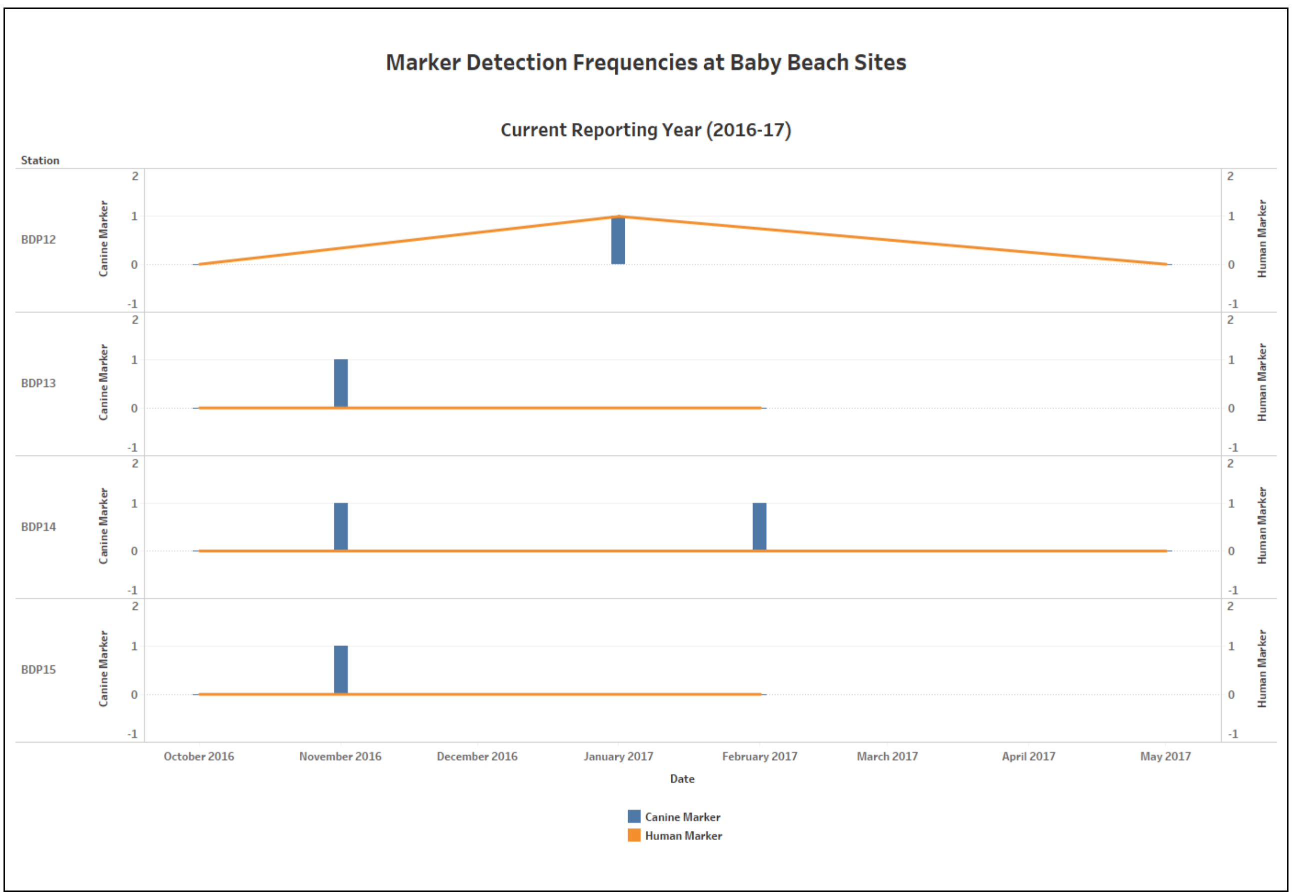
Figure 5.12: *Enterococcus* Single Sample Concentrations Exceedance Rate Comparing Baseline Period with Progress Years and Current Reporting Year



5.6 Baby Beach Microbial Source Identification Special Study

With the intent of identifying the source of the periodic bacteria exceedances at the Beach, additional testing continued during the 2016-17 reporting period as part of a microbial source identification special study. For this study, a subset of the Beach samples, which exceeded numeric targets, were tested for genetic markers indicating either human or canine bacterial sources. In 2016-17, only 1 out of the 20 samples was positive for human markers while 5 out of the 20 were positive for canine markers (**Figure 5.13**). Samples with genetic marker detections were all taken during wet weather. It should be noted that the County does not allow dogs on the Beach itself, but they are allowed in the Harbor in non-Beach areas. Since dry weather urban runoff is diverted, and all sewer repairs were completed in November 2015, these markers appear to be from sources other than the MS4 and sewer system, including, potentially, ones from the Harbor itself (ex. bather shedding or vessels). A review of marker detection frequencies from 2013 to 2017 showed that canine markers were predominantly detected, with twice the number of canine marker detections compared to human marker detections. Special study efforts will continue in 2017-18 as part of the TMDL work plan.

Figure 5.13: Marker Detection Frequencies at Baby Beach Sites for Current Reporting Year



6.0 2016-17 PROGRESS ON TMDL WORKPLAN

6.1 Introduction

The County and City have outlined a two-phased approach to address continued exceedances of FIB for the Beach. During the 2014-15 reporting year, the first phase included a full review of current BMP effectiveness, and review of data and infrastructure conditions. The second phase includes more intensive efforts to perform in-depth source investigations if it is determined during the initial assessment that remaining FIB exceedances are from natural or uncontrollable anthropogenic sources.

Descriptions of ongoing BMP implementation and source investigations are described in **Sections 6.2** and **6.3**. Future efforts associated with the two-phased approach are further described in **Section 6.4**.

6.2 Ongoing BMP Implementation

Table 6.1 provides a summary of the ongoing BMPs and a general schedule of implementation, the corresponding lead implementing agency, and notable achievements during the 2016-17 reporting period.

6.3 Current Ongoing Investigations

Southern California Coastal Water Research Project (SCCWRP) Source Identification Protocol Project (SIPP)

As a follow-up to the SCCWRP epidemiology study described in the BMP implementation timeline in **Attachment B** (see BMP #48), the State Water Resources Control Board's Clean Beach Task Force commissioned the *Source Identification Protocol Project* (SIPP) to develop protocols for tracking and identifying bacteria sources at beaches throughout California. The product of the multi-year study was *The California Microbial Source Identification Manual: A Tiered Approach to Identifying Fecal Pollution Sources to Beaches* (Manual) in December 2013.

The primary objective of the Manual is to provide a tiered approach for identifying sources of bacteria by implementing a hypothesis-driven, science-based methodology whilst utilizing progressive deployment of BMPs to conserve resources. The future efforts described in **Section 6.4** utilize the approach outlined in the Manual.

Baby Beach Microbial Source Identification Special Study

Culture based testing methods for fecal indicator bacteria do not identify the bacteria's source. Microbial source identification began in February 2012 to help pinpoint potential sources of periodic exceedances of FIB numeric targets. Data for 2016-17 show that human markers were found in 5% of the samples while canine markers were found in 25% of the samples. Source identification efforts will continue in the 2017-18 reporting period.

Phased Approach to Identifying and Prioritizing Investigations and BMPs

The following effort was completed during this reporting year:

- **Identification of Potential FIB Sources**

  Routine sanitary surveys continued in 2016-17 to help identify any potential point and non-point fecal contamination sources. Historically, surveys were done at site BDP14 (swim area) where people tend to recreate the most. In June 2017, it was changed to site BDP12 (west end) due to an increase in exceedances of *Enterococcus* REC-1 standards observed at the location in May 2017.

  Field observations taken during the routine survey showed a lot of plant debris/material at site BDP 12 (**Figure 6.1**). Elevated *Enterococcus* levels can occur in the absence of fecal contamination due to natural sources such as plants and growth in the environment (Ferguson and Guzman, 2017). If *Enterococcus* counts are elevated but Fecal Coliform levels are low (which is usually the case at the Beach), this suggests a natural source. Fecal waste from animals that consume plants must also be considered (Ferguson and Guzman, 2017).

  Routine sanitary survey results are presented in **Figure 6.2**. Analysis of BDP 12 site data showed a moderate positive relationship between Fecal Coliform and field pH and between Total Suspended Solids (TSS) and field pH. There was a moderate negative relationship between Fecal Coliform and field water temperature as well as TSS and field conductivity. Analysis of BDP14 site data showed a strong positive linear relationship between Total Coliform, Fecal Coliform and *Enterococcus* to field pH. Both Fecal Coliform and *Enterococcus* had a strong negative relationship with field conductivity. Fecal indicator bacteria counts and pH were generally higher at BDP 14 (from October to December 2016), while dissolved oxygen, conductivity and water temperature were generally higher at BDP 12 (from June to September 2017).

Figure 6.1: Plant debris at site BDP12

6.4 Future BMPs & Potential Projects

As part of the phased approach to identify and prioritize investigations and BMPs the following efforts are planned for the 2017-18 reporting year:

- **Identification of Potential FIB Sources**

  Planned efforts include:

  1. Continuation of the watershed sanitary surveys to identify any potential point and non-point fecal contamination sources.
  2. Continuation of microbial source tracking special study and exploration of other genetic markers like bird and wildlife.
  3. Coordinate with OC Parks/OC Dana Point Harbor staff to ensure that the final plans for the Dana Point Harbor revitalization project will address industry standard advancements to improve water quality and support efforts towards the reduction of FIB sources.

Table 6.1: Ongoing BMP Implementation, Schedule & Lead Agency

BMP	Schedule of Implementation*	Lead Implementing Agency	Notable Achievements for 2016-17
Ordinances	Ongoing enforcement	City of Dana Point, South Coast Water District (SCWD), County ofOrange	
Street sweeping	Once per week	City of Dana Point, County of Orange	
Outreach event: Ocean Awareness Day	Annually	City of Dana Point OC Dana Point Harbor	March 5, 2017 – Water quality trivia and "Bow, Wow, Vow" to promise to always scoop the poop; approx. 400 participants 

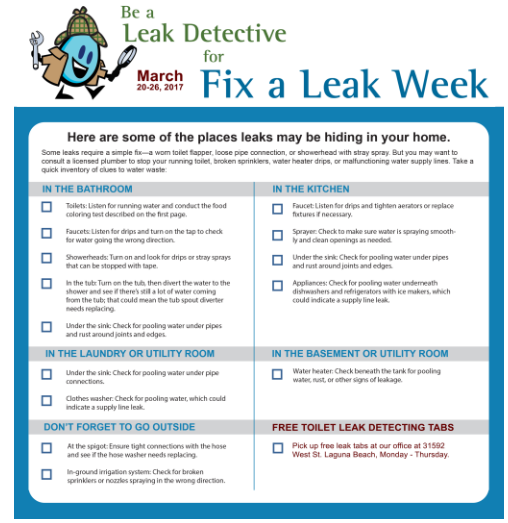
BMP	Schedule of Implementation*	Lead Implementing Agency	Notable Achievements for 2016-17
Inlet filters	Ongoing, clean 3-5 times/year	City of Dana Point – City Inlet Filters OC Dana Point Harbor – Harbor Inlet Filters	
Ocean Institute swale & trash separation unit	Ongoing maintenance, as needed	Ocean Institute	
Ocean Water Quality Subcommittee Meetings	Monthly	Host: City of Dana Point	Regularly attended by members of the public.
Pier bird screening	Regular inspections and repair/replacement as needed	County of Orange, OC Dana Point Harbor	
Baby Beach urban runoff diversion/media filter	Monthly reporting for urban run-off diversion. Minimum of annual inspection for media filters, clean and change media, as necessary.	City of Dana Point	As part of the BMP Improvement Plan, the City of Dana Point took over operation and maintenance of the Beach nuisance water diversion and media filters from Headlands Reserve, LLC in August 2016 to ensure consistency with City protocols. June 6, 2017- Agreement with SCWD to divert flows secured; July 7, 2017 - SOCWA permit secured; August 12, 2017 - Encroachment permit with County secured
Dana Point food facility roof top inspections	Annually	City of Dana Point	
Clean marina certification: • Dana Point Yacht Club (April 27, 2011) • Embarcadero Marina (Nov. 18, 2010) • Dana Point Marina (April 27, 2011) • Dana West Marina (April 27, 2011)	Formal inspection every 5 years, maintain certification	OC Dana Point Harbor Dana Point Yacht Club Embarcadero Marina Dana Point Marina Dana West Marina	

BMP	Schedule of Implementation*	Lead Implementing Agency	Notable Achievements for 2016-17
American Boat Builders & Repairers Association (ABBRA) Clean Maritime Certification: Dana Point Ship Yard	Verification inspection, meeting numerous environmental requirements, various high-compliance standards, implementation of best management practices	OC Dana Point Harbor Dana Point Ship Yard	
Maintenance of "Do Not Feed the Bird Signs"	Annual inspection and maintain as necessary	County of Orange	
Bird dropping beach sweeping	Daily	OC Dana Point Harbor	Bird dropping beach sweep program reinstituted on July 2017 after County department reorganization and staff changes.
Smoker's outposts	Bi-annual inspection. Repair/replace as needed	OC Dana Point Harbor	
Bird-proof trash can maintenance	Daily inspection and maintenance.	OC Dana Point Harbor	
Harboring the Good Life calendar tips	Once per year	City of Dana Point	
Harbor Flo-Guard inlet filters	Monthly inspections, maintenance/cleaning, as needed.	OC Dana Point Harbor	
Maintenance and refill of pet waste bags/dispensers	Weekly inspections; Refill pet waste bag dispensers as needed.	OC Dana Point Harbor	
Trash skimmers	Daily cleaning, replacement of bilge pads.	OC Dana Point Harbor	

BMP	Schedule of Implementation*	Lead Implementing Agency	Notable Achievements for 2016-17
Outreach Publications	Varies	City of Dana Point	Please don't "Poo-lute" ad in Dana Point Times, April 14, 2017. 
Outreach- Ocean Institute Kids Conference on Watersheds	Annual	Ocean Institute	Reaches 2000 5th grade children. City of Dana Point and County do speaker presentations.
Prohibition of dogs in water	Ongoing	OC Dana Point Harbor	

BMP	Schedule of Implementation*	Lead Implementing Agency	Notable Achievements for 2016-17
Coastal clean-up day	Annually	OC Parks OC Dana Point Harbor Ocean Institute Dana Point Yacht Club	Successful beach, harbor and water clean-up on September 17, 2016 with four partnering agencies providing a variety of options for volunteers: • Dana Point Harbor Cigarette Butt Roundup: 205 participants • Dana Point Harbor Underwater Cleanup: 172 Participants • Dana Point Marine Protected Area (behind the Ocean Institute): 47 Participants • Dana Point Yacht Club: 30 Participants
Facebook posts	Started 2016-17	City of Dana Point	Focused on prevention of overwatering, sprinkler runoff, water balloons use in water, importance of street sweeping and water quality, etc. 
Elimination of boat baths	Completed 2016-17	OC Parks OC Dana Point Harbor	

<table>
<tr><th>BMP</th><th>Schedule of Implementation*</th><th>Lead Implementing Agency</th><th>Notable Achievements for 2016-17</th></tr>
<tr><td>Outreach Publications – SCWD newsletter in water bill (also provided on City’s website)</td><td>Varies</td><td>City of Dana Point</td><td>

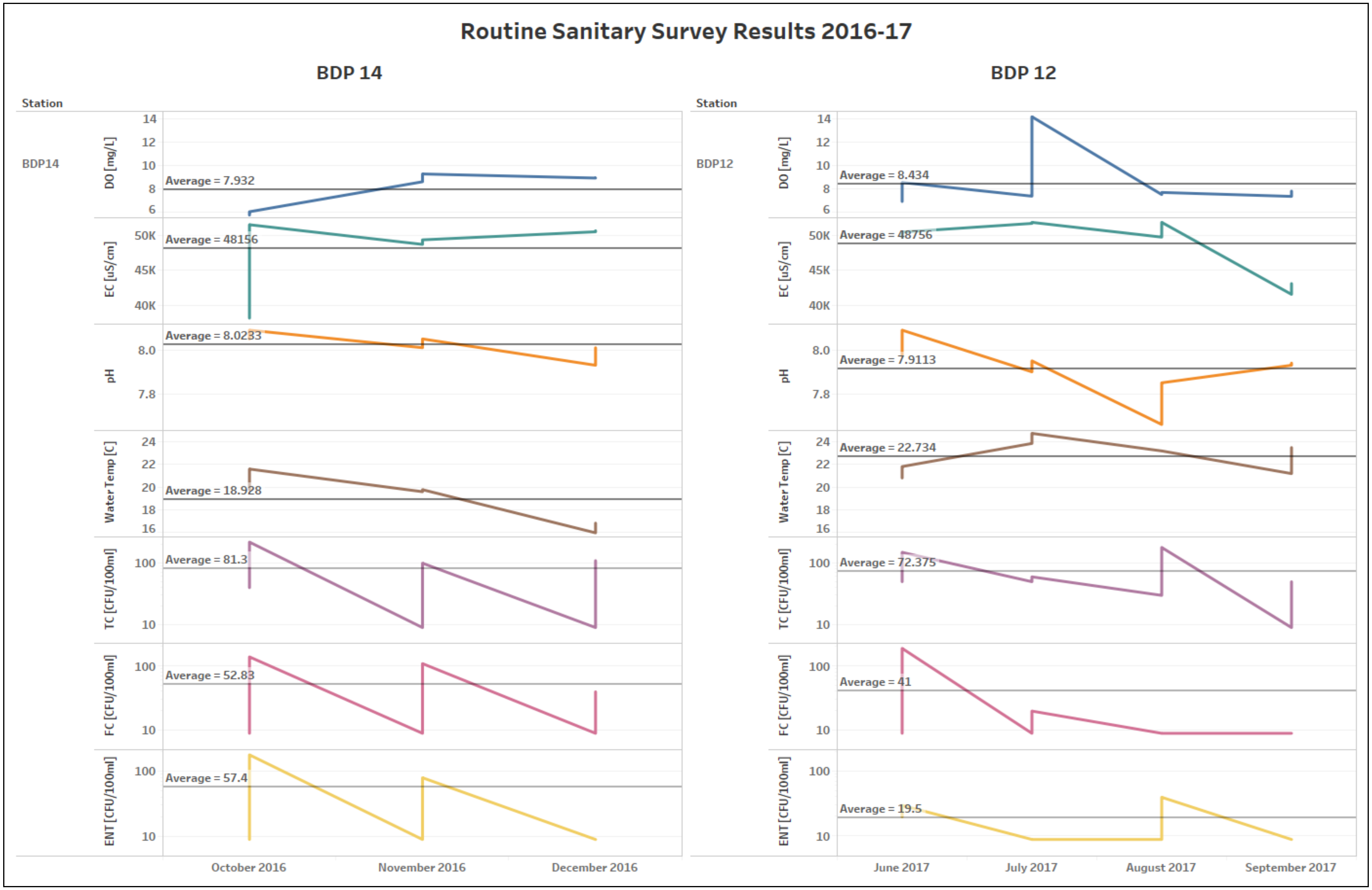


</td></tr>
<tr><td>Conversion to recycled water and various irrigation system upgrades.</td><td>Fall 2016</td><td>OC Dana Point Harbor</td><td>Dana Point Harbor was converted to a recycled water system for landscaping. The irrigation system was upgraded in many areas with water wise sprinkler heads, bubblers and such. The median at Harbor Drive and Casita’s Place also had water wise landscaping installed with associated irrigation upgrades. These improvements help to reduce/eliminate runoff due to irrigation, which is one of the High Priority Goals of the South Orange County Water Quality Improvement Plan (WQIP).</td></tr>
</table>

BMP	Schedule of Implementation*	Lead Implementing Agency	Notable Achievements for 2016-17
Maintenance & use of Self-reclaiming sidewalk cleaning machine	Use as needed. Maintenance as needed	OC Dana Point Harbor	 

*The schedule is provided to give a general sense of frequency and is subject to change based on effectiveness assessments, staffing, weather conditions, etc.

Figure 6.2: Routine Sanitary Survey Results for 2016-17



7.0 REFERENCES AND NOTED STUDIES (including Attachments)

Allen, Shannon M. and Scheidt, Vincent N. *Baby Beach Avian Use: Results of a Focused Bird Survey*. January 2005

Colford, John M. Jr., et al. *Using rapid indicators for Enterococcus to assess the risk of illness after exposure to urban runoff contaminated marine water*. January 2012. Available online at www.sciencedirect.com (for purchase)

California Regional Water Quality Control Board San Diego Region. *Technical Report for Total Maximum Daily Loads for Indicator Bacteria, Baby Beach in Dana Point Harbor and Shelter Island Shoreline Park in San Diego Bay*. June 2008.

County of Orange Health Care Agency. *2016 Annual Ocean, Harbor & Bay Water Quality Report.* June 2017.

County of Orange Public Facilities and Resources Department. *State of the Beach Report, Baby Beach Region, Dana Point Harbor, California*. Prepared with the assistance of Science Applications International Corporation. June 2003. www.ocwatersheds.com/Documents/sanjuan_bb_cbi_SOTB_rev4.pdf

County of Orange Public Facilities and Resources Department and Science Applications International Corporation. *Baby Beach Circulation Study Sampling and Analysis Plan (SAP)*. September 2002. www.ocwatersheds.com/Documents/sanjuan_bb_cbi_QAPP_overall.pdf

County of Orange Resources & Development Management Department Watershed and Coastal Resources Division. *Ocean Institute Stormwater BMP Performance Evaluation, Clean Beach Initiative Grant No. CBI-19.* March 28, 2006.

County of Orange Resources & Development Management Department Watershed and Coastal Resources Division. *Ocean Institute Stormwater BMP Performance Evaluation Monitoring and Quality Assurance Project Plan, January 14, 2003.* www.ocwatersheds.com/Documents/sanjuan_bb_cbi_Ocean_Institute_BMP_Monitoring_Plan.pdf

Ferguson, Donna and Joe Guzman. *Fecal Indicator Bacteria Methods: The Good, Bad and Ugly*. October 18, 2017. http://www.mywaterquality.ca.gov/monitoring_council/collaboration_network/docs/ferguson_guz man10201.pdf

Everest International Consultants, Inc. *Circulation Improvement Pilot Project At Baby Beach, Dana Point Final Report*. January 2006.

Gilbert, Richard O. *Statistical Methods for Environmental Pollution Monitoring*. New York, NY: Van Nostrand Reinhold. 1987.

Griffith, John F., et al. *The California Microbial Source Identification Manual: A Tiered Approach to Identifying Fecal Pollution Sources to Beaches*. SSCWRP Technical Report 804. December 2013.

Haugland, R.A., Varma, M., Sivaganesan M., Kelty, C., Peed, L., Shanks, O.C. 2010. Evaluation of genetic markers from the 16S rRNA gene V2 region for use in quantitative detection of selected Bacteroidales species and human fecal waste by qPCR. Systematic and Applied Microbiology 33: 348–357.

Hirsch, R. M., J. R. Slack, and R. A. Smith, Techniques of trend analysis for monthly water-quality data, Water Resources *Research,* 18, 107-121, 1982.

Kildare, B., Leutenegger, C.M., McSwain, B.S., Banbic, D.G., Rajal, V.B., Wuertz, S. 2007. 16S rRNA-based assays for quantitative detection of universal, human-, cow-, and dog-specific fecal Bacteroidales: A Bayesian approach. Water Research 41: 3701-3715.

Orange County Public Health Laboratory, Science Applications International Corporation, County of Orange Public Facilities & Resources Department (PFRD) Watershed and Coastal Resources Division. *Quality Assurance Project Plan (QAPP) Baby Beach Clean Beaches Initiative, Dana Point, California.* December 2002

Orange County Watershed and Coastal Resources Division & Development Management Department. *Final Report for Baby Beach in Dana Point Harbor, Orange County CBI Grant Nos.19 and 260, Agreement No. 01-226-550-2*. March 30, 2006

Science Applications International Corporation, Environmental Sciences Division. *Circulation Study Report Baby Beach Region, Dana Point Harbor, California.* March 2003.

Science Applications International Corporation, Environmental Sciences Division. *Data Mining Task for State of the Beach Report: Evaluation of Bacteriological Data and Associated Parameters for Baby Beach, Dana Point Harbor, CA.* January 2003. www.ocwatersheds.com/Documents/sanjuan_bb_cbi_Data_Mining_Final_Report.pdf

State Water Resources Control Board. *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List*. September 2004

US Army Engineer Research & Development Center and Noble Consultants. *Comprehensive Condition Survey and Storm Waves, Circulation, and Sedimentation Study, Dana Point Harbor, California Final Report*. July 2011

APPENDIX G
QUALITY ASSURANCE/QUALITY CONTROL

1 CORE PROGRAM

Monitoring and reporting is supported by a quality assurance/quality control (QA/QC) program developed and implemented by the Principal Permittee. 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 QA/QC program evaluates data for accuracy, precision, and contamination using certified reference materials (CRMs) and laboratory control standards for common analyses, duplicate field samples, and equipment/trip blanks, respectively. A Quality Assurance Project Plan (QAPP) was prepared for the South Orange County Water Quality Implementation Plan (WQIP). The QAPP will serve as a standardized outline of QA/QC procedures used in the monitoring and reporting program.

The proportion of QA/QC samples submitted this year was approximately 9% of the total NPDES and TMDL field samples submitted to the contracted laboratories for key analyses referenced in **Table 1.1**

A designated QA/QC officer oversees preparation and submittal of multiple types of QA/QC samples from the Principal Permittee's water quality laboratory at the County to evaluate the quality of data produced by the contracted laboratories and the Orange County Health Care Agency Water Quality Laboratory (for bacteria samples). In house synthetic samples are prepared using aliquots of prepared standard solutions in ultra-pure (Nanopure) water matrices for the assurance of the laboratory analytical accuracy. Certified reference materials (CRMs) are also used to evaluate the accuracy of the contracted laboratories along with the in house synthetic samples. Duplicates of the environmental samples are submitted to evaluate analytical precision of the submitted sample analyses. Equipment blanks and trip blank samples are prepared and tested to rule out errors or cross contamination in the method setup, equipment used, and / or sample handling procedures.

Along with the previously described QA/QC regime, the Dry Weather Reconnaissance Monitoring program staff routinely analyzed samples that have been prepared by the in house QA/QC officer in order to assess the quality of mobile laboratory field measurements. Additionally, contracted laboratories supplied QA/QC data relating to their respective internal quality control programs utilizing CRMs, spiked, and duplicate samples analyzed along with County environmental sample batches.

Figures and charts were created to present the performance of the laboratories regarding the quality of the sample analyses between October 2016 and October 2017. The annual QA/QC Summary (**Table 1.1**) describes the analysis type and percent breakdown of quality assurance samples submitted. Accuracy charts (**Figure 1.1**) show each analysis and the percent of samples that were within acceptable result boundaries for the constituent of concern. These boundaries have been obtained from the certified reference materials (CRM) documentation for each parameter and used in our accuracy analysis; if no boundary is provided with the CRM, a +/- 25% boundary is used. The precision charts (**Table 1.2**) show the median and mean of the percent differences of all samples within the respective analysis groups. These precision charts distinguish between statistics associated with all precision data and with the subset of samples that had results above reporting limits. The blanks charts (**Table 1.3**) highlight any spikes above reporting limits. **Figure 1.1, Table 1.1, Table 1.2,** and **Table 1.3** are available at the following link: https://ocgov.box.com/v/201617-TMAR-Datasets.

Routine evaluations of the QA/QC data collected are conducted to follow possible trends and concerns more closely. The Permittees have three internal dashboards that help track synthetic samples, duplicates, and blanks, respectively, as the data is reported by contracted laboratories. The dashboards are similar to the accuracy charts (**Figure 1.1**) used to present the data, and they include interactive filters for the different laboratories, analyses, parameters, water matrices, sample dates, and results to allow users to visualize trends and investigate results more easily and efficiently. As issues are identified, comparative QC studies and investigations are initiated to resolve potential errors or concerns. Analyses from the 2016-17 QA/QC program indicate the following results:

- The majority of nutrient accuracies were within boundaries. The precision of the nutrients analysis was generally acceptable with the median of percent differences at 1% difference and the mean at 6% difference.
- The six sample results for toxicity accuracy were within boundaries.
- The precision of the General Minerals, Hardness, and Triclopyr analyses were generally acceptable with low percent differences.
- The majority of pathogen indicator bacteria accuracies were within boundaries. Due to inconsistencies with indicator bacteria precision results, Permittees are conducting an evaluation of the sampling methods for the duplicates and investigating possible improvements that can be made.
- One synthetic sample was created for Methylene Blue Active Substances (MBAS). Three duplicate samples of MBAS were collected; both had a percent difference of 0% due to the results being below the reporting limit. The Permittees plan to increase the amount of synthetic and duplicate samples next year to draw better conclusions about contracted laboratory accuracy and precision with the MBAS analysis.
- The accuracy evaluation for the oil and grease analysis showed that the QC results are consistently below their boundaries. This is due to low recoveries in synthetic samples that are related to limitation in the EPA method for this analysis. All duplicate results had a percent difference of 0% in the precision analysis due to being less than the reporting limit (<5 mg/L).
- All three saltwater synthetic sample results for total organic carbon (TOC) were within boundaries. However, 3 out of 6 TOC freshwater synthetic sample results were out of boundaries. Because of this, comparative QC studies as well as QC investigations are being evaluated. The precision of TOC and dissolved organic carbon (DOC) were generally acceptable. TOC had a median of percent differences of 3% difference and a mean of 9% difference. There was an outlier that brought the mean up to 9% difference from 4% difference. DOC had a median of percent differences of 5% difference and a mean of 4% difference.
- Accuracy results for organophosphorus pesticides (OPP) analyses, also referred to as organophosphate pesticides, trended low throughout the year for some of the analytes. 8 out of 11 of the analytes had less than 50% of samples fall within boundaries. The analytes with the least number of samples within boundaries were Dimethoate, Diazinon, Disulfoton, Malathion, Phorate and Ronnel. Regarding the precision analyses for OPP analyses, almost all duplicate results had a percent difference of 0% because the results were less than the reporting limits. As a consequence of the accuracy and precision results, the Permittees consulted the producer of the Certified Reference Material for this analysis and ordered a synthetic solution to be sent to our contracted laboratory without the usual

dilutions conducted at the Principal Permittee's laboratory. Preliminary data show more accurate results, however some accuracy boundaries were below reporting limits. Additional studies are planned with elevated concentrations, and the Permittees will compare results from ampules used for the first time versus the ampules used for a consecutive time two weeks later. To evaluate the precision of the analysis, duplicates of these synthetics will be evaluated as well.

- Trace metal accuracy results were generally within boundaries. For seawater trace metal accuracies, all elements except for Silver (Ag), Arsenic (As), Mercury (Hg), and Selenium (Se) were within boundaries. Those four constituents were consistently out of boundaries in seawater samples, but they did not present the same problems in the freshwater trace metal accuracy analysis. Because of this, comparative QC studies as well as QC investigations are being evaluated. The precision of freshwater and seawater trace metal analyses have been generally acceptable. For freshwater, the median of percent differences was 2% difference and the mean was 8% difference. For seawater, the median of percent differences was 4% difference and the mean was 14% difference. There appeared to be outliers of some metal precisions tests in both freshwater and seawater matrices affecting the percent difference statistics.
- The precision for TSS had a median of percent differences at 11% difference and a mean at 25% difference. Because of this, comparative QC studies as well as QC investigations are being evaluated.
- Due to low duplicate sample counts, the Permittees plan to increase the amount of duplicate samples next year in order to draw better conclusions about contracted laboratory precision for the following analyses: Chloride and Sulfate (SO4).
- Many of the precision results had a percent difference of 0% due to results being below reporting limits. The Permittees plan to evaluate this issue further, including potentially obtaining CRM and evaluating duplicate synthetics (with accuracy boundaries above the reporting limit) for the following analyses: Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Glyphosate, Nonylphenol, Organophosphorous Pesticides (OPPs), Organochlorine Pesticides (OCPs), Pyrethroid Pesticides (PPs), and Polychlorinated Biphenyls (PCBs).
- Trip blanks and equipment blanks for Total Organic Carbon (TOC) had an increased number of samples that were above the reporting limits. Trip blanks and equipment blanks for nutrients and trace metals were generally below the reporting limits, with the majority of the trace metal spikes being Copper and Zinc blanks. In response to these results, a Quality Assurance Investigation has been implemented with the following activities:
    - The Nanopure source water for these blanks was assessed, and the CASCADA system was replaced with new ELGA systems. The new Nanopure system will be undergoing regular disinfection cycles, and contractor support is being regularly obtained to service and calibrate the system. A trace metals blanks analysis conducted with the new Nanopure system showed QA/QC results below the reporting limits. A nutrient and TOC blanks analysis is also being evaluated.
    - The equipment used for the Dry Weather Reconnaissance Monitoring program will be completely replaced with new acid-washed Nanopure containers, and, if need be, the tubing in pumps and automatic sampling devices will be assessed.