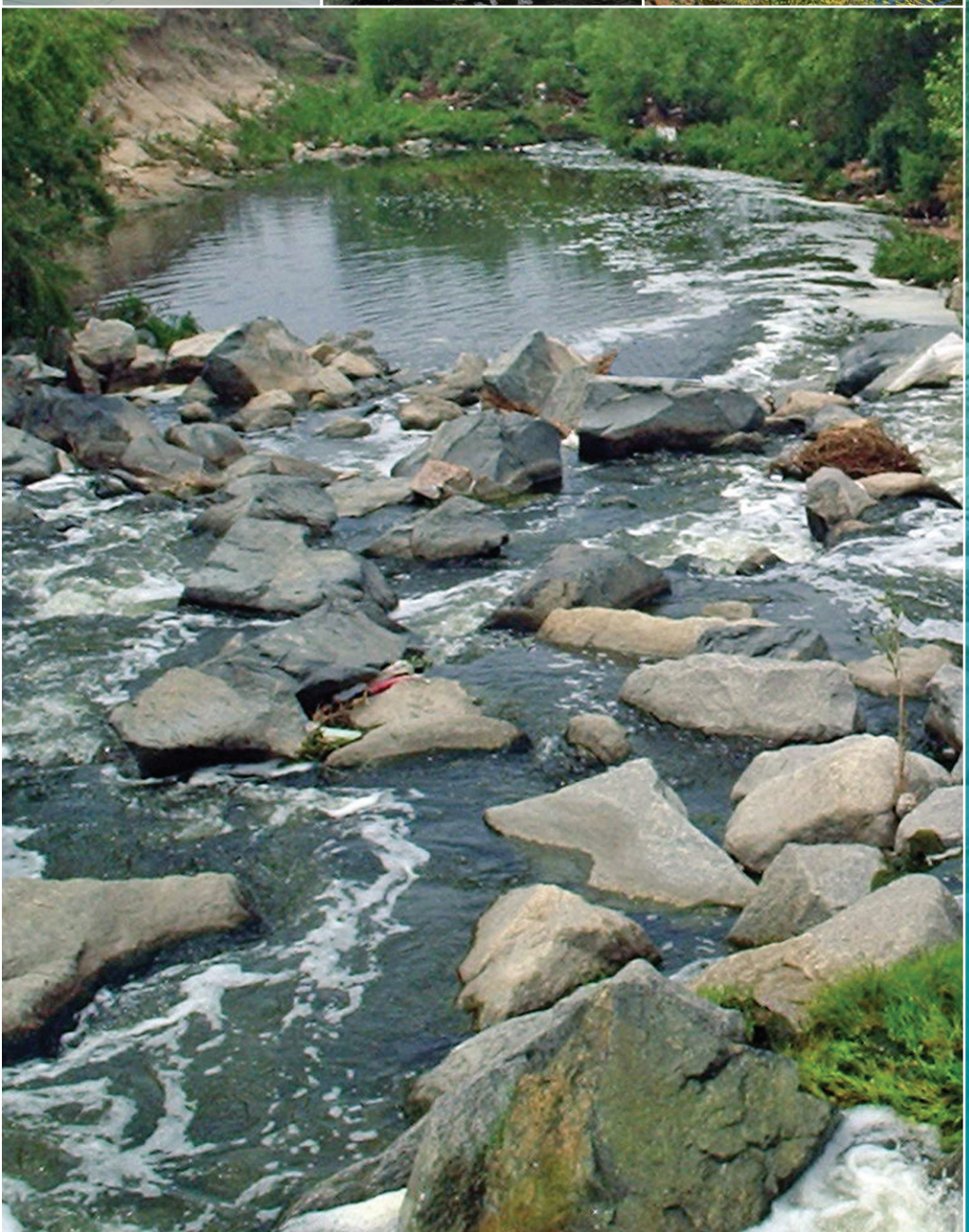
SANTA ANA WATERSHED PROJECT AUTHORITY



Santa Ana River Watershed Bacteria Monitoring Program Annual Report: 2017-2018 FINAL REPORT

June 2018

CDM Smith

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Acronyms and Abbreviations

AgSEP	Agricultural Source Evaluation Plan
Babcock	Babcock Laboratories
Basin Plan	Santa Ana Region Basin Plan
BPA	Basin Plan Amendment
CEDEN	California Environmental Data Exchange Network
cfs	Cubic Feet per Second
CFU	Colony Forming Units
COC	Chain of Custody
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
MPN	Most Probable Number
MSAR	Middle Santa Ana River
OCPHL	Orange County Public Health Laboratory
OCPW	Orange County Public Works
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance / Quality Control
RCFC&WCD	Riverside County Flood Control & Water Conservation District
RMP	Regional Monitoring Program
Santa Ana Water Board	Santa Ana Regional Water Quality Control Board
SAR	Santa Ana River
SAWDMS	Santa Ana Watershed Data Management System
SAWPA	Santa Ana Watershed Project Authority
SBCFCD	San Bernardino County Flood Control District
SOP	Standard Operating Procedures
SSV	Single Sample Value
State Water Board	State Water Resources Control Board
SWAMP	California's surface ambient monitoring program
SWQSTF	Stormwater Quality Standards Task Force
Task Force	MSAR TMDL / Regional Water Quality Task Force
TMDL	MSAR Bacteria Indicator Total Maximum Daily Limit
TSS	Total Suspended Solids
UAA	Use Attainability Analysis
USEP	Urban Source Evaluation Plan

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Section 1
Introduction

The Santa Ana River (SAR) Watershed Bacteria Monitoring Program or Regional Monitoring Program (RMP) was developed to achieve the following objectives regarding bacteria sampling:

- Provide the data needed to determine if water quality is safe when and where people are most likely to engage in water contact recreation.
- Facilitate the Total Maximum Daily Load (TMDL) implementation process and track progress toward attainment of applicable water quality standards, where water quality is impaired due to excessive bacterial indicator levels.
- Apply a risk-based implementation strategy to allocate public resources in a manner that is expected to produce the greatest public health benefit.

1.1 Regulatory Background

The SAR RMP supports the implementation of several regulatory-related activities associated with the protection of recreational uses in the Santa Ana River Watershed, including the Basin Plan Amendment (BPA) to *Revise Recreation Standards for Inland Freshwaters in the Santa Ana Region* and the Middle Santa Ana River (MSAR) Bacteria TMDL. Each of the activities addressed by the SAR RMP is described below.

1.1.1 Basin Plan Amendment

On June 15, 2012, the Santa Ana Regional Water Quality Control Board (Santa Ana Water Board) adopted the BPA to *Revise Recreation Standards for Inland Freshwaters in the Santa Ana Region.*[1] This BPA resulted in the following key modifications to the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) for the Santa Ana region:[2]

- Addition of "Primary Contact Recreation" as an alternative name for the REC1 (water contact recreation) beneficial use;
- Addition of narrative text clarifying the nature of REC1 activities and the bacteria objectives established to protect these activities;
- Differentiation of inland surface REC1 waters on the basis of frequency of use and other characteristics for the purposes of assigning applicable single sample maximum values;
- Revision of REC1/REC2 (non-contact water recreation) designations for specific inland surface waters based on the results of completed Use Attainability Analyses (UAA);

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[1] Santa Ana Water Board Resolution: R8-2012-0001, June 15, 2012

[2] Santa Ana Basin Plan Chapter 5, Page 5-92; http://www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/docs/2016/Chapter_5_February_2016.pdf

- Revised water quality objectives to protect the REC1 use of inland freshwaters; and
- Identification of criteria for temporary suspension of recreation use designations and objectives (high flow suspension).

Santa Ana Water Board staff developed this BPA in collaboration with the Stormwater Quality Standards Task Force (SWQSTF), comprised of representatives from various stakeholder interests, including the Santa Ana Watershed Project Authority (SAWPA); the counties of Orange, Riverside, and San Bernardino; Orange County Coastkeeper; Inland Empire Waterkeeper; and the Environmental Protection Agency (EPA) Region 9. The BPA was approved by the State Water Resources Control Board (State Water Board) on January 21, 2014[3] and the California Office of Administrative Law on July 2, 2014.[4] However, the EPA did not approve all provisions of the BPA, which required revisions in the form of letters. The EPA issued its comment letter on April 8, 2015, and provided a letter of clarification on August 3, 2015.[5]

The BPA required the establishment of a comprehensive monitoring program to support implementation of the changes to the Basin Plan.[6] The SAR RMP fulfills this requirement.

1.1.2 MSAR Bacteria TMDL

There is currently one bacteria TMDL adopted for freshwaters in the Santa Ana River Watershed, the MSAR Bacteria TMDL, which became effective on May 16, 2007. Due to exceedances of the fecal coliform objective established to protect REC1 use during the 1990s, the Santa Ana Water Board added the following waterbodies in the MSAR watershed to the state 303(d) list of impaired waters.

- Santa Ana River, Reach 3 – Prado Dam to Mission Boulevard
- Chino Creek, Reach 1 – Santa Ana River confluence to beginning of hard lined channel south of Los Serranos Road
- Chino Creek, Reach 2 – Beginning of hard lined channel south of Los Serranos Road to confluence with San Antonio Creek
- Mill Creek (Prado Area) – Natural stream from Cucamonga Creek Reach 1 to Prado Basin
- Cucamonga Creek, Reach 1 – Confluence with Mill Creek to 23rd Street in City of Upland
- Prado Park Lake

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[3] State Water Board Resolution: 2014-0005, January 21, 2014

[4] Office of Administrative Law: #2014-0520-02 S; July 2, 2014

[5] http://www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/recreational_standards.shtml

[6] Santa Ana Basin Plan Chapter 5, Page 5-114; http://www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/docs/2016/Chapter_5_February_2016.pdf

The Santa Ana Water Board adopted the MSAR Bacteria TMDL in 2005[7] and it was subsequently approved by the EPA on May 16, 2007. The TMDL established compliance targets for both fecal coliform and *E. coli*:

- Fecal coliform: 5-sample/30-day logarithmic mean less than 180 organisms/100 mL and not more than 10 percent of the samples exceed 360 organisms/100 mL for any 30-day period.
- *E. coli*: 5-sample/30-day logarithmic mean less than 113 organisms/100 mL and not more than 10 percent of the samples exceed 212 organisms/100 mL for any 30-day period.

Per the TMDL, the above compliance targets for fecal coliform are no longer effective as a result of EPA approval of the BPA.[8]

To focus MSAR Bacteria TMDL implementation activities, stakeholders established the MSAR Watershed TMDL Task Force (MSAR TMDL Task Force) to coordinate TMDL implementation activities designed to manage or eliminate sources of bacterial indicators to waterbodies listed as impaired. The MSAR TMDL Task Force includes representation by key watershed stakeholders, including urban stormwater dischargers, agricultural operators, and the Santa Ana Water Board.

The MSAR Bacteria TMDL required urban and agricultural dischargers to implement a watershed-wide bacterial indicator compliance monitoring program by November 2007.[9] Stakeholders worked collaboratively through the MSAR TMDL Task Force to develop this program and prepared the MSAR Water Quality Monitoring Plan and associated Quality Assurance Project Plan (QAPP) for submittal to the Santa Ana Water Board. The MSAR TMDL Task Force implemented the TMDL monitoring program in July 2007; the Santa Ana Water Board formally approved the monitoring program documents in April 2008.[10] This TMDL monitoring program has been incorporated into the SAR RMP.

The MSAR Bacteria TMDL also required the development and implementation of source evaluation plans by urban and agricultural dischargers within six months of the TMDL effective date. These urban and agricultural source evaluations plans (USEP and AgSEP, respectively) were approved by the Santa Ana Water Board in 2008. These programs were incorporated into the SAR Watershed Bacteria Monitoring Program Monitoring Plan and QAPP.[11]

1.1.3 Antidegradation Targets

The BPA established site-specific antidegradation targets for waterbodies with only a REC2 designation. For each of these waterbodies, the REC1 beneficial use was de-designated through an approved UAA. The antidegradation targets serve as triggers for additional monitoring or efforts to prevent degradation of water quality in REC2 waterbodies. The targets were developed using a statistical method that fits historical dry weather data to a lognormal distribution. The 75th

[7] Santa Ana Water Board Resolution: R8-2005-0001, August 26, 2005

[8] Page 3 of 15 of Attachment A to Santa Ana Water Board Resolution R8-2005-0001

[9] Page 6 of 15, Table 5-9y of Attachment A to Santa Ana Water Board Resolution R8-2005-0001

[10] Santa Ana Water Board Resolution: R8-2008-0044; April 18, 2008

[11] SAR Monitoring Plan and QAPP Version 1.0 February 2016: http://www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/recreational_standards.shtml

percentile of the fitted lognormal distribution was selected as the antidegradation target when relying on a single sample result. The geomean targets are selected from at least five samples within 30 days. These targets provide the Santa Ana Water Board with the ability to assess the status and trend of bacterial indicator water quality as part of the Triennial Review process. Table 1-1 summarizes the antidegradation targets for the REC2 waterbodies included in the SAR RMP.

Table 1-1 *E. coli* Antidegradation Targets for Waterbodies with only a REC2 Designation in the SAR RMP

Waterbody	Geomean Target	75th Percentile Target
Temescal Creek Reach 1a/1b	353 MPN/100 mL	725 MPN/100 mL
Santa Ana Delhi Channel Reach 1/2	399 MPN/100 mL	1,067 MPN/100 mL
Santa Ana Delhi Channel in Tidal Prism[1]	240 MPN/100 mL	464 MPN/100 mL
Greenville-Banning Channel in Tidal Prism[1]	24 MPN/100 mL	64 MPN/100 mL
Cucamonga Creek Reach 1	509 MPN/100 mL	1,385 MPN/100 mL

[1] Targets are for *Enterococcus* instead of *E. coli* due to location in tidal prism

1.2 Monitoring Strategy

One of the principal goals for updating recreational water quality standards in the Santa Ana region was to encourage the most cost-effective allocation of finite public resources. As such, all efforts undertaken to assure compliance with these revised standards should concentrate on projects and programs that are likely to produce the greatest public health benefit.

When the Basin Plan was amended in 2012, the Santa Ana Water Board identified several high priority waterbodies where significant recreational use frequently occurred. They also assigned most of the remaining lakes and streams to "Tiers" based on the expected level of recreational use.[12] These tiered classifications were intended to help local authorities prioritize their implementation efforts by providing some indication of the potential risk exposure for each waterbody.

This risk-based approach, which is designed to guide all aspects of protecting water contact recreation, provides the foundation for this RMP. Just as it is prudent to prioritize mitigation projects in a manner that assures the greatest public health benefit, it is wise to organize related water quality monitoring efforts along the same lines. The RMP is structured to direct water quality monitoring resources to the highest priority waterbodies.

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[12] The BPA (Santa Ana Water Board Resolution R8-2012-0001), which is incorporated into Chapter 5 of the Basin Plan (page 5-92), establishes four tiers of waterbodies: (a) Tier A REC1 Waters: includes freshwater lakes and streams that are or may be heavily used by the public for primary contact recreational activities, relative to other freshwater bodies in the Santa Ana Region; (b) Tier B REC1 Waters: includes freshwater lakes and streams that are or may be moderately-used by the public for primary contact recreational activities. Moderate use occurs where the number of people accessing the waterbody is approximately half that which generally occurs in Tier A waters; (c) Tier C REC1 Waters: includes freshwater lakes and streams that are or may be lightly-used by the public for primary contact recreational activities. Light use occurs where the number of people accessing the waterbody is less than half that which generally occurs in Tier A waters; and (d) Tier D REC1 Waters: includes freshwater lakes and streams that are infrequently used by the public for primary contact recreational activities. Infrequent use occurs where people only access the waterbody rarely or occasionally. For any waterbody regardless of Tier, an "N" designation means "Natural Conditions" and per the BPA, "includes freshwater lakes and streams located in largely undeveloped areas where ambient water quality is expected to be better than necessary to protect primary contact recreational activities regardless of whether such activities actually occur in these waterbodies." http://www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/docs/2016/Chapter_5_February_2016.pdf

1.2.1 Priority Designation

Basin Plan requirements for a RMP and the risk-based approach described above were used as a basis for the development of a monitoring approach that designates varying levels of monitoring priority. General principles include:

- The most rigorous monitoring should occur in REC1 Tier A waterbodies during dry weather conditions. These are the waterbodies and the conditions where the expectation for water contact recreation is the highest. Data collection must occur at a sufficient frequency to demonstrate that these waters are safe for recreation.
- Where a waterbody has an adopted TMDL for bacterial indicators, consider existing monitoring requirements that have already been established to evaluate progress towards achieving attainment with water quality objectives.
- For waterbodies listed as impaired, but no TMDL has been adopted, monitoring should occur periodically to provide additional data regarding the impairment status of these waterbodies.
- Ensure sufficient sample collection from REC2 only waters to assess compliance with antidegradation targets established per the BPA.

These general principles provide the foundation for the development of the SAR RMP which prioritizes waterbodies as follows:

- *Priority 1*: The first priority is to establish a monitoring program that can determine whether bacteria levels are "safe" at those locations where and when people are most likely to engage in water contact recreation. These waters are all Tier A waters per the 2012 BPA (Note: A Priority 1 water may also include impaired waterbodies that are designated Tier A REC1 Waters).
- *Priority 2:* The second priority is to focus monitoring resources on those waterbodies that have been identified as "impaired" due to excessive bacterial indicator concentrations and a TMDL has already been adopted (Note: A Priority 2 water may also be Priority 1 because it is also a Tier A REC1 Water). Monitoring efforts in these waters focus on evaluating progress toward attainment with the water quality standard in these impaired waters.
- *Priority 3:* The third priority is 303(d)-listed or impaired waterbodies where a TMDL has not yet been developed. For these Priority 3 sites the RMP includes periodic 5-weeks of sample collection on an annual basis. Data from Priority 3 sites will be used to evaluate compliance with the Santa Ana region *E. coli* water quality objective.
- *Priority 4*: The fourth priority is to collect the bacteria indicator data needed to implement the antidegradation targets that have been established for waterbodies designated as REC2 only. Data from Priority 4 sites will be used to evaluate compliance with the site-specific antidegradation targets (see Table 1-1).

1.2.2 Monitoring Plan and Quality Assurance Project Plan

To support the watershed-wide SAR RMP, the MSAR TMDL Task Force was expanded to include SAR watershed stakeholders and formed the MSAR TMDL / Regional Water Quality Monitoring Task Force (Task Force). The Task Force stakeholders worked collaboratively to prepare the SAR RMP Monitoring Plan and QAPP[13] to support this monitoring program. The monitoring program documents were submitted on February 8, 2016, and were formally approved by the Santa Ana Water Board on March 11, 2016.[14]

1.2.3 Annual Report

This Annual Report summarizes the results of the 2017-2018 monitoring efforts. Previous seasonal water quality reports prepared only for the sites subject to the MSAR Bacteria TMDL (2007 – 2015) are available from SAWPA.[15]

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[13] SAR RMP Monitoring Plan and QAPP, Version 1.0, February 2016: http://www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/recreational_standards.shtml

[14] Resolution No. R8-2016-0022 http://www.waterboards.ca.gov/santaana/board_decisions/adopted_orders/resolutions/R8-2016-0022_Resolution_Santa_Ana_River_Watershed_Bacterial_Monitoring_Program.pdf

[15] http://www.sawpa.org/task-forces/middle-santa-ana-river-watershed-tmdl-taskforce/

Section 2

Santa Ana River Study Area

This section describes the study area and identifies the monitoring locations sampled during the 2017-2018 monitoring year. The Monitoring Plan and QAPP provide a more detailed characterization of the watershed.

2.1 Physical Characteristics

The Santa Ana River watershed encompasses approximately 2,840 square miles of Orange, Riverside, San Bernardino, and a small portion of Los Angeles Counties (Figure 2-1). The mainstem Santa Ana River is the primary waterbody in the watershed. It flows in a generally southwest direction nearly 100 miles from its headwaters to the Pacific Ocean.

2.1.1 Major Geographic Subareas

The Santa Ana River watershed can be divided into three major geographic subareas:

- San Jacinto River and Temescal Creek Region – This area covers much of the south central and southeastern portions of the watershed and is located mostly within Riverside County. The San Jacinto River drains an area of approximately 780 square miles to Canyon Lake and Lake Elsinore. Often flows from the upper San Jacinto River watershed are captured by Mystic Lake, which is a natural sump or hydrologic barrier to flows moving further downstream to Canyon Lake or Lake Elsinore. Downstream of Lake Elsinore, Temescal Creek carries surface flow, when it occurs, from below Lake Elsinore to where it drains into the Prado Basin Management Zone.

- Santa Ana River above Prado Dam and Chino Basin Region – This area includes much of the north central and northeastern portions of the watershed and is located mostly within San Bernardino County. This region drains to the Prado Basin Management Zone where Prado Dam captures all surface flows from this region and the Temescal Creek watershed.

  The Santa Ana River headwaters are located in the San Bernardino Mountains in the northeastern part of the watershed. Major tributaries to the Santa Ana River in this region include Warm Creek, Lytle Creek, and San Timoteo Creek.

  In the north central portion, several major Santa Ana River tributaries arise in the San Gabriel Mountains and drain generally south into the Chino Basin before their confluence with the Santa Ana River, including Day Creek, Cucamonga Creek and San Antonio Creek. Many of these drainages carry little to no flow during dry conditions because of the presence of extensive recharge basins in this region.

  The Prado Basin Management Zone above Prado Dam is a flood control basin that captures all flows from the upper part of the Santa Ana River Watershed. For the most part the basin is an undisturbed, dense riparian wetland.

- Santa Ana River below Prado Dam and Coastal Plains Region – This area covers the western portion of the Santa Ana River watershed and includes coastal waterbodies that are not part of the Santa Ana River drainage area. This area is located within Orange County. Below Prado Dam the Santa Ana River flows through the Santa Ana Mountains before crossing the coastal plain and emptying into the Pacific Ocean near Huntington Beach. Groundwater recharge areas near the City of Anaheim capture water in the Santa Ana River and the Santa Ana River is often dry below this area. Other watersheds on the Coastal Plain include Newport Bay, Anaheim Bay-Huntington Harbour and Coyote Creek.

2.1.2 Middle Santa Ana River Watershed

The MSAR watershed covers approximately 488 square miles and lies largely in the southwestern corner of San Bernardino County and the northwestern corner of Riverside County. A small part of Los Angeles County (Pomona/Claremont area) is also included. Per the TMDL, the MSAR watershed includes three sub–watersheds (Figure 2-2):

- Chino Basin (San Bernardino County, Los Angeles County, and Riverside Counties) – Surface drainage in this area, which is directed to Chino Creek and Mill-Cucamonga Creek, flows generally southward, from the San Gabriel Mountains, and west or southwestward, from the San Bernardino Mountains, toward the Santa Ana River and the Prado Management Zone.

- Riverside Watershed (Riverside County) – Surface drainage in this area is generally westward or southeastward from the City of Riverside and the community of Rubidoux to Reach 3 of the Santa Ana River.

- Temescal Canyon Watershed (Riverside County) – Surface drainage in this area is generally northwest to Temescal Creek (however, note that Temescal Creek is not included as an impaired waterbody in the MSAR Bacteria TMDL).

Land uses in the MSAR watershed include urban, agriculture, and open space. Although originally developed as an agricultural area, the watershed continues to rapidly urbanize. Incorporated cities in the MSAR watershed include Chino, Chino Hills, Claremont, Corona, Eastvale, Fontana, Jurupa Valley, Montclair, Norco, Ontario, Pomona, Rancho Cucamonga, Rialto, Riverside, and Upland. In addition, there are several pockets of urbanized unincorporated areas. Open space areas include National Forest lands and State Park lands.

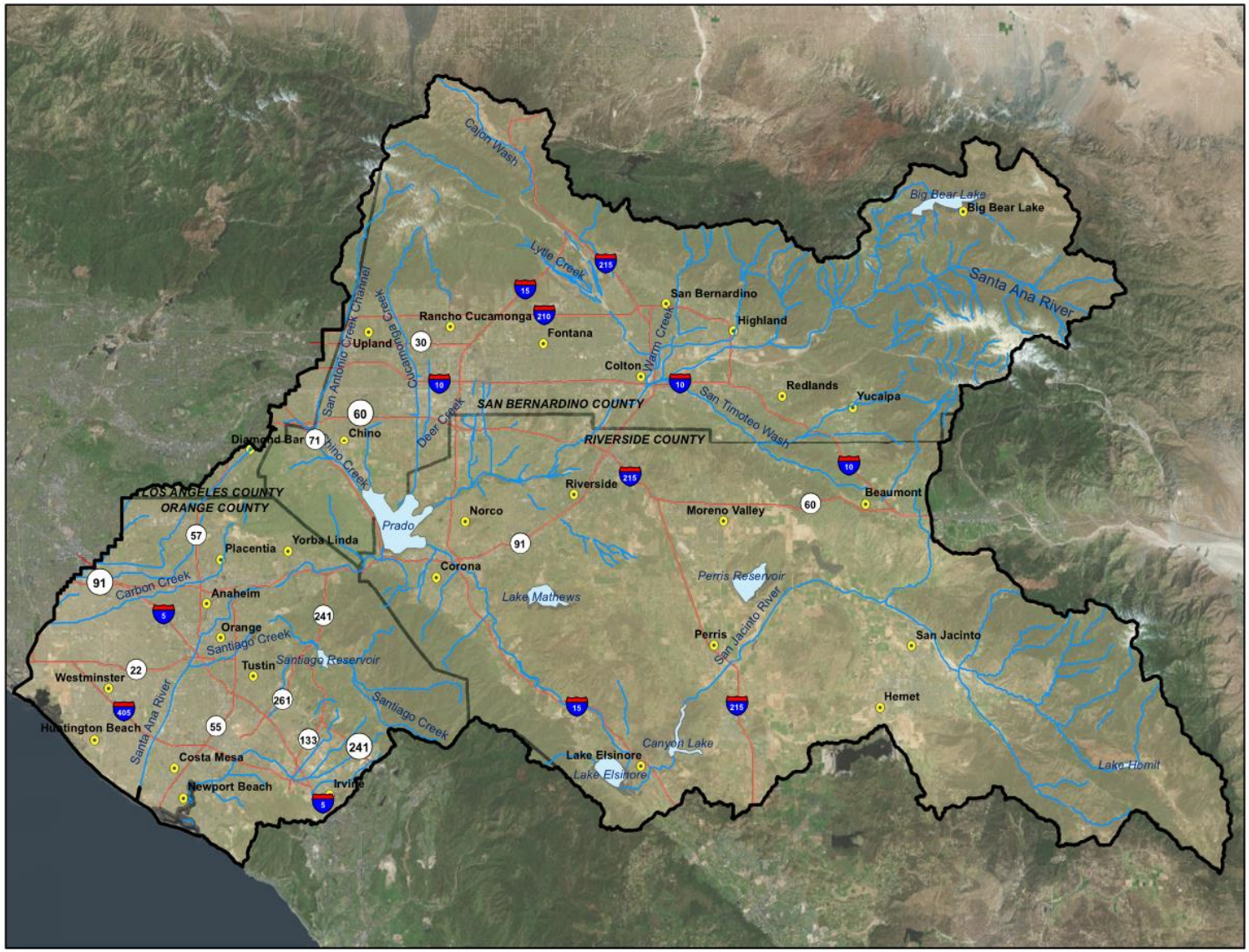

Figure 2-1
Santa Ana River Watershed and Location of Orange, Riverside and San Bernardino Counties (Source: SAWPA)

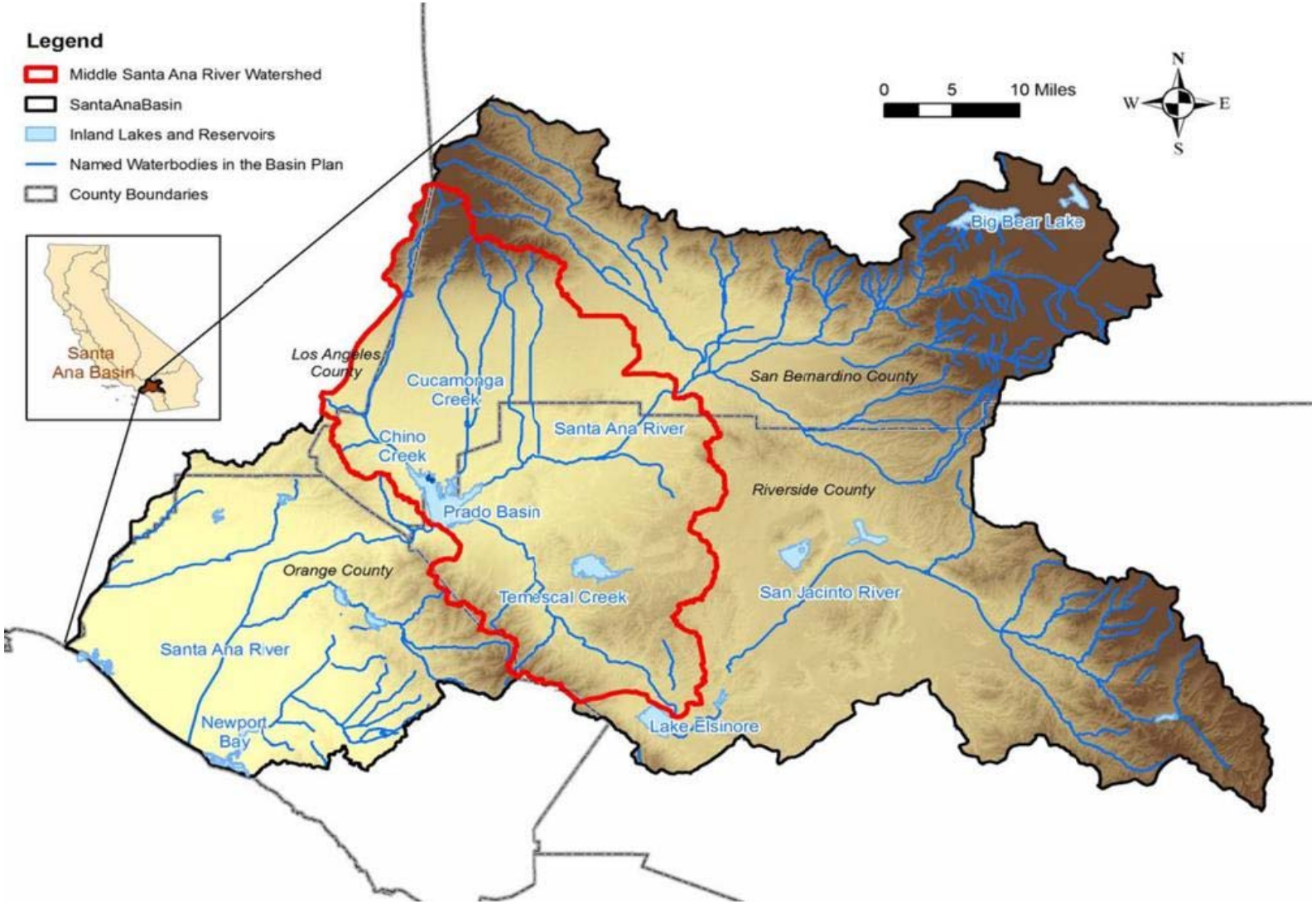

Figure 2-2
Middle Santa Ana River Watershed

2.1.3 Rainfall

Rainfall varies considerably across the watershed with highest average rainfall occurring in the upper mountain areas of the watershed (San Gabriel, San Bernardino, and San Jacinto mountains) (Figure 2-3). Historical average annual rainfall in the northern and eastern areas can be more than 35 inches but is much lower in the lowland regions and central parts of the watershed. In these areas that include Chino and Prado Basin, average annual rainfall ranges from approximately 11 to 19 inches.

Key rainfall gages in the SAR watershed were identified and considered representative of the variability across the watershed (Figure 2-4). Table 2-1 provides the locations of key rainfall gages in the watershed[16] and Table 2-2 summarizes the total monthly rainfall data from each location for the 2017 calendar year.

Table 2-1 Location of Key Rainfall Gages in the SAR Watershed

Station No.	Station Name	Source	Latitude	Longitude
178	Riverside North	RCFC&WCD	34.0028	-117.3778
179	Riverside South	RCFC&WCD	33.9511	-117.3875
35	Corona	RCFC&WCD	33.8450	-117.5744
131	Norco	RCFC&WCD	33.9215	-117.5724
067	Elsinore	RCFC&WCD	33.6686	-117.3306
90	Idyllwild	RCFC&WCD	33.7472	-116.7144
9022	Fawnskin	SBCFCD	34.2726	-116.9718
2965	Lytle Creek Canyon	SBCFCD	34.2164	-117.4553
2808	Highland Plunge Creek	SBCFCD	34.1120	-117.1278
61	Tustin-Irvine Ranch	OCPW	33.7200	-117.7231
169	Corona del Mar	OCPW	33.6093	-117.8583
219	Costa Mesa Water District	OCPW	33.6453	-117.9336
163	Yorba Reservoir	OCPW	33.8719	-117.8112
5	Buena Park	OCPW	33.8571	-117.9923

[16] Data provided by Orange County Public Works (OCPW), Riverside County Flood Control & Water Conservation District (RCFC&WCD), and San Bernardino County Flood Control District (SBCFCD)

Table 2-2 Monthly Rainfall Totals (inches) During 2017 at Key Rainfall Gages

Rainfall Gage	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Riverside North	6.4	2.2	0.2	0.06	0.04	0	0	0.18	0.6	0	0	0
Riverside South	5.5	2.2	0.26	0.07	0.09	0	0.01	0.07	0.57	0	0.05	0
Corona	8.2	2.9	0.25	0.17	0.14	0	0.02	0.03	0.13	0	0.03	0
Norco	6.5	2.3	0.2	0.1	0.21	0	0.04	0.04	0.31	0	0.04	0
Elsinore	6.7	3.0	0.03	0.02	0.27	0	0.04	0.08	0.22	0.01	0.02	0.01
Idyllwild	12.9	8.2	0	0	0	0	0.02	0.13	0.74	0.06	0.16	0
Fawnskin	3.4	2.6	1.0	0.04	0.19	0	0	1.1	0	0	0	0
Lytle Creek Canyon	12.0	3.5	0	0	0.27	0	0	0.51	0.04	0	0.43	0
Highland Plunge Creek	6.4	3.0	0.24	0	0.39	0	0.2	7.3	2.9	0.12	0.04	0
Tustin-Irvine Ranch	5.2	3.4	0.1	0.03	0.27	0.04	0	0.02	0	0	0.19	0
Corona del Mar	5.5	3.3	0.09	0.05	0.3	0.01	0	0.01	0.07	0.02	0.09	0.12
Costa Mesa Water District	5.7	4.3	0.03	0.06	0.03	0.01	0	0	0	0.03	0.48	0.02
Yorba Reservoir	9.6	3.2	0.16	0.04	0.5	0.05	0	0.01	0.28	0	0.1	0
Buena Park	7.2	3.0	0.27	0.08	0.75	0.01	0	0	0.12	0	0.05	0.01

Rainfall varies throughout the watershed with heavier precipitation recorded in the upper watershed and during winter months. Smaller storms occurred during the summer months, however, all dry weather monitoring adhered to the dry weather condition established in the Monitoring Plan, which states that dry weather samples will be collected only if there is no measurable rainfall in the preceding 72-hour period.

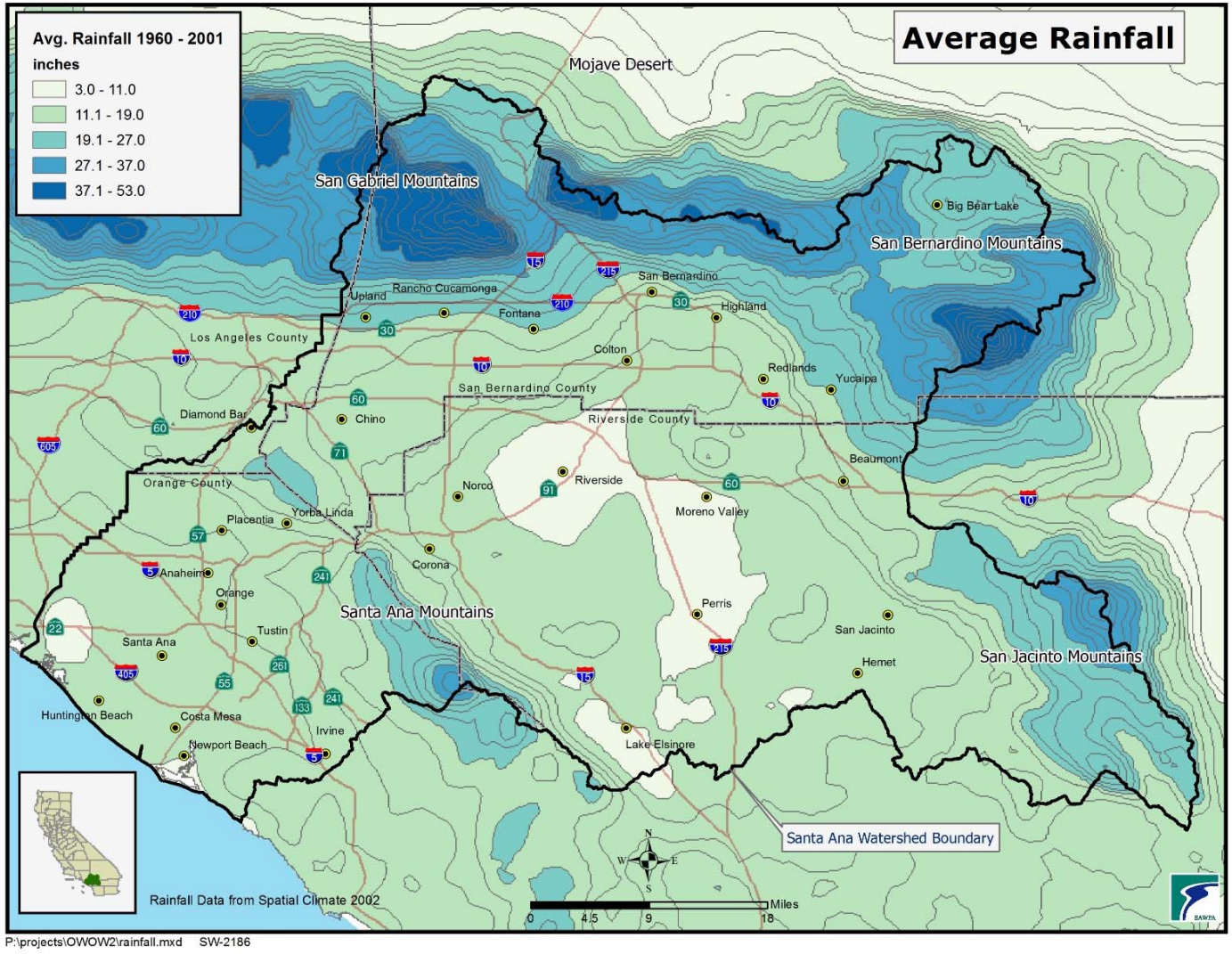

Figure 2-3
Historical Average Annual Rainfall in the Santa Ana River Watershed (Source: OWOW 2.0 Report SAWPA)

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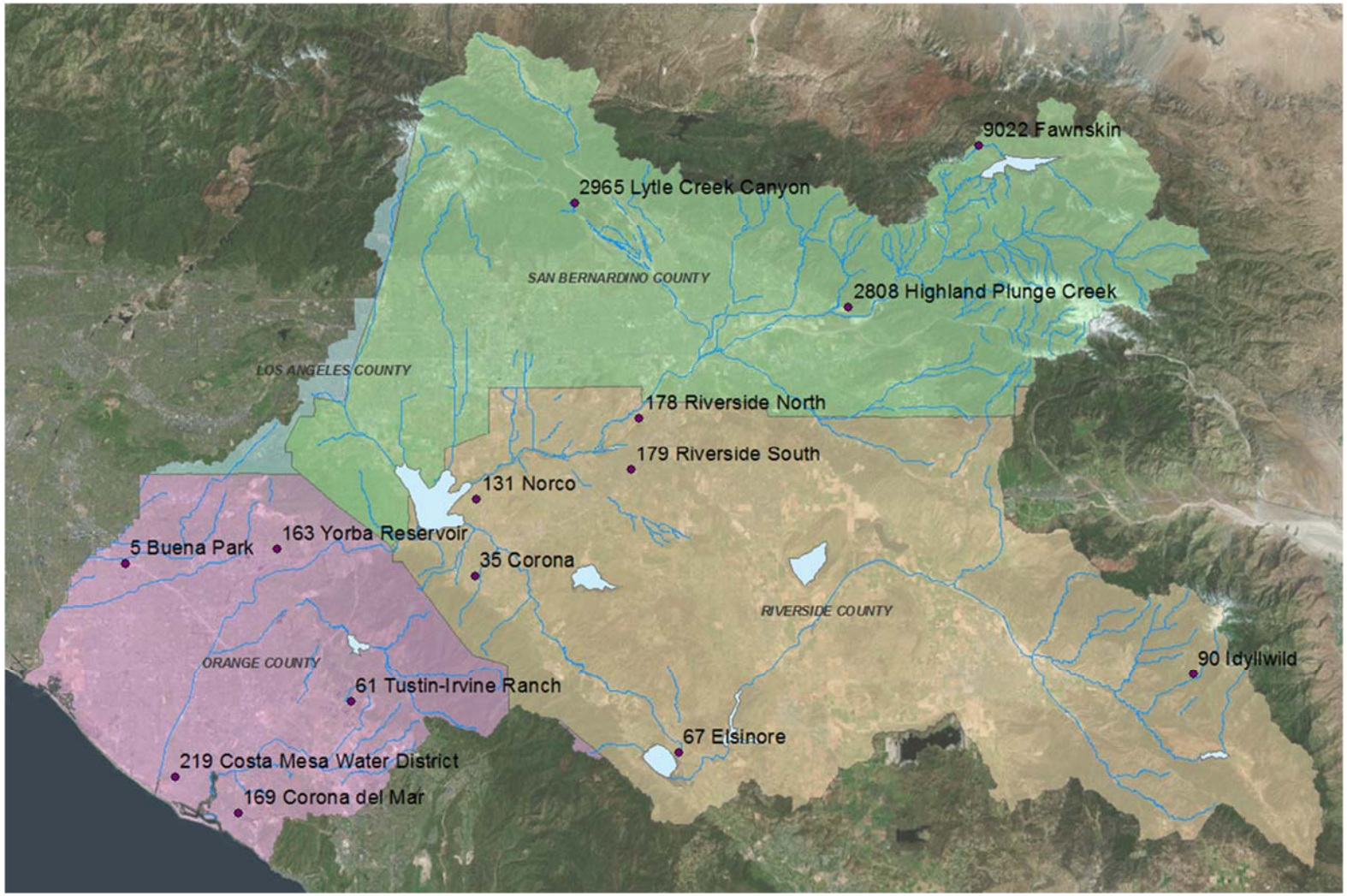

Figure 2-4
Key Rainfall Gages

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2.2 Monitoring Locations

The following sections describe the monitoring sites based on priority designations described in Section 1.2.1. Based on the previous year's Task force input, the Mill-Cucamonga Creek monitoring site was moved from Chino-Corona Road (WW-M5) to downstream of the Mill Creek wetlands (WW-M6), Priority 1 Lytle Creek was relocated from North Fork to Middle Fork, and Priority 4 Temescal Creek (P4-RC1) at Main Street was relocated to Lincoln Avenue (P4-RC2).

2.2.1 Priority 1

Eight monitoring sites, identified as REC1 Tier A waters, are included for Priority 1 monitoring. This includes four lakes: Big Bear Lake, Lake Perris, Canyon Lake, and Lake Elsinore; and four flowing water sites: SAR Reach 3 (two sites), Lytle Creek, and Mill Creek Reach 2. Five sites are located in Riverside County and two sites are located in San Bernardino County (Table 2-3, Figure 2-5).

The two Priority 1 Santa Ana River sites (MWD Crossing and Pedley Avenue) are also MSAR Bacteria TMDL compliance sites (Table 2-4). Data collected from these Priority 1 sites will also be used for evaluating compliance with the MSAR Bacteria TMDL.

Table 2-3 Priority 1 REC 1 Tier A Monitoring Sites

Site ID	Site Description	County	Latitude	Longitude
P1-1	Canyon Lake at Holiday Harbor	Riverside	33.6808	-117.2724
P1-2	Lake Elsinore	Riverside	33.6753	-117.3674
P1-3	Lake Perris	Riverside	33.8614	-117.1908
P1-4	Big Bear Lake at Swim Beach	San Bernardino	34.2482	-116.9034
P1-5	Mill Creek Reach 2	San Bernardino	34.0891	-116.9247
P1-6	Lytle Creek (Middle Fork)	San Bernardino	34.2480	-117.5110
WW-S1	Santa Ana River Reach 3 at MWD Crossing	Riverside	33.9681	-117.4479
WW-S4	Santa Ana River Reach 3 at Pedley Avenue	Riverside	33.9552	-117.5327

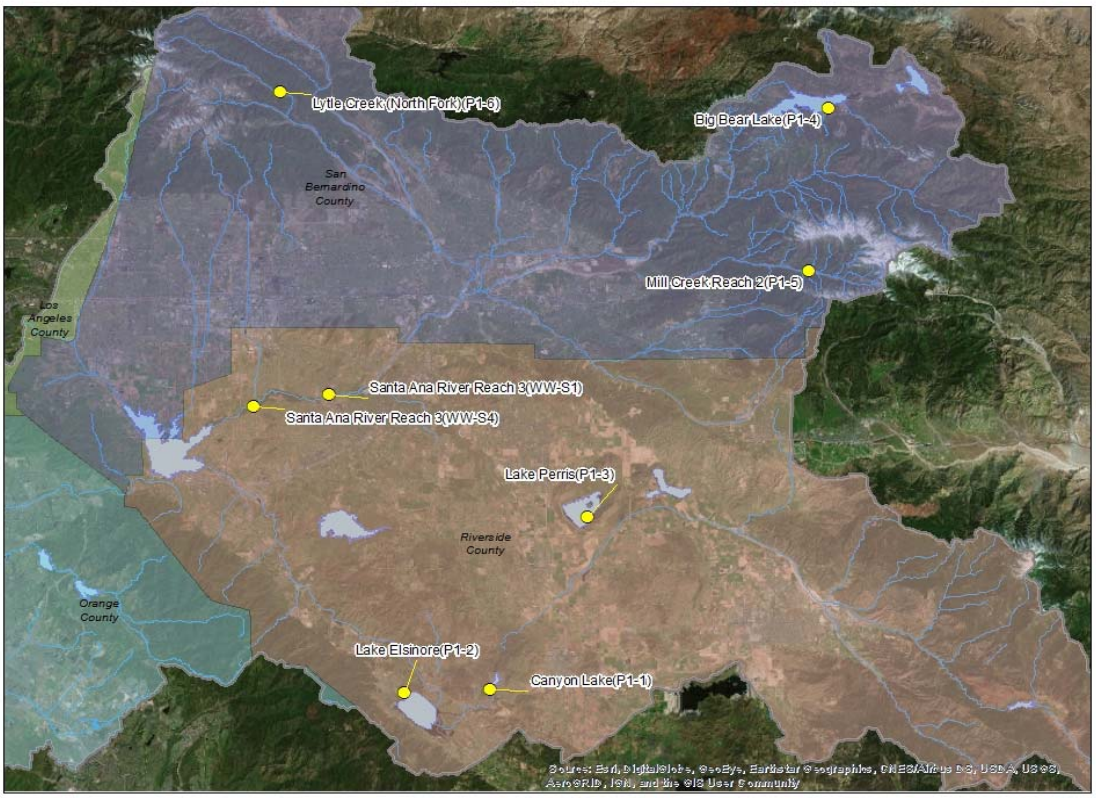

Figure 2-5
Priority 1 Monitoring Sites

2.2.2 Priority 2

Priority 2 monitoring sites are primarily the same monitoring sites previously established for evaluating compliance with the numeric targets in the MSAR Bacteria TMDL: two Santa Ana River Reach 3 sites (at MWD Crossing and at Pedley Avenue), and one site each on Mill-Cucamonga Creek, Chino Creek, and Prado Park Lake[17] (Table 2-4; Figure 2-6). As discussed in Section 2.2.1, the two Santa Ana River sites are also Priority 1 waters, i.e., as Tier A waters, they are locations where the risk of exposure to pathogens during recreational activities is highest. Figures 2-5 and 2-6 indicate the dual designation for these sites.

Table 2-4 Priority 2 Monitoring Sites

Site ID	Site Description	County	Latitude	Longitude
WW-M6	Mil-Cucamonga Creek below Wetlands	San Bernardino	33.9268	-117.6250
WW-C7	Chino Creek at Central Avenue	San Bernardino	33.9737	-117.6889
WW-C3	Prado Park Lake	San Bernardino	33.9400	-117.6473
WW-S1	Santa Ana River Reach 3 at MWD Crossing	Riverside	33.9681	-117.4479
WW-S4	Santa Ana River Reach 3 at Pedley Avenue	Riverside	33.9552	-117.5327

[17] See Section 4.1.1 in the Monitoring Plan for the original basis for the selection of these monitoring sites.

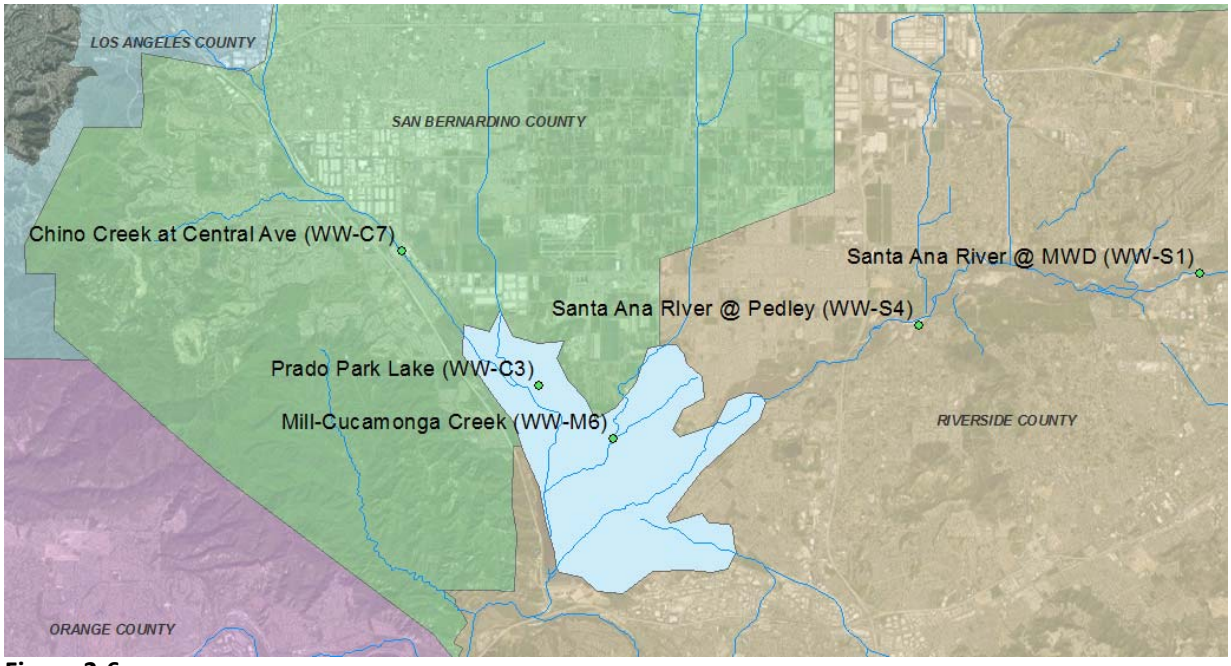

Figure 2-6
Priority 2 Monitoring Sites

2.2.3 Priority 3

In the Santa Ana River watershed, twenty-one waterbodies are currently on the 303(d) List as impaired for Indicator Bacteria, but no TMDL has been adopted. Eight waterbodies were not included in the RMP for reasons described in the Monitoring Plan Section 3.3.3.2. Of the thirteen waterbodies that are monitored in the RMP, ten are located in Orange County, two in Riverside County, and one in San Bernardino County (Figure 2-7). Table 2-5 provides the location of each Priority 3 monitoring site. Previous water quality data and the basis for listing these monitoring sites are described in the Monitoring Plan.

Table 2-5 Priority 3 Monitoring Sites

Site ID	Site Description	County	Latitude	Longitude
P3-OC1	Bolsa Chica Channel upstream of Westminster Blvd/Bolsa Chica Rd	Orange	33.7596	-118.0430
P3-OC2	Borrego Creek upstream of Barranca Parkway	Orange	33.6546	-117.7321
P3-OC3	Buck Gully Creek Little Corona Beach at Poppy Avenue/Ocean Blvd	Orange	33.5900	-117.8684
P3-OC5	Los Trancos Creek at Crystal Cove State Park	Orange	33.5760	-117.8406
P3-OC6	Morning Canyon Creek at Morning Canyon Beach	Orange	33.5876	-117.8658
P3-OC7	Peters Canyon Wash downstream of Barranca Parkway	Orange	33.6908	-117.82404
P3-OC8	San Diego Creek downstream of Campus Drive (Reach 1)	Orange	33.6553	-117.8454
P3-OC9	San Diego Creek at Harvard Avenue (Reach 1)	Orange	33.6880	-117.8187

Site ID	Site Description	County	Latitude	Longitude
P3-0C10	Santa Ana River Reach 2 downstream of Imperial Highway	Orange	33.8574	-117.7916
P3-OC11	Serrano Creek upstream of Barranca/Alton Parkway	Orange	33.6483	-117.7248
P3-RC1	Goldenstar Creek at Ridge Canyon Drive	Riverside	33.8964	-117.3586
P3-RC2	Lake Fulmor at the Lakeside Boardwalk	Riverside	33.8052	-116.7798
P3-SBC1	Santa Ana River Reach 4 above S. Riverside Avenue Bridge	San Bernardino	34.0248	-117.3628

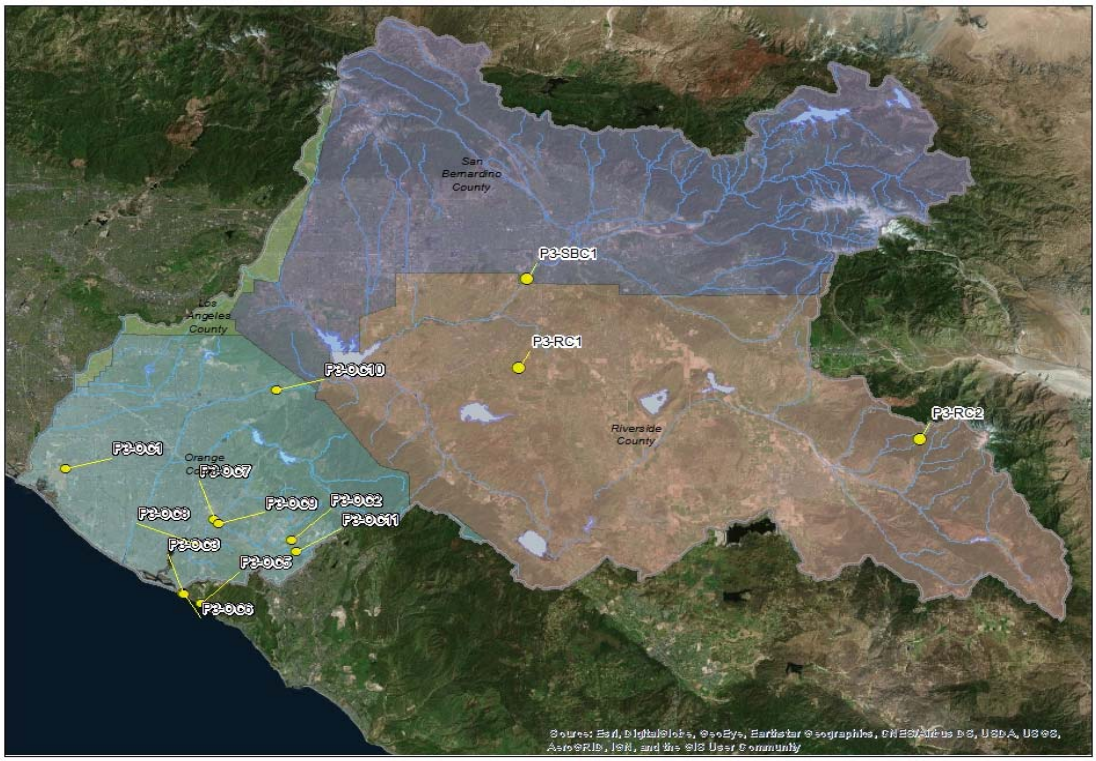

Figure 2-7
Priority 3 Monitoring Sites

2.2.4 Priority 4

Four waterbodies designated REC2 only as a result of approved UAAs were monitored as Priority 4 sites. San Bernardino County and Riverside County each have one Priority 4 waterbody. Two Priority 4 waterbodies are located in Orange County with one waterbody having two sites. These sites are summarized in Table 2-6 and Figure 2-8 and described as follows:

- *Santa Ana Delhi Channel* – The Santa Ana Delhi Channel has two reaches (Reaches 1 and 2) that are REC2 only. Two monitoring sites have been selected for the Santa Ana Delhi Channel to provide sample results from freshwater and tidal prism areas: (a) Upstream of Irvine Avenue (P4-OC1); and (b) within the tidal prism at the Bicycle Bridge (P4-OC2).

- *Greenville-Banning Channel Tidal Prism Segment*– The 1.2-mile segment extending upstream of the confluence between Santa Ana River and Greenville-Banning Channel is designated REC2 only. The monitoring site is located at an access ramp approximately 60 meters downstream of the trash boom below the rubber diversion dam.
- *Temescal Creek* – The monitoring site is located on the concrete section of Temescal Channel just upstream of the Lincoln Avenue Bridge.
- *Cucamonga Creek Reach 1* – Cucamonga Creek Reach 1 extends from the confluence with Mill Creek in the Prado area to near 23rd Street in the City of Upland. The monitoring site for Cucamonga Creek Reach 1 is at Hellman Road.

Table 2-6 Priority 4 Monitoring Sites

Site ID	Site Description	County	Latitude	Longitude
P4-RC2	Temescal Creek at Lincoln Avenue	Riverside	33.8941	-117.5772
P4-OC1	Santa Ana Delhi Channel Upstream of Irvine Avenue	Orange	33.6602	-117.8810
P4-OC2	Santa Ana Delhi Channel in Tidal Prism	Orange	33.6529	-117.8837
P4-OC3	Greenville-Banning Channel in Tidal Prism	Orange	33.6594	-117.9479
P4-SBC1	Cucamonga Creek at Hellman Avenue	San Bernardino	33.9493	-117.6104

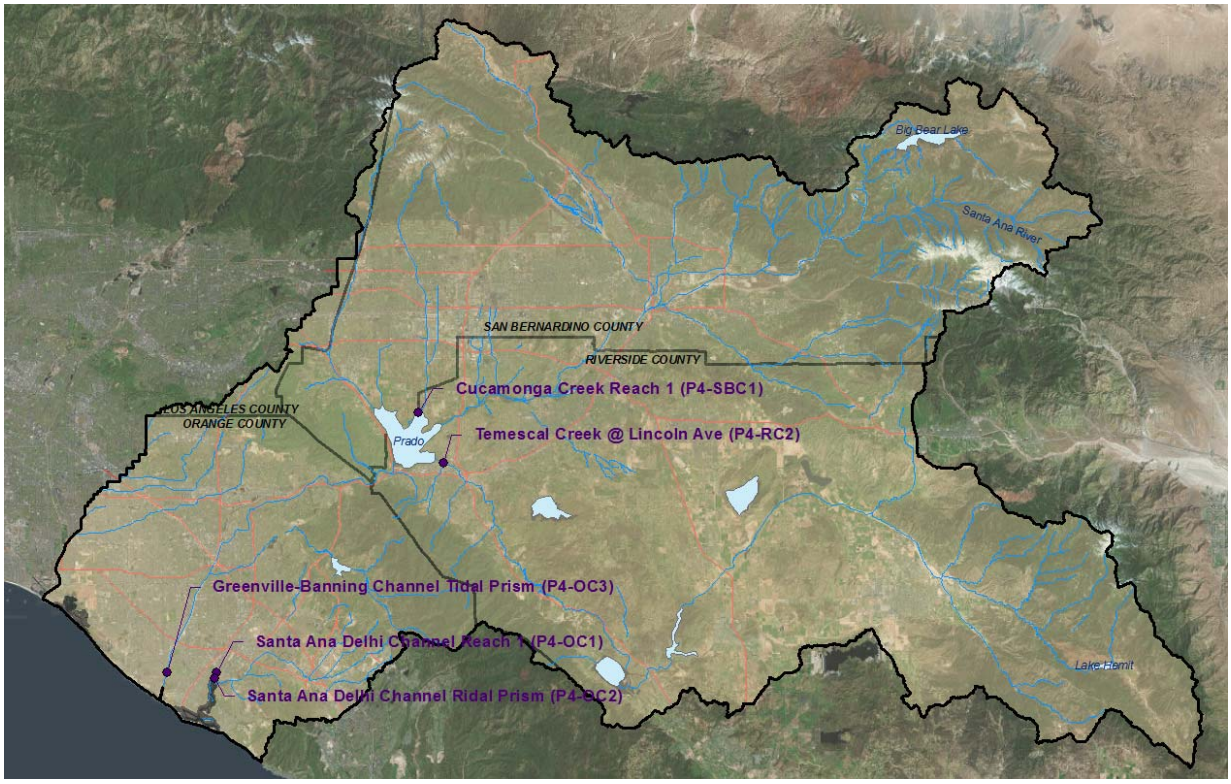

Figure 2-8
Priority 4 Monitoring Sites (top: Riverside County and San Bernardino County; bottom: Orange County)

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Section 3
Methods

The RMP Monitoring Plan and QAPP provide detailed information regarding the collection and analysis of field measurements and water quality samples. The following sections provide a summary of these methods.

3.1 Sample Frequency

3.1.1 Dry Weather

Dry weather sample collection occurs during both warm, dry (April 1 – October 31) and cool, wet (November 1 – March 31) season periods. Sample collection dates for each year of the monitoring program are established in Section 3.3 of the Monitoring Plan and are summarized in this section. Dry weather, warm season monitoring was conducted at most sites over a 20-week period from May 7, 2017 through September 17, 2017. Dry weather, cool season monitoring occurred over a five-week period from October 29, 2017, through November 26, 2017. Dry weather conditions are defined as no measurable rainfall within a 72-hour period prior to sampling.

During dry weather monitoring, the frequency of sample collection for each priority level varies as follows:

- Priority 1 and Priority 2 sites were monitored weekly for twenty consecutive weeks during the warm, dry season and for five consecutive weeks during the cool, wet season.
- Priority 3 sites were monitored weekly for five consecutive weeks during the warm, dry or cool, wet seasons. The fourteen Priority 3 sites were separated into five groups to maximize efficiency during sample collection periods.
- Priority 4 sites were sampled once per year between June 21 and September 21. Site P4-SBC1 (Cucamonga Creek at Hellman Avenue) exceeded the antidegradation target of 1,385 MPN/100 mL, and follow up samples were taken until three consecutive samples did not exceed the antidegradation target, as specified by the monitoring plan.

3.1.2 Wet Weather

Per the MSAR Bacteria TMDL, wet weather monitoring is conducted for one storm event per wet season. For each storm event, samples are collected from Priority 2 sites on the day of the storm event as well as 48, 72, and 96 hours after the onset of the storm. During the 2017-2018 wet season, samples were collected from the February 27, 2018, storm event with samples collected on February 27, 2018, and March 1, 2, and 3, 2018.

3.1.3 Summary of Sample Collection Effort

In general, the monitoring program was successful in meeting the requirements with the exception of some events where site conditions could not accommodate sampling. Dry weather samples are typically collected during consecutive weeks. Due to recorded rainfall in the

watershed during the dry season (week of August 27, 2017), the sampling schedule was modified to ensure samples were collected only under dry conditions. This modification required sampling twice in one week (week of September 3, 2017), but the total number of planned samples from each site (5) was still collected within a 5-week sampling period to support appropriate calculation of a geometric mean. Table 3-1 summarizes the results of the sampling effort.

Table 3-1 Summary of Water Quality Sample Collection Activity

Priority	Planned/Collected	Dry Weather	Wet Weather
Priority 1	Planned	200	0
	Collected	200	0
Priority 2	Planned	125	20
	Collected	107 [A]	20
Priority 3	Planned	65	0
	Collected	60 [B]	0
Priority 4	Planned	5	0
	Collected	10 [C]	0

[A] Prado Park Lake (WW-C3) was drained for repairs for a portion of the dry weather monitoring season. As there was no water flowing from the monitoring site, samples were not collected for the first 18 weeks.
[B] Five samples were not collected from Borrego Creek (P3-OC2) as conditions were dry during each monitoring event.
[C] Additional samples were collected from Cucamonga Creek following an exceedance of the antidegradation target in the initial sample (see discussion in Section 4.4.3).

3.2 Sample Analysis

Monitoring at each site included recording field measurements and collection of water quality samples. OCPW staff monitored all sites located in Orange County under their jurisdiction, while CDM Smith and CWE, on behalf of the MSAR TMDL / Regional WQ Monitoring Task Force, monitored all sites located in Riverside County and San Bernardino County. Two sites located in Orange County that were not the responsibility of OCPW, Los Trancos Creek and Morning Canyon Creek, were monitored by Santa Ana Water Board staff. The following water quality data were gathered from each site:

- Field measurements: temperature, pH, dissolved oxygen (DO), conductivity, turbidity, and flow
- Laboratory analysis: total suspended solids (TSS), bacteria (*E. coli* or *Enterococcus)*
  - *E. coli* is quantified at all but two sites in this Regional Monitoring Program.
  - *Enterococcus* is quantified at two Orange County sites, Santa Ana Delhi Channel in Tidal Prism (P4-OC2) and Greenville-Banning Channel in Tidal Prism (P4-OC3) due to presence of marine water.

3.3 Sample Handling

Sample collection and laboratory delivery followed approved chain-of-custody (COC) procedures, holding time requirements, and required storage procedures for each water quality sample as described in the Monitoring Plan and QAPP. Samples collected from Riverside County and San Bernardino County were analyzed for *E. coli* and TSS concentrations by Babcock Laboratories (Babcock). Samples collected from Orange County by OCPW were analyzed by the Orange County Health Care Agency Water Quality Laboratory (OCPHL) for *E. coli* and by Weck Laboratories for TSS. Samples collected from Los Trancos Creek and Morning Canyon Creek were collected by Santa Ana Water Board staff and analyzed for both *E. coli* and TSS by the American Environmental Testing Laboratory, Inc. Appendix C includes a brief summary of quality assurance/quality control (QA/QC) activities conducted during the period covered by this report, including field blanks and field duplicates

3.4 Data Handling

CDM Smith and SAWPA maintain a file of all laboratory and field data records (e.g., data sheets, chain-of-custody forms) as required by the QAPP. CDM Smith's field contractor, CWE, OCPW and the Santa Ana Water Board provided CDM Smith all field measurements and laboratory results, laboratory reports, field forms, photos, and COCs. CDM Smith compiled the field measurements and laboratory analysis results into a project database that is compatible with guidelines and formats established by the California Surface Water Ambient Monitoring Program for the California Environmental Data Exchange Network (CEDEN). CDM Smith conducts a QA/QC review of the data for completion and compatibility with the databases. After the QA/QC review, CDM Smith submits the data annually to CEDEN and to SAWPA.

3.5 Data Analysis

Data analysis relied primarily on the use of descriptive and correlation statistics. For any statistical analyses, the bacterial indicator data were assumed to be log-normally distributed as was observed in previous studies.[18] Accordingly, prior to conducting statistical analyses, the bacterial indicator data were log transformed.

[18] Middle Santa Ana River Bacterial Indicator TMDL Data Analysis Report, prepared by CDM Smith on behalf of the Task Force. March 19, 2009. http://www.sawpa.org/wp-content/uploads/2015/02/FinalDataAnalysisReport_033109.pdf

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Section 4
Results

This section summarizes the results of data analyses applied to the 2017 to 2018 dataset, which includes the 2017 dry season and the 2017-2018 wet season. Where appropriate to provide context, data results are compared to water quality results previously reported for the same locations. Appendix A (Tables A-1 through A-34) summarizes the water quality results observed at each site throughout the sample period covered by this report.

E. coli concentrations observed at each site will be summarized and compliance will be assessed using water quality standards or antidegradation targets established by the Basin Plan and numeric targets established by the MSAR Bacteria TMDL. Data analysis relied primarily on the use of descriptive and correlation statistics.

4.1 Priority 1

4.1.1 Water Quality Observations

Water quality parameters measured in the field during the warm, dry and cool, wet seasons at Priority 1 sites (Table 4-1) are summarized in Figures 4-1 through 4-7. Key observations are summarized as follows:

- Figure 4-1 shows that pH at the Santa Ana River sites were generally within the allowable pH range of 6.5 to 8.5, established by the EPA water quality standards. At the two SAR sites and the Lytle Creek sites, 12 percent of samples exceeded the upper limit of allowable pH values. However, 48 percent of Mill Creek samples exceeded the upper allowable pH limit. In lake sites, pH observations are slightly higher than other sites, with 46 to 96 percent of observations at each lake site greater than 8.5

- Figure 4-2 shows results by station demonstrating that water temperature has a direct relationship with cooler ambient air temperatures (median less than 20 degrees Celsius) at higher elevations and higher ambient air temperatures (median greater than 23 degrees Celsius) in lower elevations. Likewise, water temperature responds directly to the seasonal ambient temperatures of the wet and dry seasons.

- Figure 4-3 shows that the majority of DO levels observed range from 6 to 10 mg/L. Minimum DO levels for waterbodies with the WARM and COLD habitat beneficial use designations are 5 mg/L and 6 mg/L, respectively.[19] These standards were always met by all Priority 1 sites except Canyon Lake (P1-1) and Lake Elsinore (P1-2). Both Canyon Lake and Lake Elsinore have the WARM habitat beneficial use designation with 8 and 12 percent of samples at Canyon Lake and Lake Elsinore, respectively, below the WARM DO threshold. More rigorous measurement of vertical DO profiles is conducted to support the

[19] Basin Plan Chapters 3 and 4. WARM represents warm freshwater habitat while COLD represents cold freshwater habitat.

implementation of the Lake Elsinore and Canyon Lake nutrient TMDL. Results should be consulted for a more complete assessment of DO in these waters.[20]

- Conductivity (Figure 4-4) appears to vary based on geography as sites located in the upper portions of the watershed (Mill Creek Reach 2, Big Bear Lake, and Lytle Creek) have lower conductivity (less than 500 µS/cm) than sites located in the downstream portions of the watershed (550 to 4,200 µS/cm). Lake Elsinore exhibits particularly high conductivity (3,298 to 4,237 µS/cm), which is not unusual for a terminal lake.
- Turbidity for Lake Elsinore and Big Bear Lake show substantial variability throughout the year ranging from 14 to 101 NTU and 4 to 97 NTU, respectively. Turbidity at the remaining six sites is generally low (less than 12 NTU).
- Similar to turbidity, Figure 4-6 shows TSS variability among Priority 1 sites, however, most measurements are below 20 mg/L. TSS in Big Bear Lake (3 to 160 mg/L) is notably higher than other sites, although Lake Elsinore (16 to 54 mg/L) is slightly higher as well.
- Flow is lower at the upstream sites, Mill Creek Reach 2 (4 to 57 cubic feet per second [cfs]) and Lytle Creek (2 to 15 cfs). Flow is greatest at SAR at Pedley Avenue (11 to 218 cfs), which is fed into by the other sites (Figure 4-7). Note that Figure 4-7 shows flow only for stream sites and does not include lake sites, where flow is not measured.

Table 4-1 Priority 1 Monitoring Sites

Site ID	Site Description	County
P1-1	Canyon Lake at Holiday Harbor	Riverside
P1-2	Lake Elsinore	Riverside
P1-3	Lake Perris	Riverside
P1-4	Big Bear Lake at Swim Beach	San Bernardino
P1-5	Mill Creek Reach 2	San Bernardino
P1-6	Lytle Creek (Middle Fork)	San Bernardino
WW-S1	Santa Ana River Reach 3 at MWD Crossing	Riverside
WW-S4	Santa Ana River Reach 3 at Pedley Avenue	Riverside

[20] http://www.sawpa.org/task-forces/lake-elsinore-canyon-lake-tmdl-task-force/#monitoring-program

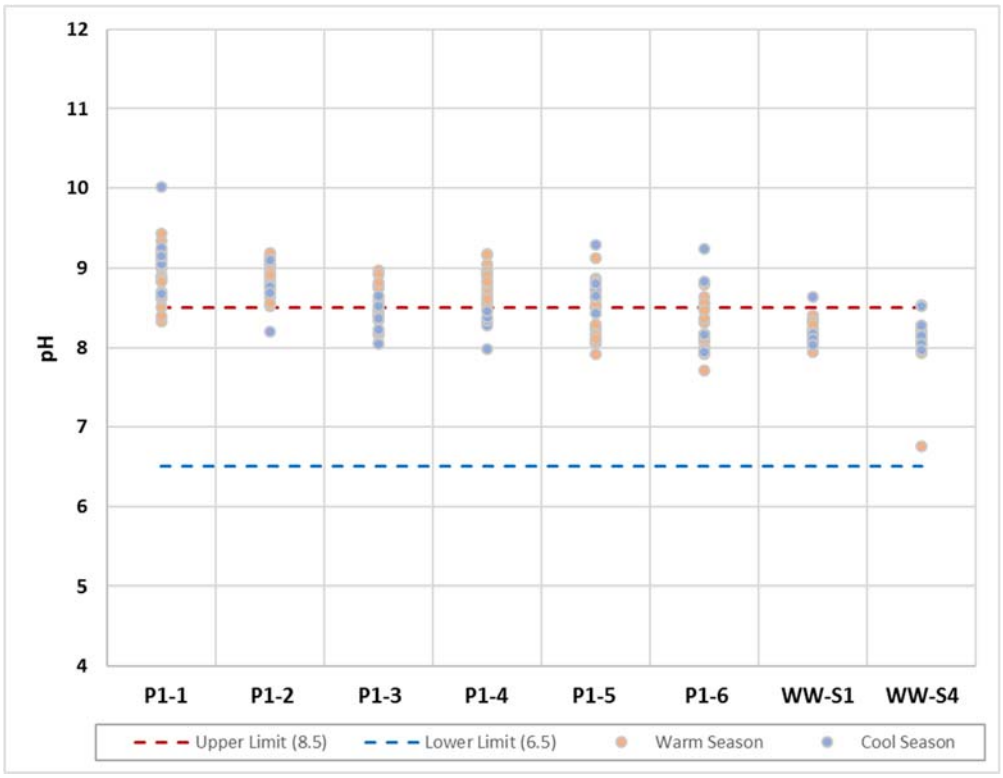

Figure 4-1
Distribution of pH Measurements at Priority 1 Sites

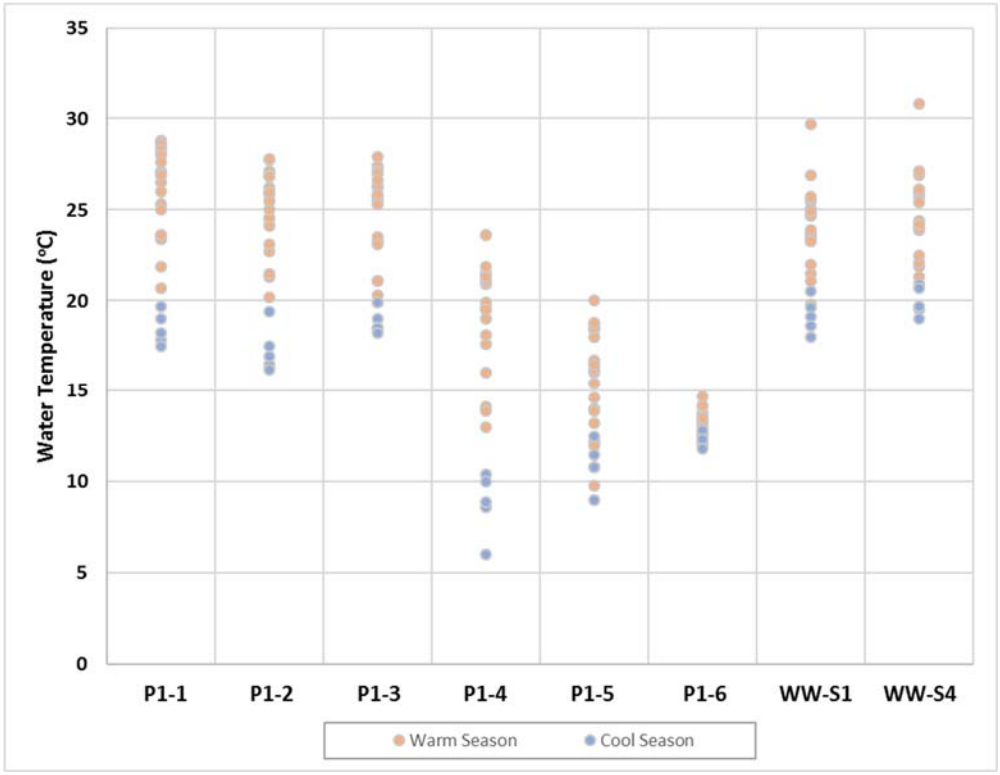

Figure 4-2
Distribution of Water Temperature Measurements at Priority 1 Sites

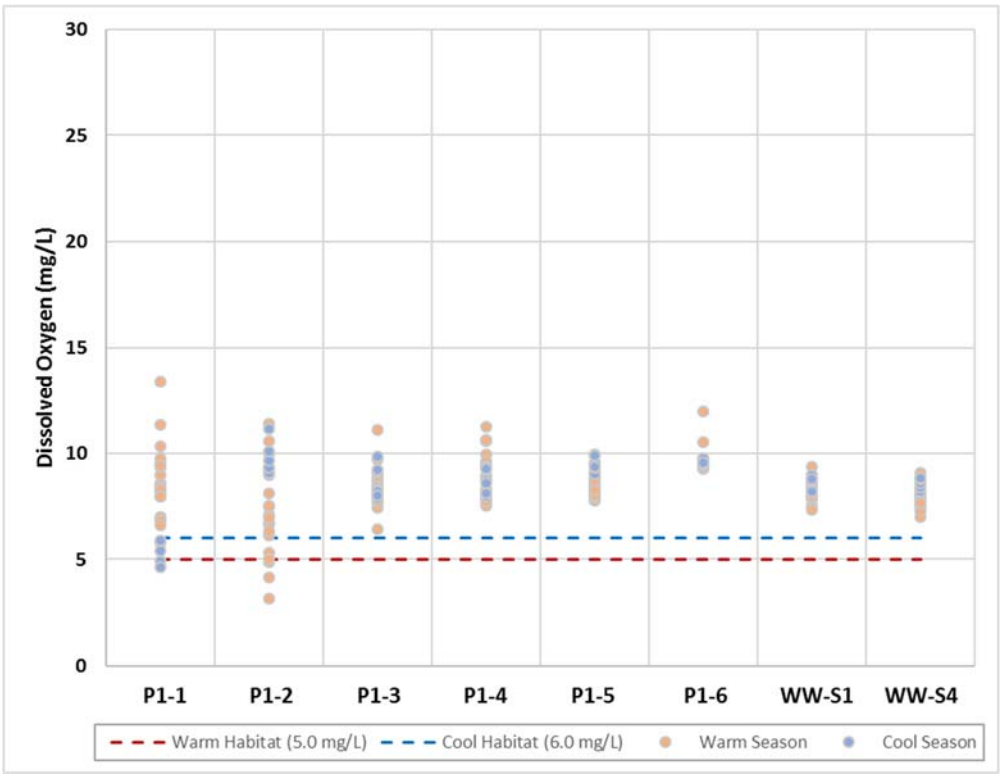

Figure 4-3
Distribution of Dissolved Oxygen Measurements at Priority 1 Sites

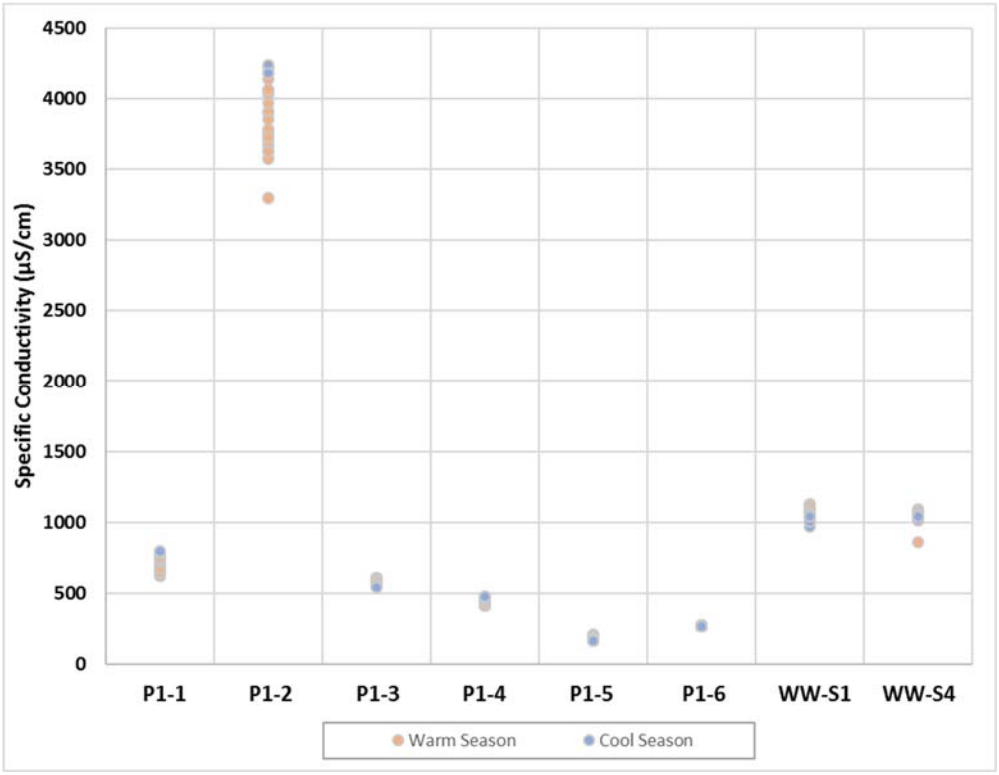

Figure 4-4
Distribution of Specific Conductivity Measurements at Priority 1 Sites

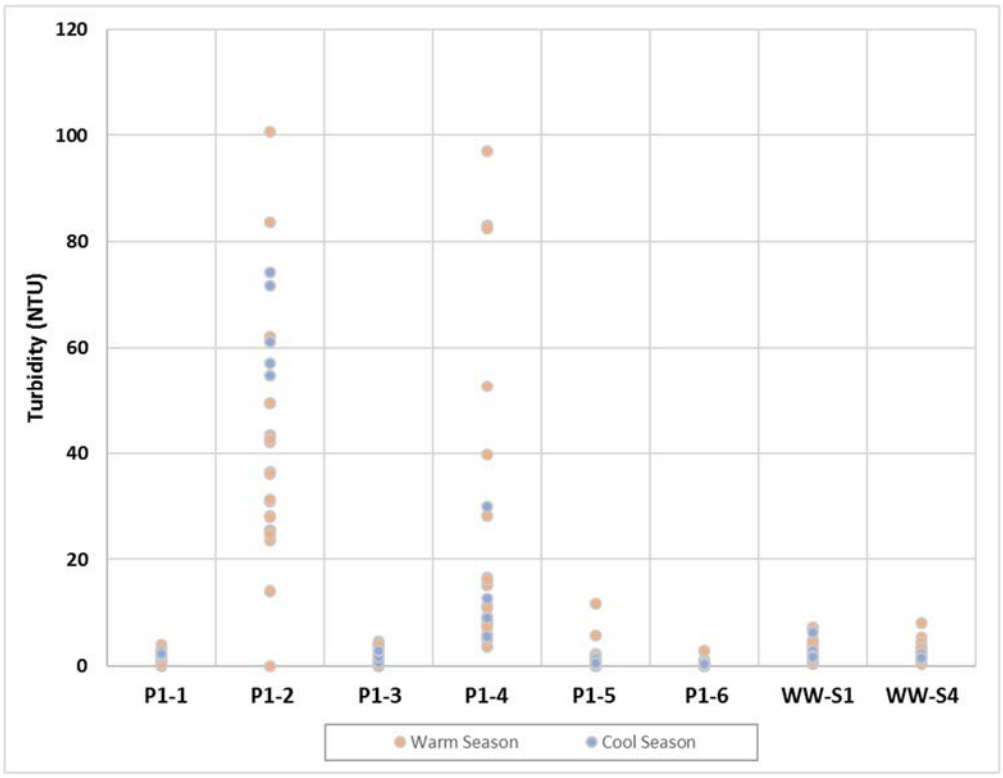

Figure 4-5
Distribution of Turbidity Measurements at Priority 1 Sites

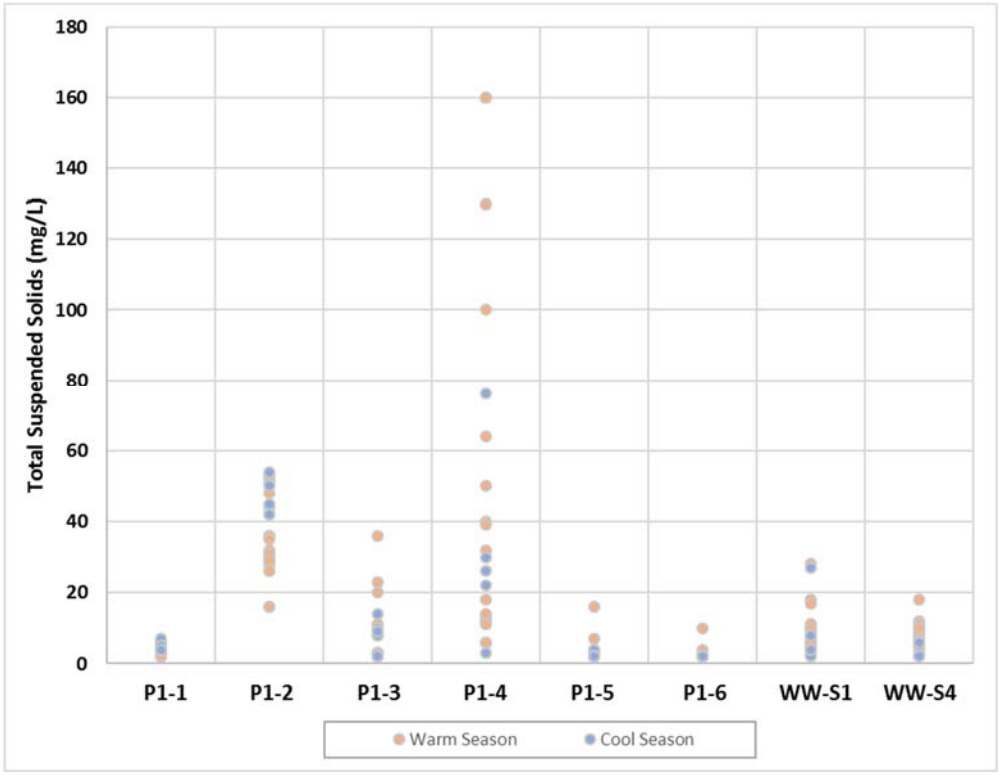

Figure 4-6
Distribution of TSS Measurements at Priority 1 Sites

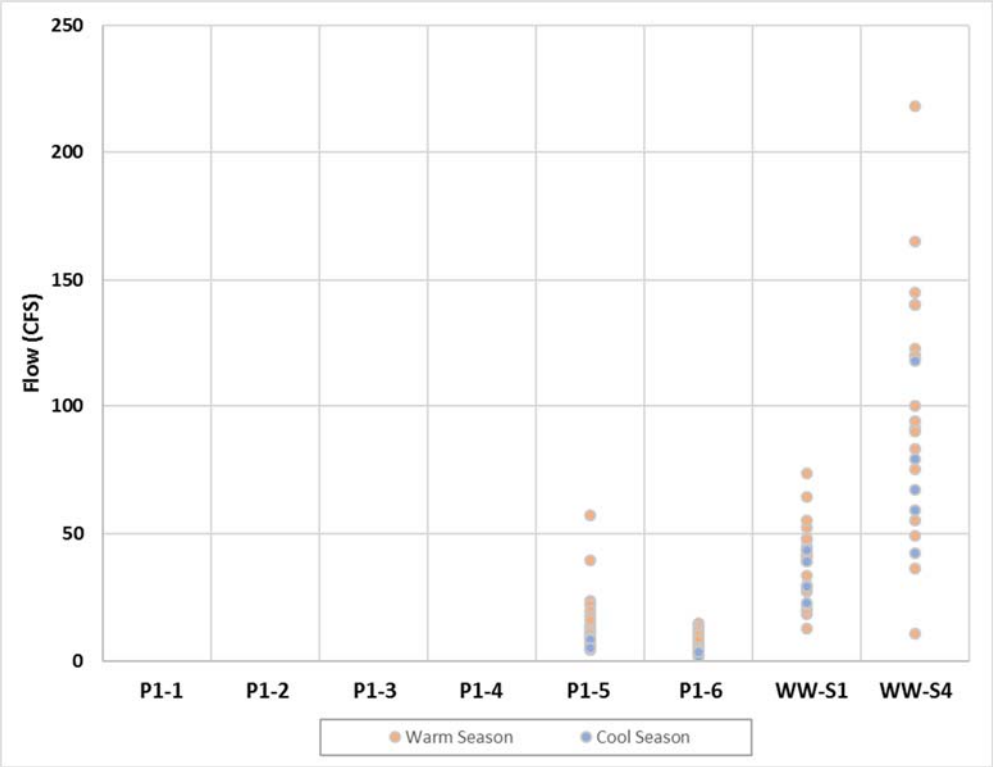

Figure 4-7
Distribution of Flow Measurements at Priority 1 Sites
**Note that lake sites are not monitored for flow*

4.1.2 Bacteria Characterization

Figure 4-8 presents the distribution of *E. coli* concentrations observed at Priority 1 sites during the warm, dry and cool, wet seasons. Lake Elsinore, Lake Perris, Lytle Creek, Canyon Lake, and Mill Creek had generally low concentrations of *E. coli*. Only 4 percent of the samples collected from Lake Elsinore, Lake Perris, and Lytle Creek were greater than 100 MPN/100mL. Canyon Lake and Mill Creek had particularly low *E. coli* levels (below detection limit of 23 MPN/100mL).

E. coli concentrations at the two SAR sites were consistently higher than concentrations at all other Priority 1 sites (Figure 4-8). Approximately 96 percent of the individual *E. coli* sample results from the six sites not located in SAR were less than 100 MPN/100 mL while only 3 percent of the individual sample results from the two SAR sites were less than 100 MPN/100 mL. Twenty percent of samples from the four lake sites had *E. coli* concentrations below the detection limit.

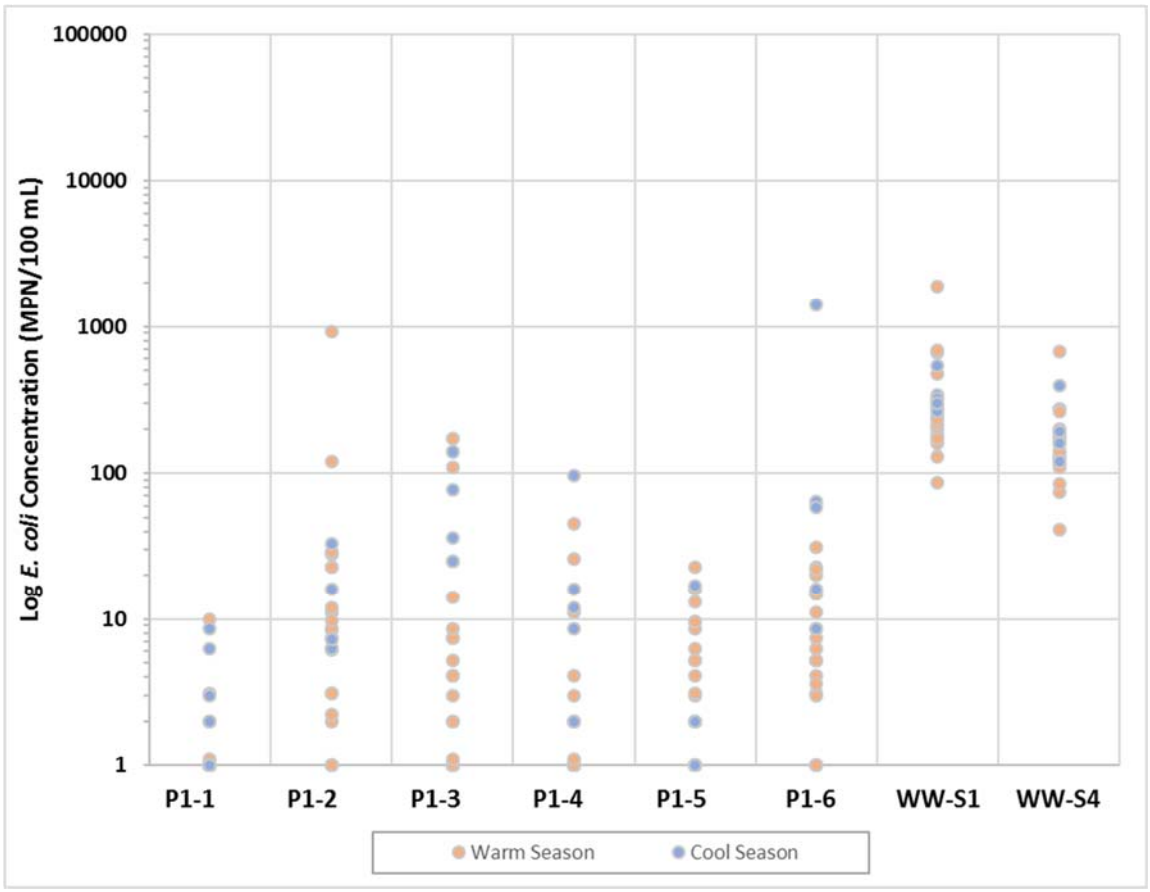

Figure 4-8
Distribution of *E. coli* Concentrations at Priority 1 Sites

Figures 4-9 through 4-16 show the individual and 5-week geomean *E. coli* concentrations for each Priority 1 site. They illustrate the variability in single sample results and the calculated rolling geometric mean values. The figures show that for several sites, the cool, wet season samples had slightly higher *E. coli* concentrations. Although there were a few small summer storms, they generally occurred outside of the warm, dry season and did not impact sample results and flow measurements.

Key observations from the Priority 1 site data include:

- The highest *E. coli* concentration observed at a Priority 1 site was 1,900 MPN/100 mL at SAR at Pedley Avenue during the week of July 2, 2017 (Figure 4-11).
- At the two SAR sites, *E. coli* concentrations are generally increasing throughout the summer, which is consistent with past trends observed along SAR (Figures 4-15 and 4-16).[21] The increasing trend is also observed at Mill Creek Reach 2 (P1-5) (Figure 4-13) and for a portion of the warm, dry data at other sites.

Basin Plan Chapters 3 and 4. WARM represents warm freshwater habitat while COLD represents cold freshwater habitat.
shed Project Authority MSAR TMDL Task Force website: http://www.sawpa.org/collaboration/projects/tmdl-taskforce/

Calculated geomeans did not exceed the Santa Ana Basin Plan WQO of 126 MPN/100 ML at six of the eight Priority 1 sites. Only geomeans from the two SAR sites exceeded the WQO. All geomeans from SAR at MWD Crossing exceeded the WQO, while 53 percent of the rolling geomeans from SAR at Pedley Avenue exceeded the WQO.

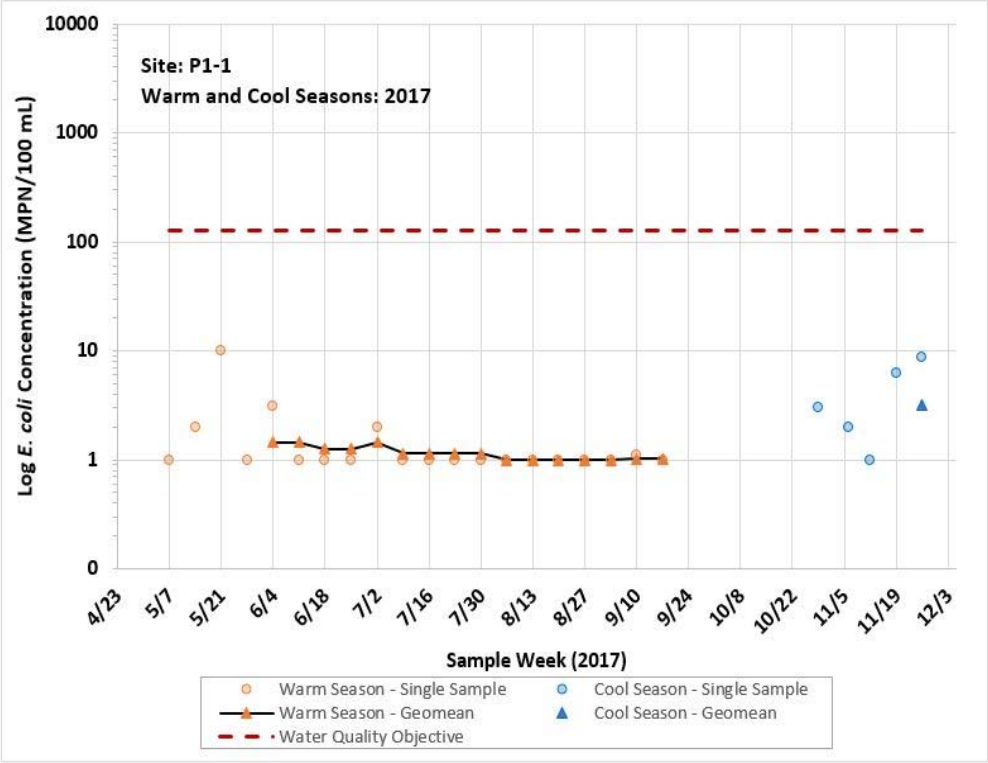

Figure 4-9
***E. coli* Concentrations and Geomeans at Canyon Lake (P1-1)**

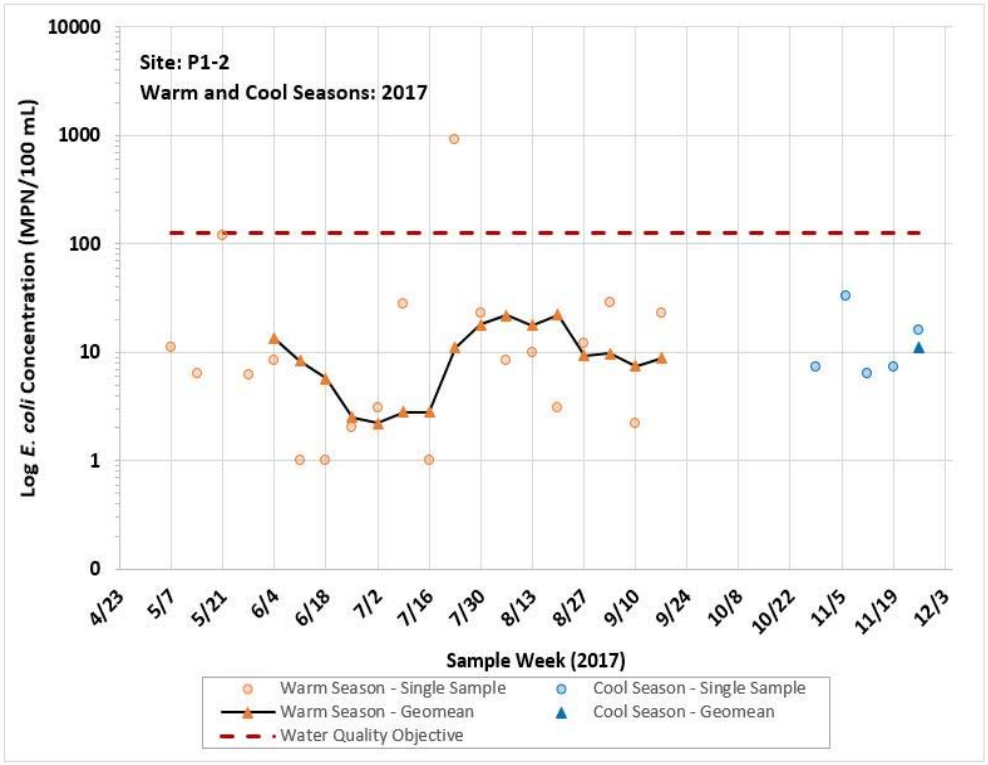

Figure 4-10
***E. coli* Concentrations and Geomeans at Lake Elsinore (P1-2)**

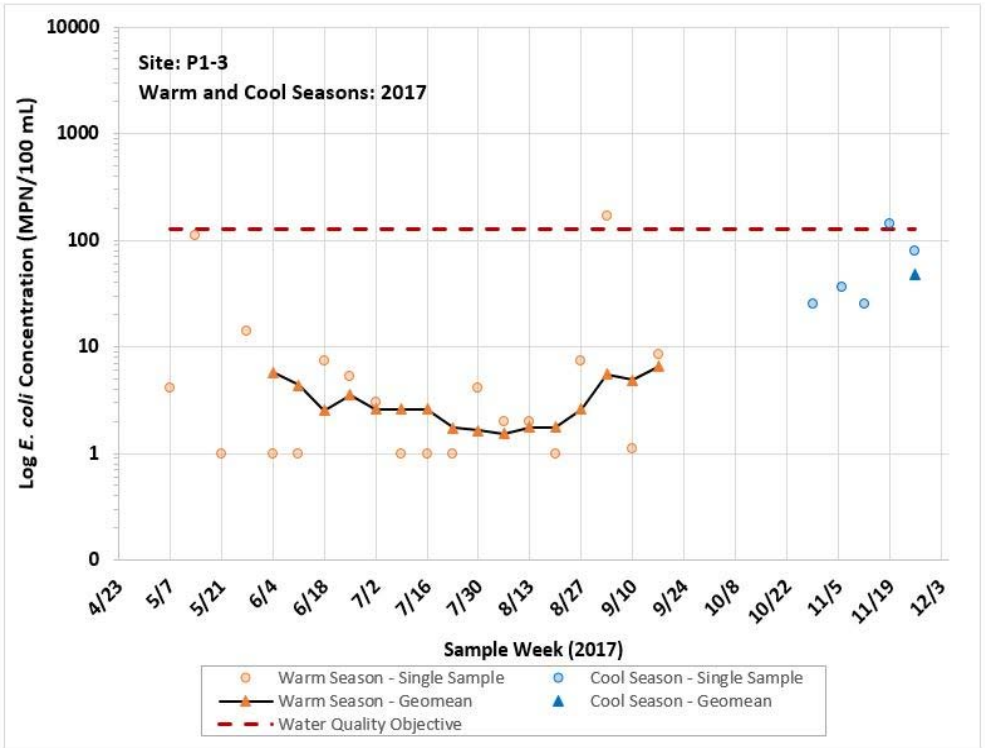

Figure 4-11
***E. coli* Concentrations and Geomeans at Lake Perris (P1-3)**

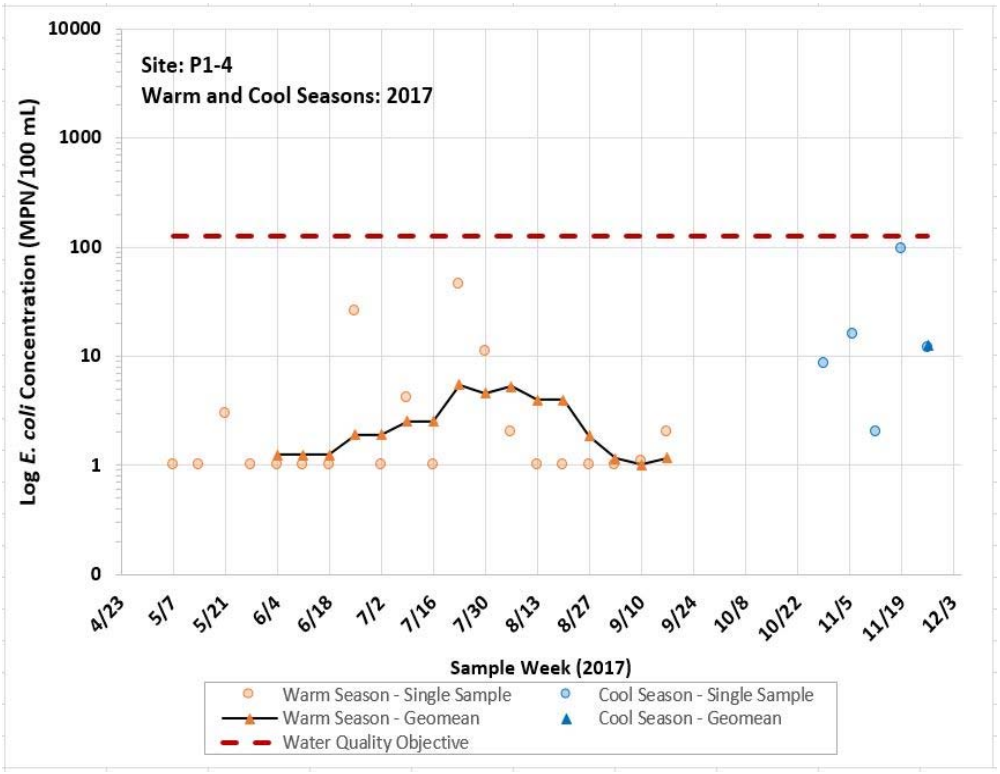

Figure 4-12
***E. coli* Concentrations and Geomeans at Big Bear Lake (P1-4)**

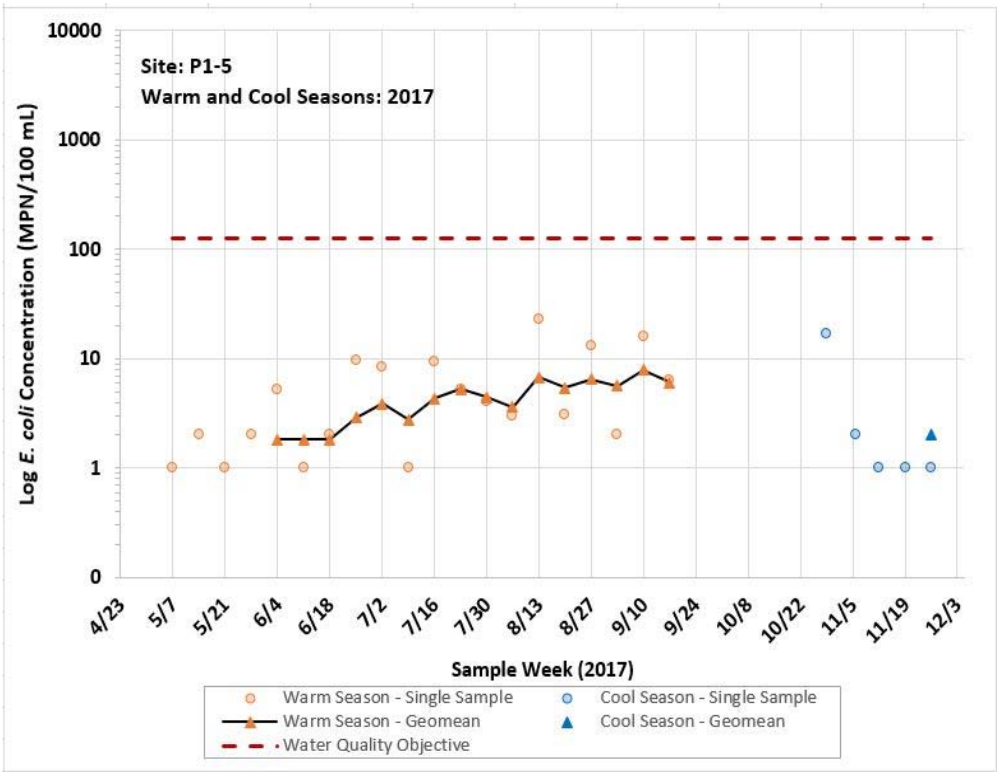

Figure 4-13
***E. coli* Concentrations and Geomeans at Mill Creek Reach 2 (P1-5)**

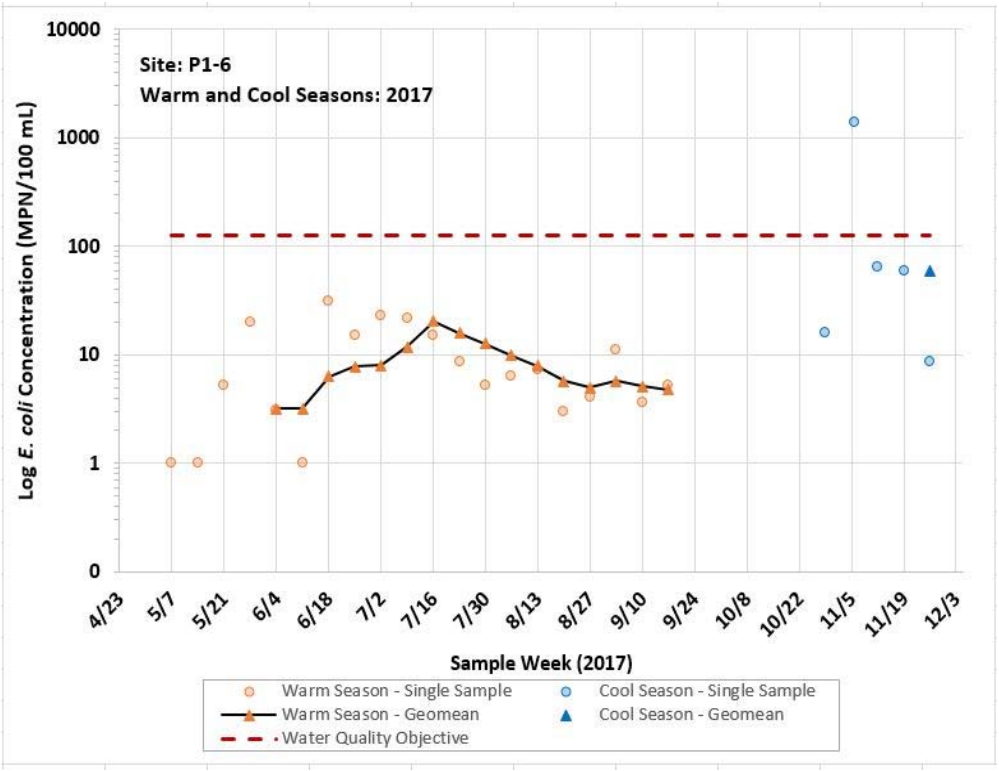

Figure 4-14
***E. coli* Concentrations and Geomeans at Lytle Creek (P1-6)**

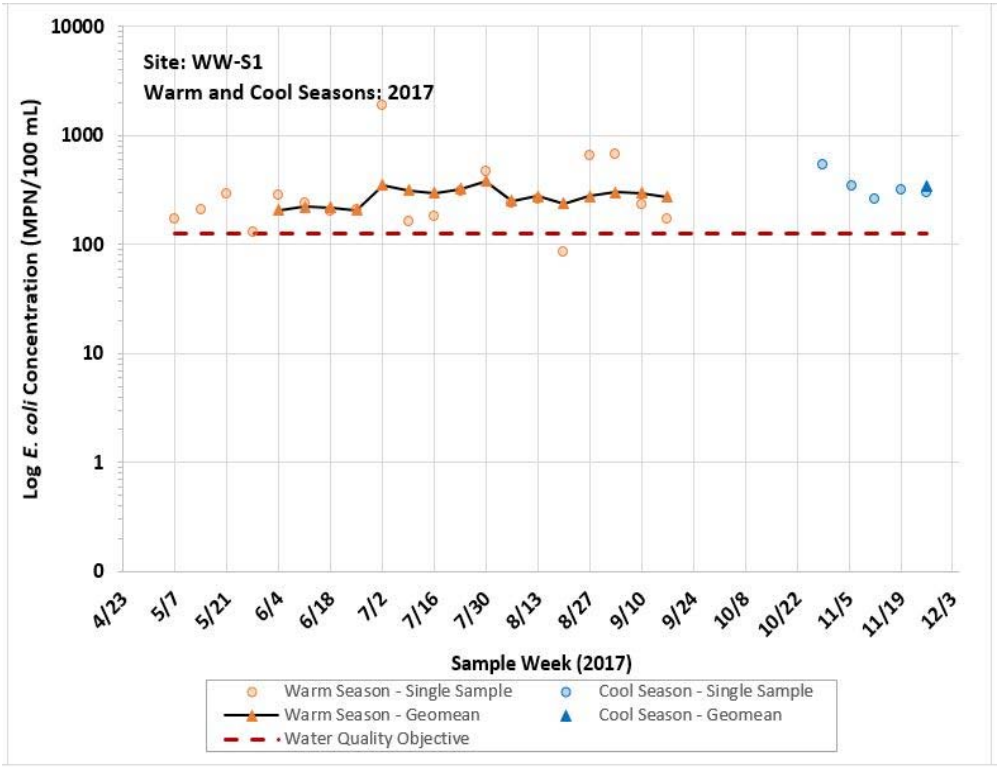

Figure 4-15
***E. coli* Concentrations and Geomeans at Santa Ana River at MWD Crossing (WW-S1)**

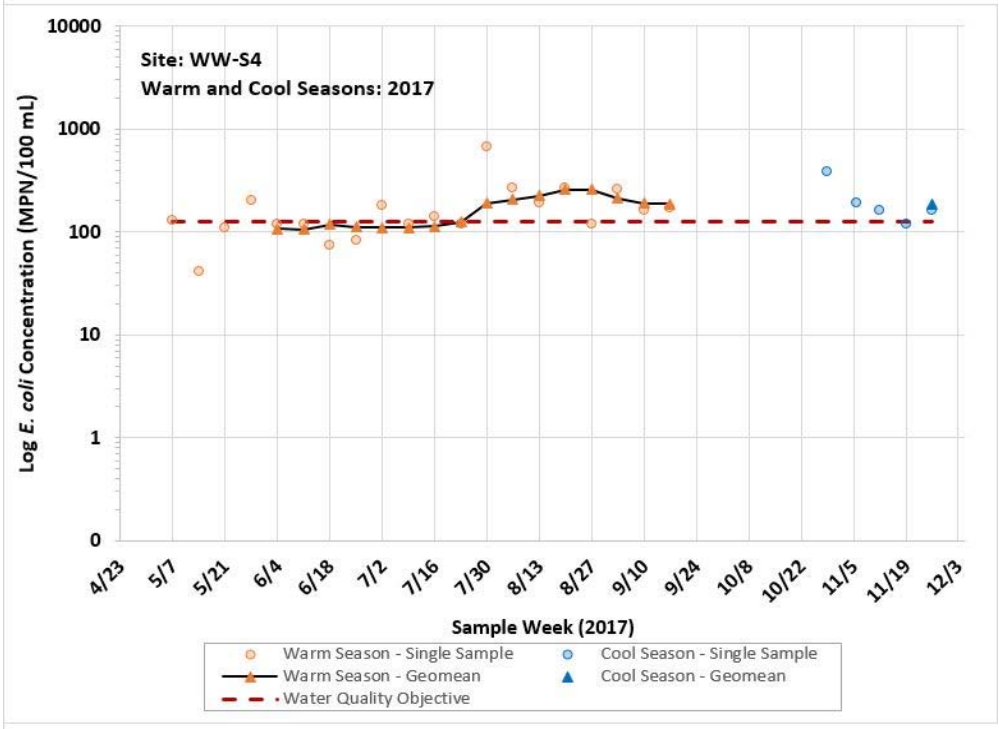

Figure 4-16
***E. coli* Concentrations and Geomeans at Santa Ana River at Pedley Avenue (WW-S4)**

4.1.3 Bacteria Compliance Analysis

The compliance analysis compared the *E. coli* geomeans to the Santa Ana Basin Plan geomean WQO of 126 MPN/100 mL. Geometric means were calculated only when at least five sample results were available from the previous 30-day period. The Basin Plan also establishes a single sample value objective of 235 MPN/100 mL for Tier A REC-1 waters. However, this single sample value objective only applies when a geomean is unavailable and is provided only as a reference as the RMP allowed for 17 rolling geomeans to be calculated for Priority 1 sites.

Six out of eight Priority 1 sites had 0 percent geomean exceedances (Table 4-2). The two sites that exceeded the WQO were SAR at MWD Crossing (WW-S1) and SAR at Pedley Avenue (WW-S4) with 100 percent and 53 percent exceedance frequencies, respectively.

Table 4-2 Frequency of Exceedance with *E. coli Geomean* Water Quality Objective During the 2017 Dry Weather Samples (126 MPN/100 mL)

Site ID	Site	Geometric Mean Criterion Exceedance Frequency (%)
P1-1	Canyon Lake at Holiday Harbor	0
P1-2	Lake Elsinore	0
P1-3	Lake Perris	0
P1-4	Big Bear Lake at Swim Beach	0
P1-5	Mill Creek Reach 2	0
P1-6	Lytle Creek (Middle Fork)	0
WW-S1	Santa Ana River Reach 3 at MWD Crossing	100
WW-S4	Santa Ana River Reach 3 at Pedley Avenue	53

4.2 Priority 2

4.2.1 Water Quality Observations

Water quality parameters measured in the field at Priority 2 sites (Table 4-3) are summarized in Figures 4-17 through 4-23. Note that due to dry conditions during Prado Park Lake repair, measurements at Prado Park Lake are limited to seven out of the planned twenty-five. Key observations are summarized as follows:

- Figure 4-17 shows that none of the pH measurements were below the lower allowable limit of 6.5, however, one measurement at SAR at MWD Crossing exceeded the upper allowable limit of 8.5.
- Water temperatures are generally similar among Priority 2 sites and are slightly lower during the cold, wet season than the dry, warm season (Figure 4-18).
- All of the Priority 2 sites are designated with the WARM beneficial use and should meet a minimum DO level of 5 mg/L. All DO levels from the two SAR sites, Mill-Cucamonga Creek, and Prado Park Lake are greater than 5 mg/L (Figure 4-19), while eleven dry weather samples from Chino Creek were below 5 mg/L. Algae growth documented on the bottom of Chino Creek during dry sample events may have caused low DO levels.
- Specific conductivity is generally similar at all sites except Mill-Cucamonga Creek. At the other four sites, measurements ranged from 858 to 1325 µS/cm while measurements at Mill-Cucamonga Creek are higher, ranging from 845 to 2245 µS/cm.
- TSS (Figure 4-21) and turbidity (Figure 4-22) show similar trends with slightly lower levels in Chino Creek and slightly higher, broader levels in other sites. Cool, wet season measurements are also generally lower than warm, dry season measurements.
- Flow is lower at Prado Park Lake (spill from the lake) with rates ranging from 2 to 8 cfs. Chino Creek and Cucamonga Creek had similar ranges of flow (2 to 15 cfs and 2 to 24 cfs, respectively). Flow is notably higher in SAR and greatest at the most downstream site SAR at Pedley Avenue (Figure 4-23). Maximum flow at SAR at Pedley Avenue (218 cfs) is nearly three times as high as the maximum flow observed at any other Priority 2 site (74 cfs).

Table 4-3 Priority 2 Monitoring Sites

Site ID	Site Description	County
WW-M6	Mill-Cucamonga Creek below Wetlands	San Bernardino
WW-C7	Chino Creek at Central Avenue	San Bernardino
WW-C3	Prado Park Lake	San Bernardino
WW-S1	Santa Ana River Reach 3 at MWD Crossing	Riverside
WW-S4	Santa Ana River Reach 3 at Pedley Avenue	Riverside

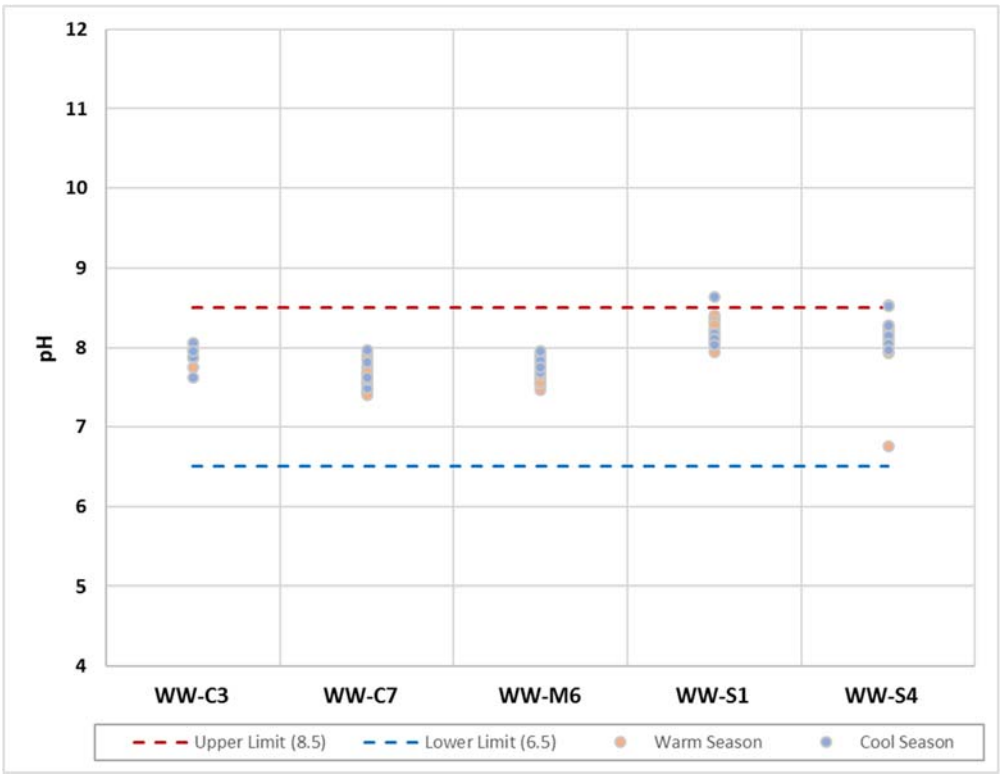

Figure 4-17
Distribution of pH Measurements at Priority 2 Sites

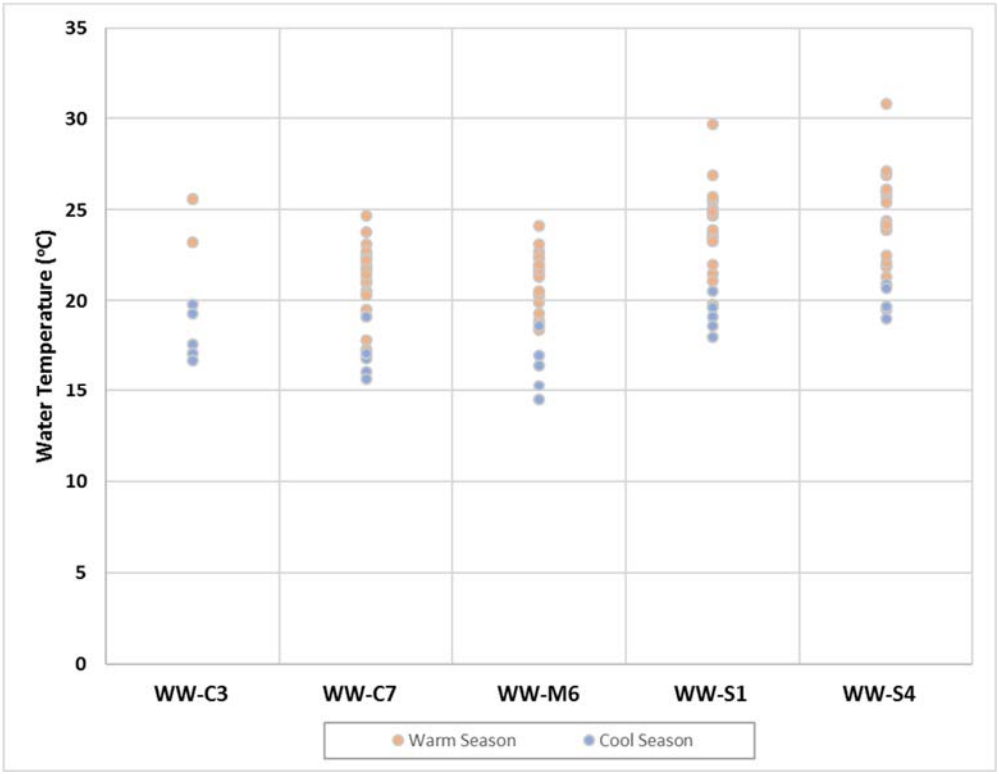

Figure 4-18
Distribution of Water Temperature Measurements at Priority 2 Sites

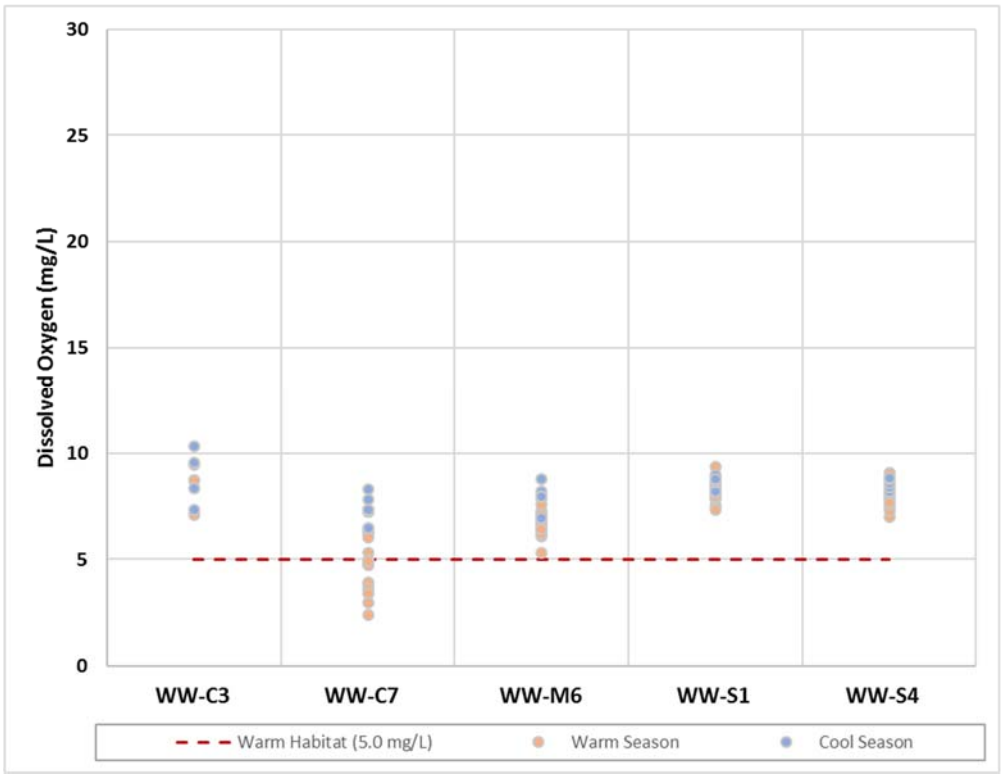

Figure 4-19
Distribution of Dissolved Oxygen Measurements at Priority 2 Sites

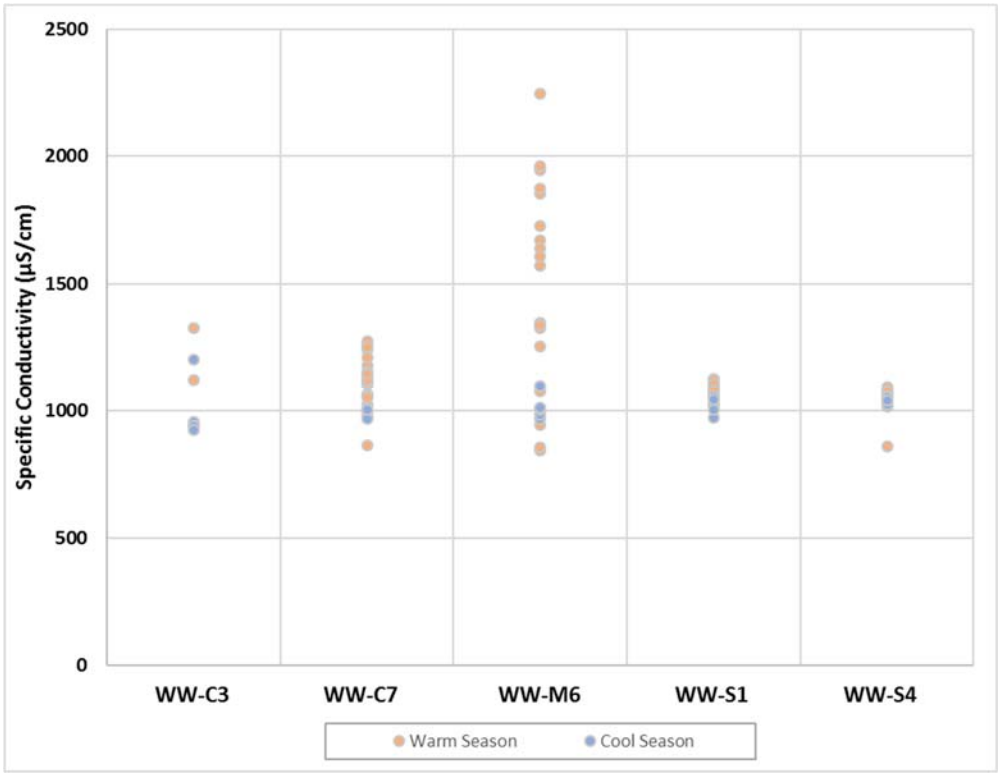

Figure 4-20
Distribution of Specific Conductivity Measurements at Priority 2 Sites

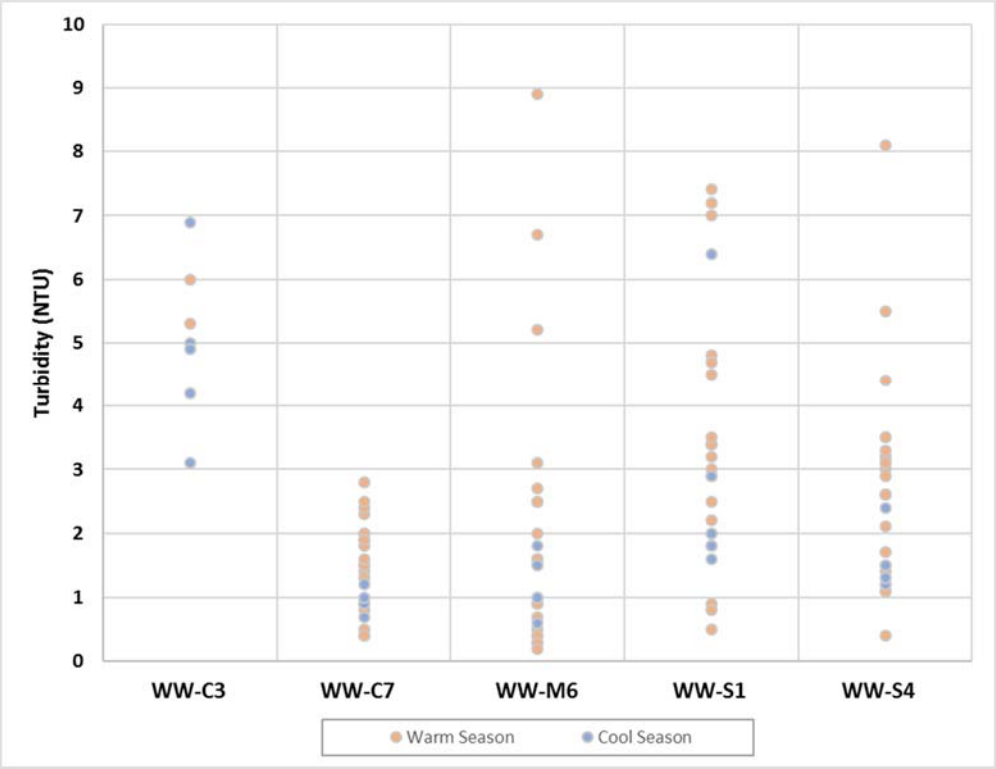

Figure 4-21
Distribution of Turbidity Measurements at Priority 2 Sites

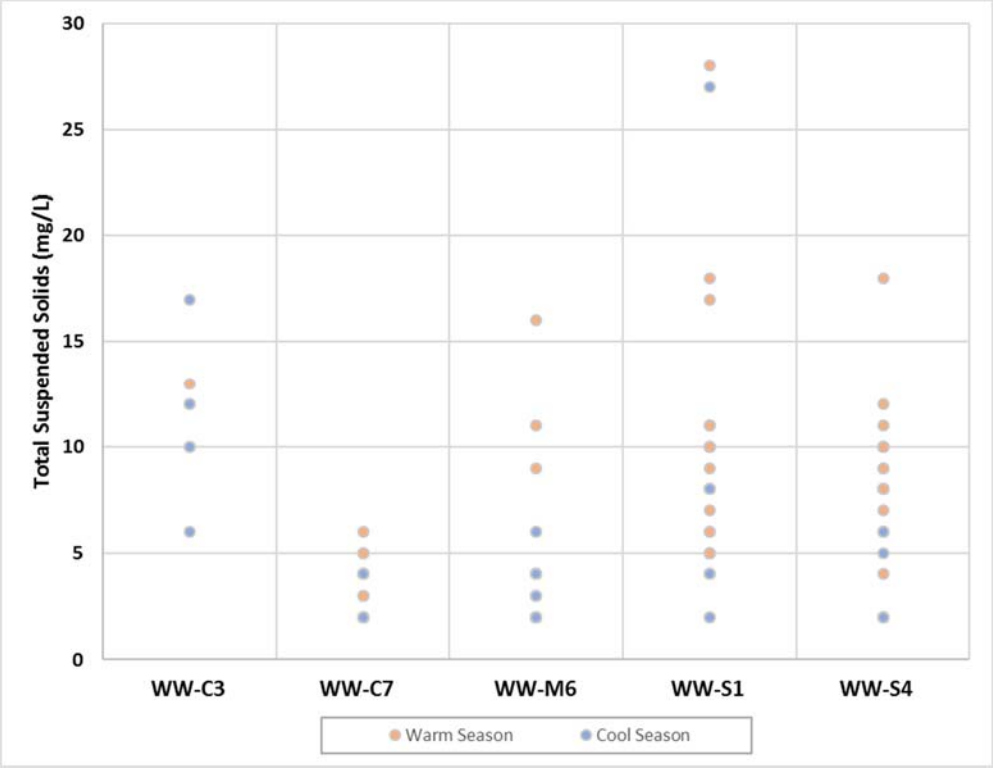

Figure 4-22
Distribution of TSS Measurements at Priority 2 Sites

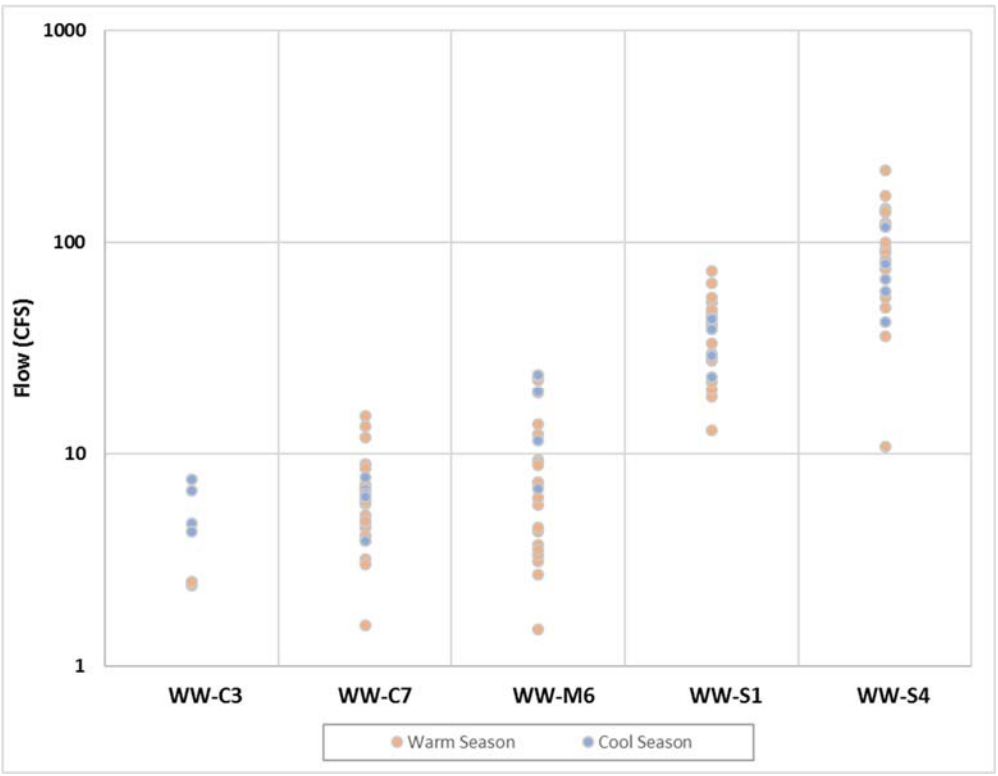

Figure 4-23
Distribution of Flow Measurements at Priority 2 Sites

4.2.2 Bacteria Characterization

Figure 4-24 summarizes the distribution of *E. coli* concentrations observed at Priority 2 sites during the warm, dry and cool, wet seasons.

4.2.2.1 Dry Weather

Chino Creek (WW-C7) had the highest single-sample observed *E. coli* concentration of 2,900 MPN/100 mL. Most sites generally had similar ranges of *E. coli* concentrations, except for SAR at Pedley Avenue which had a slightly lower range from 41 to 610 MPN/100 mL.

Figure 4-24 illustrates individual wet weather storm samples from the 2017-2018 (green triangles) wet season.[22] Results from storm samples are summarized in Section 4.2.2.2. Figure 4-24 shows that peak concentrations from the storm samples are higher than most *E. coli* concentrations observed in dry weather samples except at Prado Park Lake. In particular, peak storm concentrations are greater than dry weather concentrations by over an order of magnitude at SAR at Pedley Avenue.

[22] See Section 4.2.2.2 of this report for more information on wet weather event sampling.

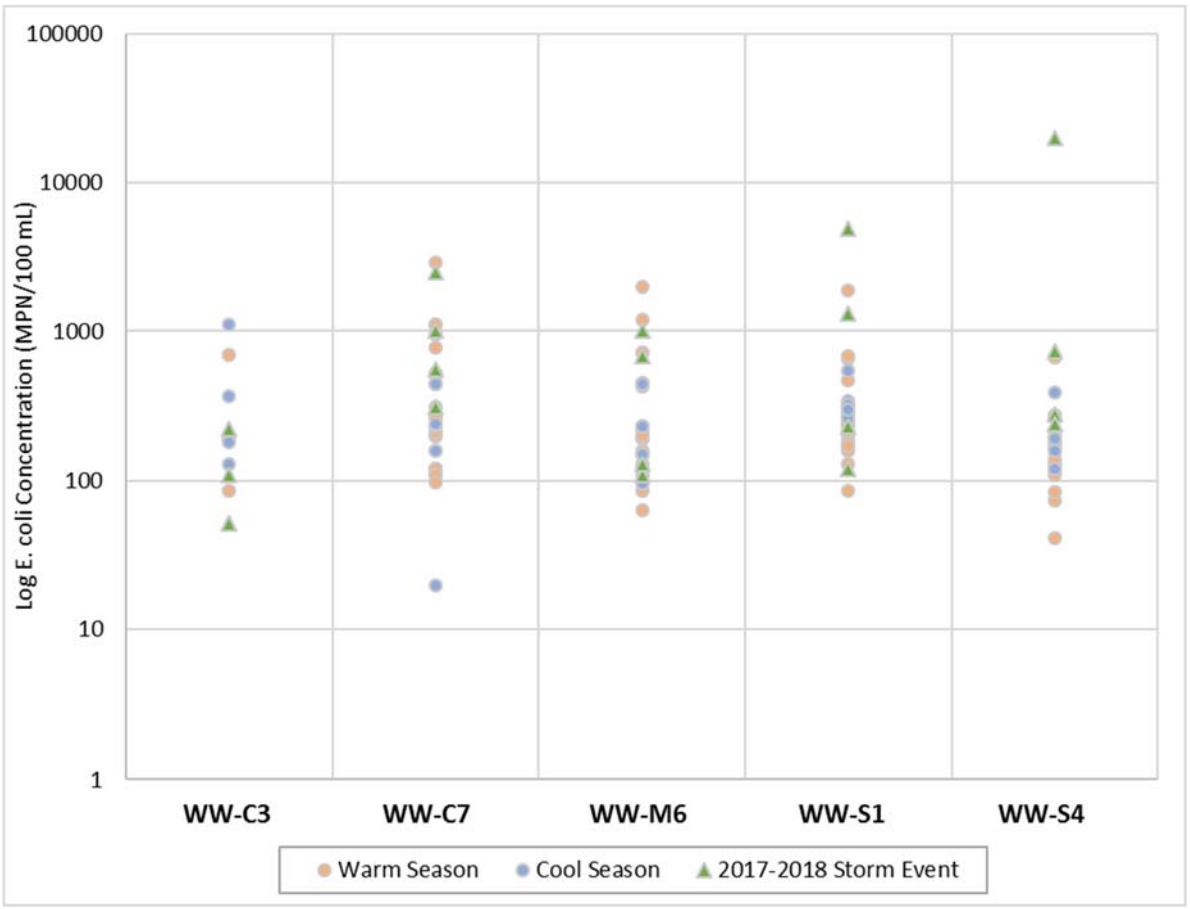

Figure 4-24
Distribution of *E. coli* Concentrations at Priority 2 Sites

Figures 4-25 through 4-29 show the individual and 5-week calculated rolling geomean *E. coli* concentrations as well as concentrations from four storm samples during the 2017-2018 storm event. They illustrate the variability in single sample results and rolling geometric mean values. Unlike Priority 1 sites, the figures show that the cool, wet season samples resulted in generally similar *E. coli* concentrations as warm, dry season samples except at Prado Park Lake (WW-C3) where concentrations from the warm season were limited to two observations. Similar to Priority 1 sites, storms during the monitoring period did not appear to influence bacteria concentrations as concentrations following storm events were not consistently higher.

Key observations from the Priority 2 site data include:

- Prado Park Lake was drained in the spring of 2017 to repair a storm drain pipe underneath the lake. Refilling of the lake with flows from RP1 commenced in late summer, and *E. coli* concentrations exceeded the TMDL numeric target (Figure 4-25). The elevated bacteria may be influenced by the lake draining and refilling or maintenance activities. With the repaired storm drain pipe, most stormwater runoff from the upstream drainage area will bypass the lake, reducing the effective drainage area to the land immediately surrounding the lake. *E. coli* concentrations in the February 2018 storm event samples measured 220, 52, 52, and 110 MPN/100 mL for days 1, 3, 4, and 5, respectively. This suggests the repair

has eliminated most stormwater from reaching the lake. No dry weather inflow from any source except for RP1 discharge is expected to persist.

- Nearly all geomeans from the other four Priority 2 sites exceeded the TMDL numeric target (Figures 4-26 through 4-29). Only 29 percent of *E. coli* concentrations from SAR at Pedley Avenue had geomeans that met the TMDL numeric target.
- *E. coli* concentrations at SAR at MWD Crossing (Figure 4-28), and SAR at Pedley Avenue (Figure 4-29) are generally increasing during the warm, dry season, which is consistent with historic trends.

Peak storm *E. coli* concentrations are more than one order of magnitude greater than dry weather concentrations at the two SAR sites (Figures 4-28 and 4-29). At Chino Creek (Figure 4-26), and Mill-Cucamonga Creek (Figure 4-27), peak storm concentrations are greater than most of the dry weather concentrations but similar in magnitude as peak dry weather concentrations.

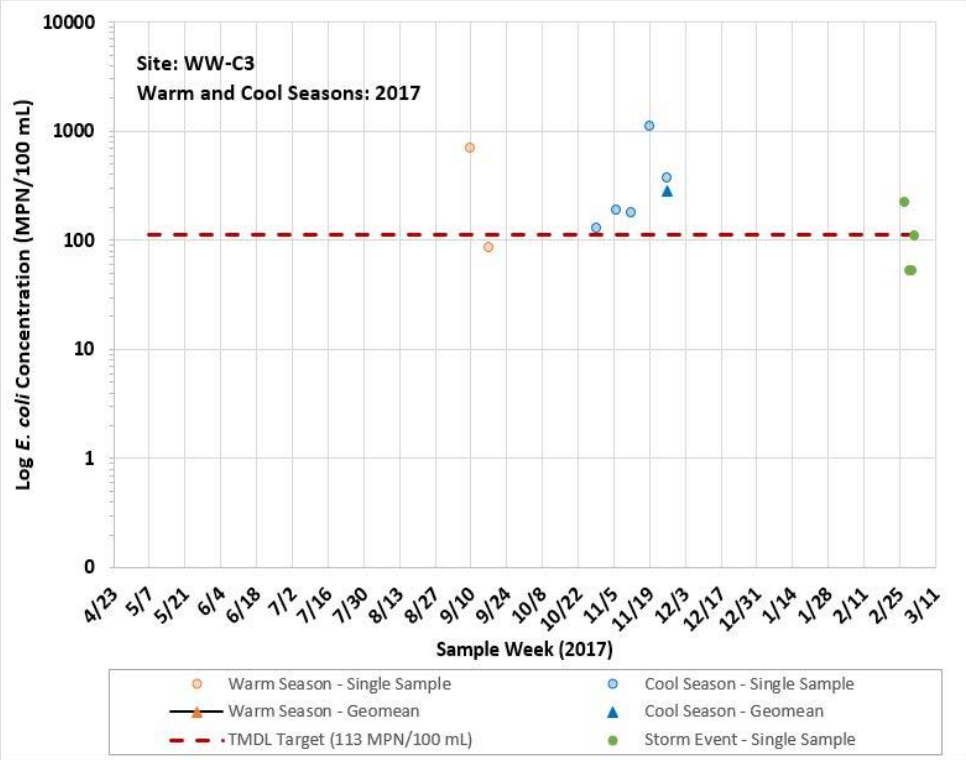

Figure 4-25
***E. coli* Concentrations and Geomeans at Prado Park Lake (WW-C3)**

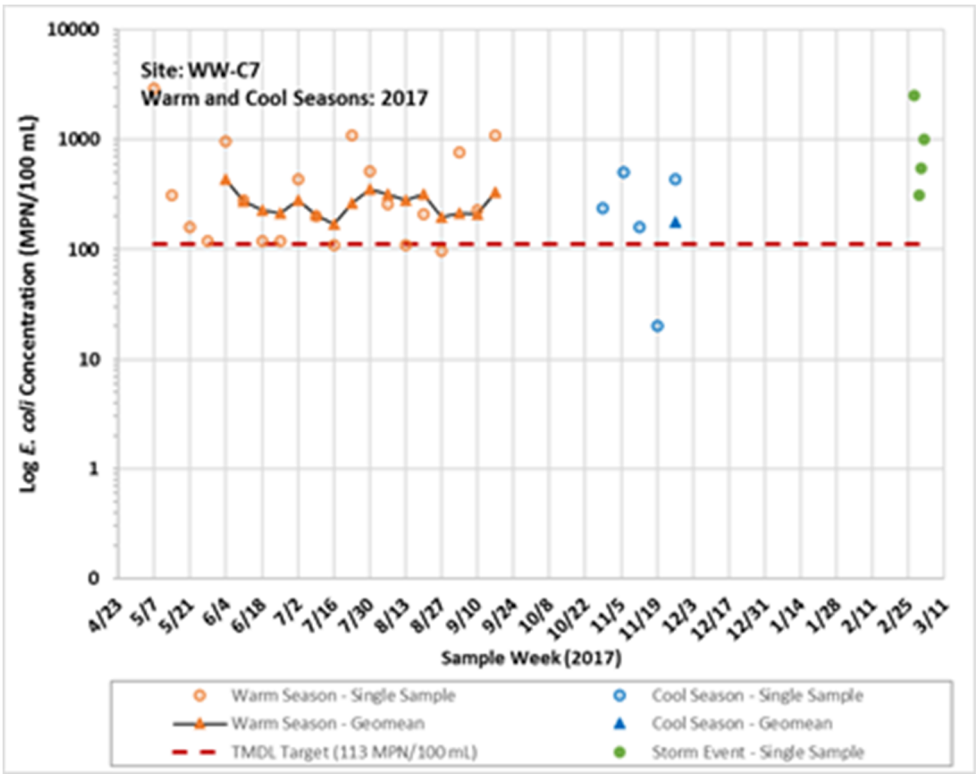

Figure 4-26
***E. coli* Concentrations and Geomeans at Chino Creek at Central Avenue (WW-C7)**

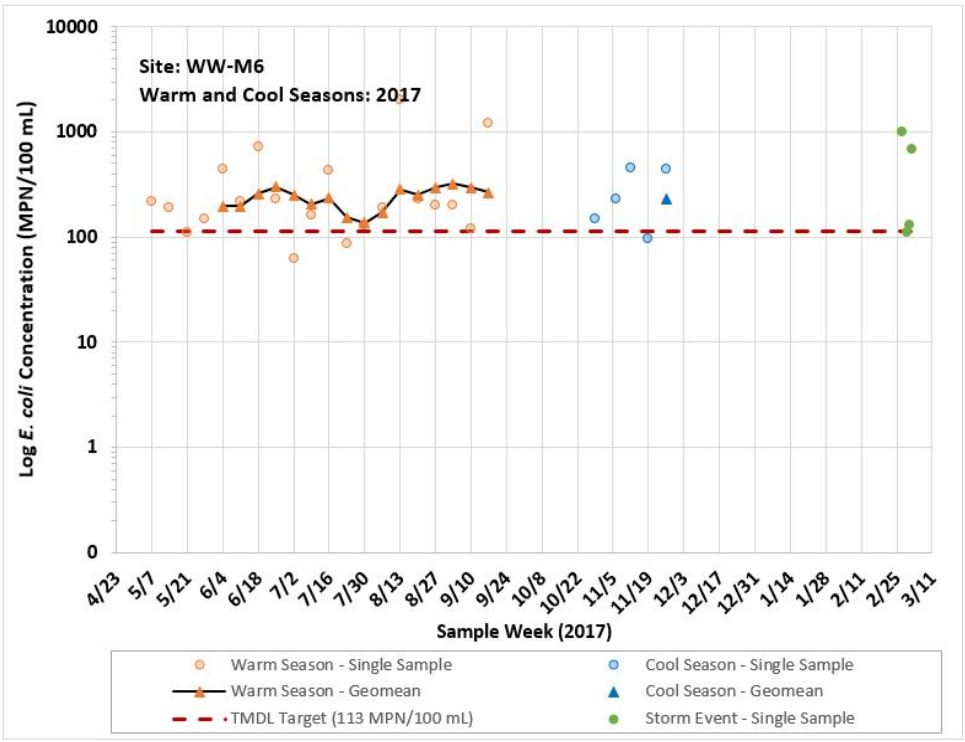

Figure 4-27
***E. coli* Concentrations and Geomeans at Mill-Cucamonga Creek Below Wetlands (WW-M6)**

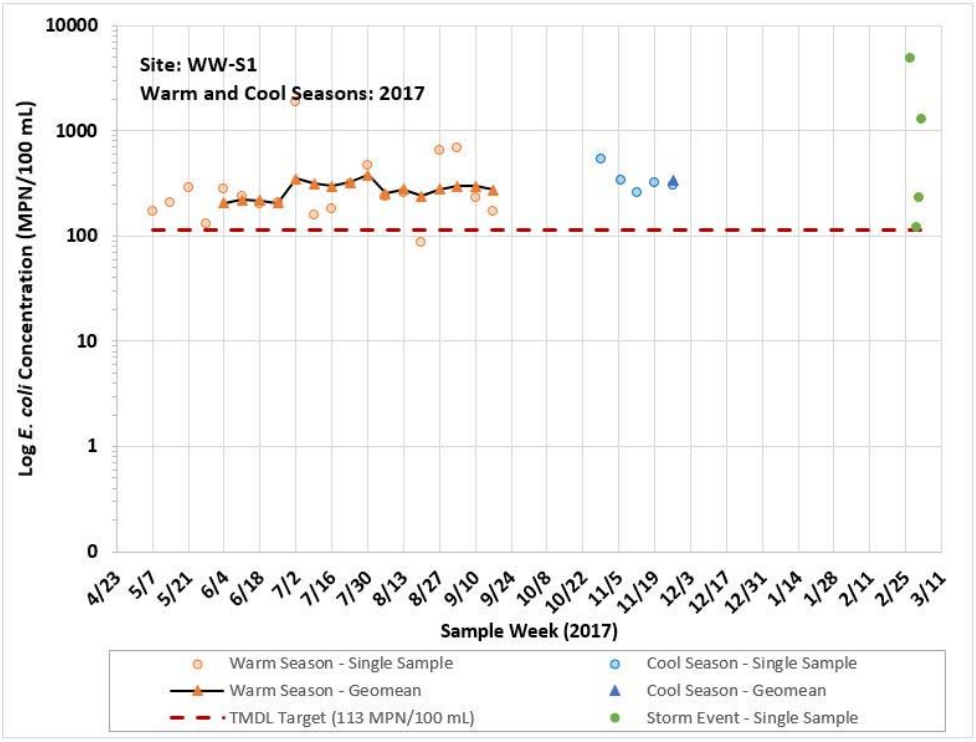

Figure 4-28
***E. coli* Concentrations and Geomeans at Santa Ana River at MWD Crossing (WW-S1)**

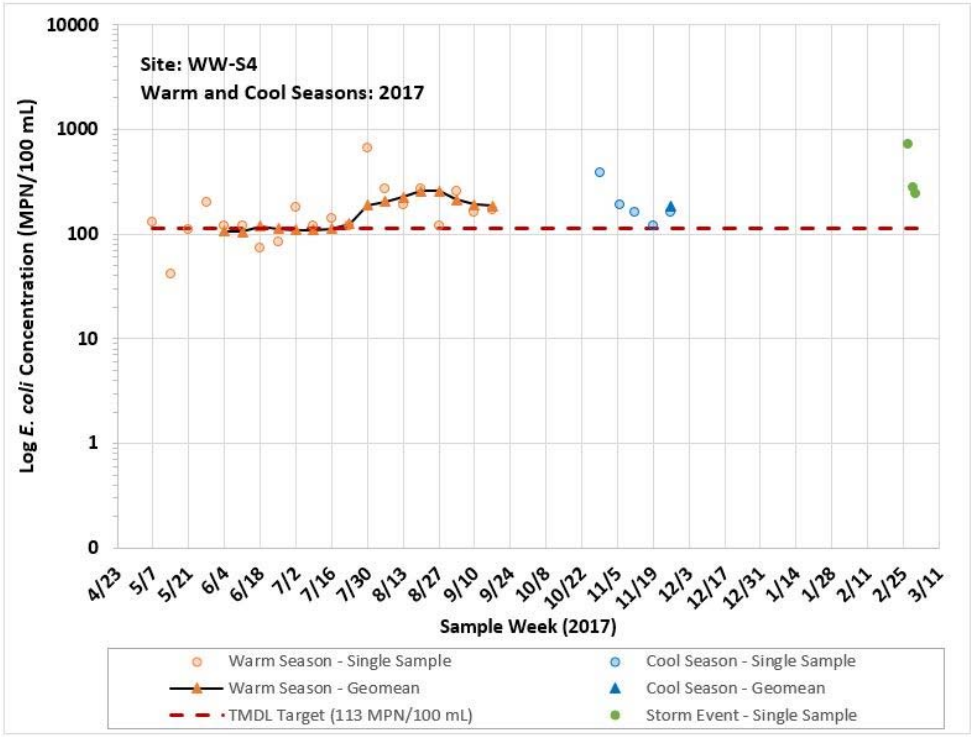

Figure 4-29
***E. coli* Concentrations and Geomeans at Santa Ana River at Pedley Avenue (WW-S4)**

4.2.2.2 Wet Weather[23]

Storm samples collected for the February 27, 2018 storm event are summarized in Table 4-4. Figures 4-30 and 4-31 illustrate examples of changing *E. coli* concentrations over the sampling period during and after the storm at various sites with flows classified as wet weather conditions. *E. coli* concentrations are generally lower at Prado Park Lake, ranging from 52 to 220 MPN/100 mL while concentrations at the other four sites range from 110 to 20,000 MPN/100 mL. The highest concentration (20,000 CFU/100 mL) was observed on March 3, 2018, at SAR at Pedley Avenue. Although *E. coli* concentrations decrease after the first day of the storm, Day 4 *E. coli* concentrations increased at all five sites due to the onset of a second storm on March 3, 2018.

Table 4-4 *E. coli* Concentrations (MPN/100 mL) Observed During the 2017-2018 Storm Event

Site	2/27/2018	3/1/2018	3/2/2018	3/3/2018
Prado Park Lake (WW-C3)	220	52	52	110
Chino Creek at Central Avenue (WW-C7)	2500	310	550	1000
Mill-Cucamonga Creek below Wetlands (WW-M6)	1000	110	130	680
SAR Reach 3 at MWD Crossing (WW-S1)	4900	120	230	1300
SAR Reach 3 at Pedley Avenue (WW-S4)	730	280	240	20000

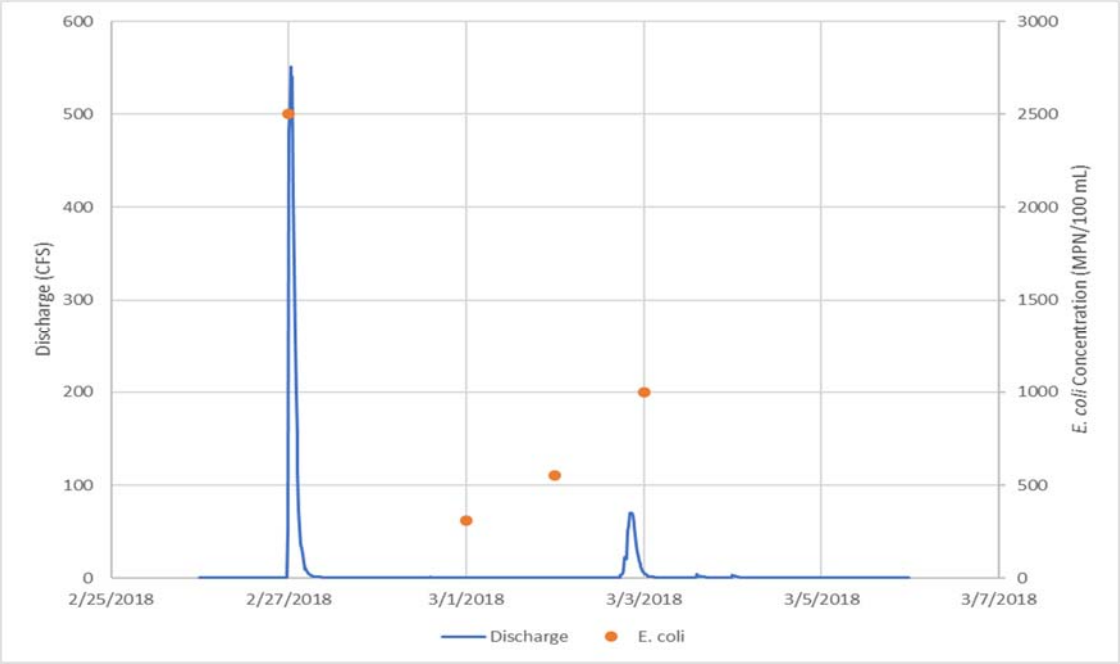

Figure 4-30
***E. coli* Concentrations Observed at Chino Creek During and After the February 27, 2018 Storm Event**

[23] Storm samples collected during the 2015-2016 and 2016-2017 wet seasons were collected under different monitoring plans and QAPPs. The 2015-2016 storm samples were subject to 2013 MSAR TMDL Water Quality Monitoring Plan and QAPP, which utilized EPA Method 1603 for *E. coli* analysis (units of CFU/100 mL). The 2016-2017 storm samples are subject to the current SAR RMP Monitoring Plan and QAPP, which supersedes the 2013 MSAR TMDL plans, and utilize Standard Method 9223 for *E. coli* analysis (units of MPN/100 mL).

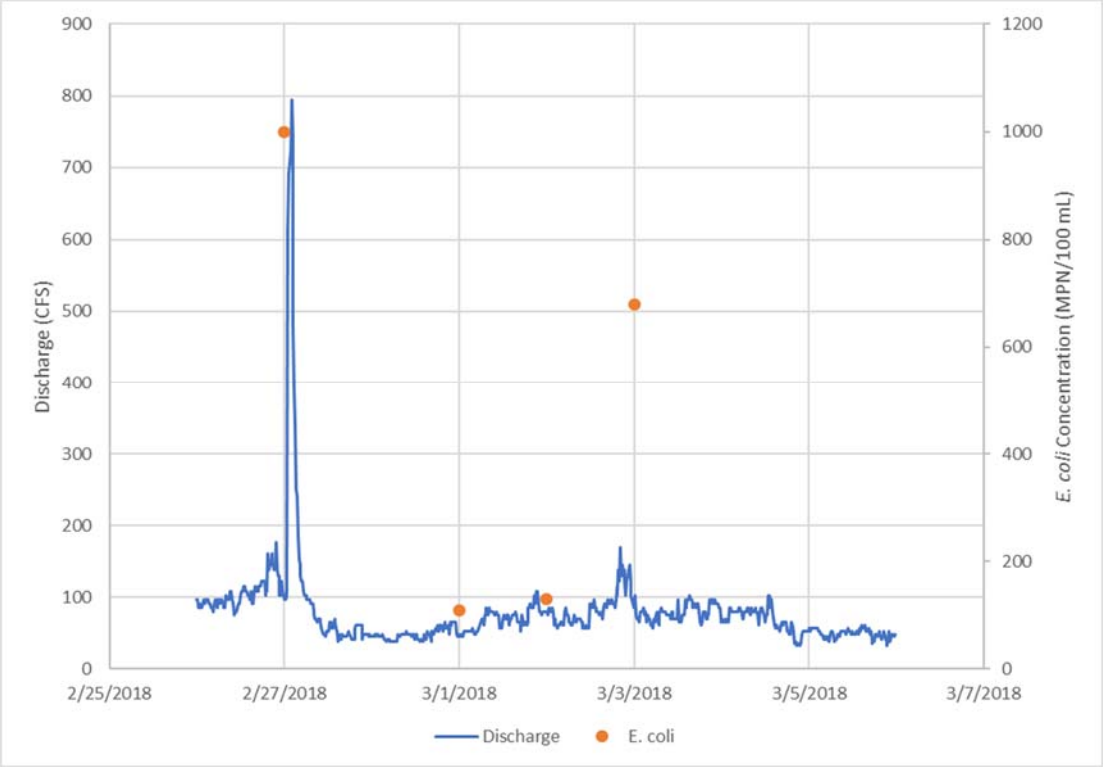

Figure 4-31
***E. coli* Concentrations Observed at Mill-Cucamonga Creek During and After the February 27, 2018 Storm Event**

4.2.3 Historical Trend

Figures 4-32 through 4-36 illustrate how the distribution and variability of rolling geometric mean values for *E. coli* have varied over time since 2007.[24] The extended period of record illustrates how *E. coli* geomean concentrations have been comparable for the period of record. *E. coli* concentrations from 2007 through 2015 are presented in CFU/100 mL while 2016 and 2017 concentrations are presented in MPN/100 mL.

[24] Results of previous sample collection activities may be obtained from seasonal reports posted at the Santa Ana Watershed Project Authority MSAR TMDL Task Force website: http://www.sawpa.org/collaboration/projects/tmdl-taskforce/

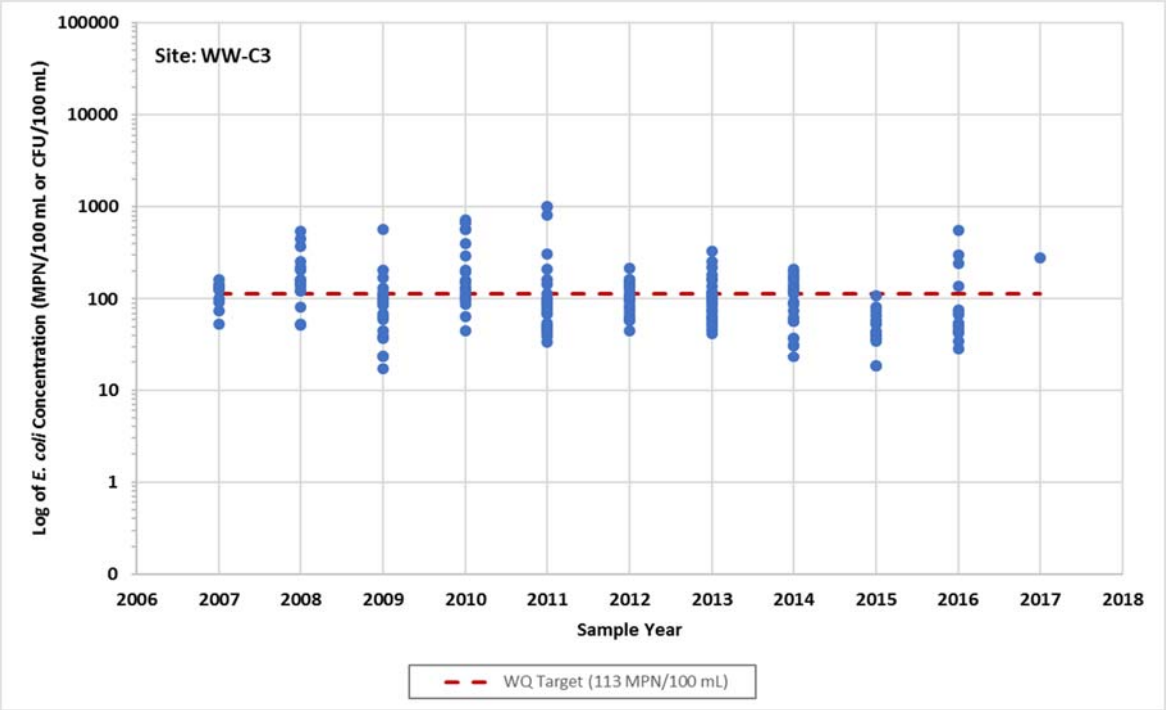

Figure 4-32
Time Series Distribution of *E. coli* Geomean Concentrations at Prado Park Lake from 2007 through 2017

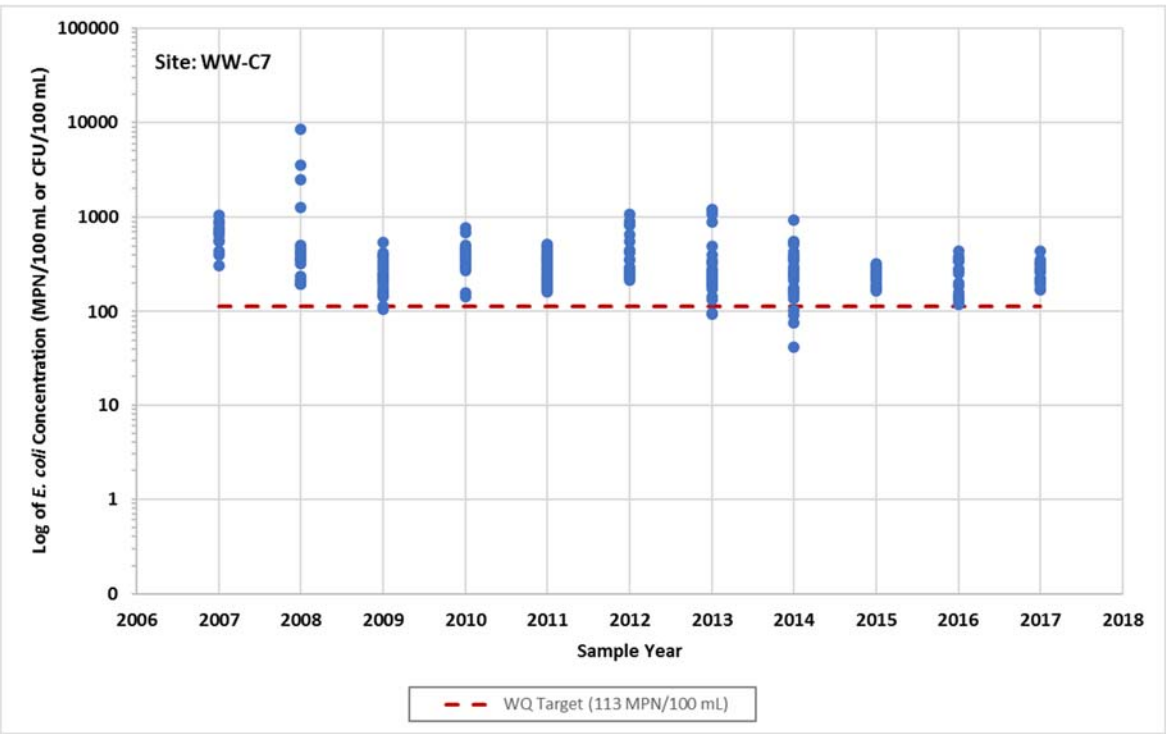

Figure 4-33
Time Series Distribution of *E. coli* Geomean Concentrations at Chino Creek from 2007 through 2017

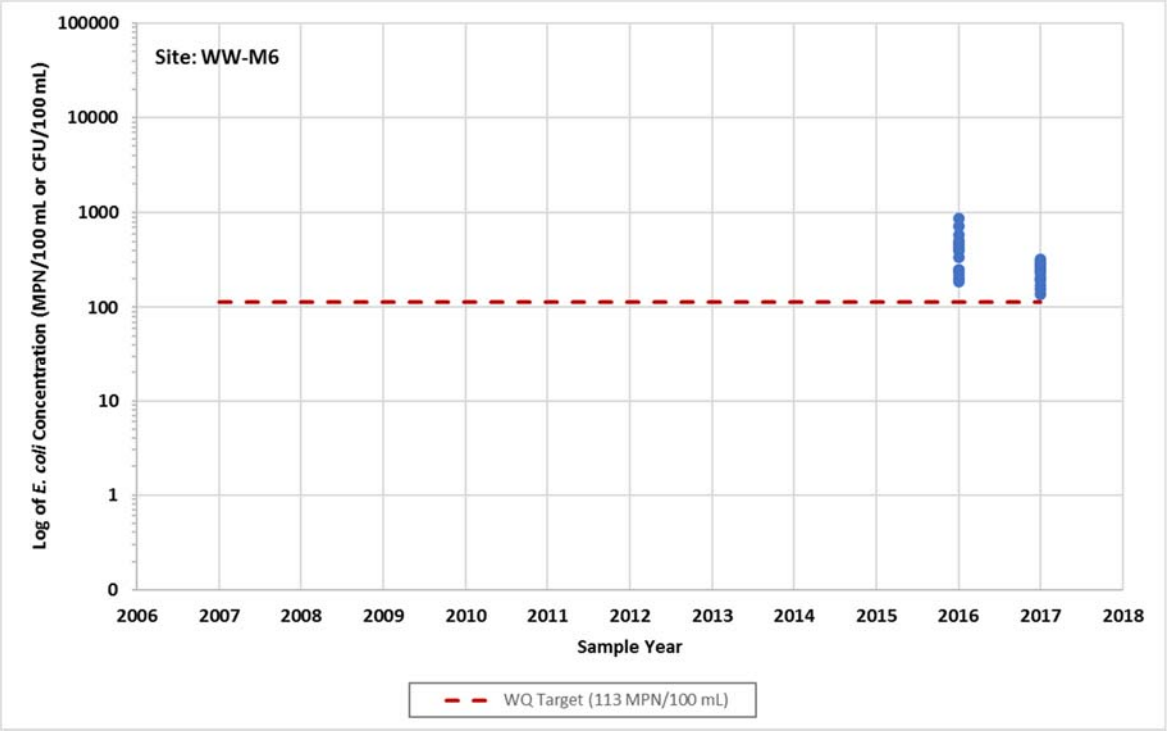

Figure 4-34
Time Series Distribution of *E. coli* Geomean Concentrations at Cucamonga Creek Below Wetlands from 2016 through 2017

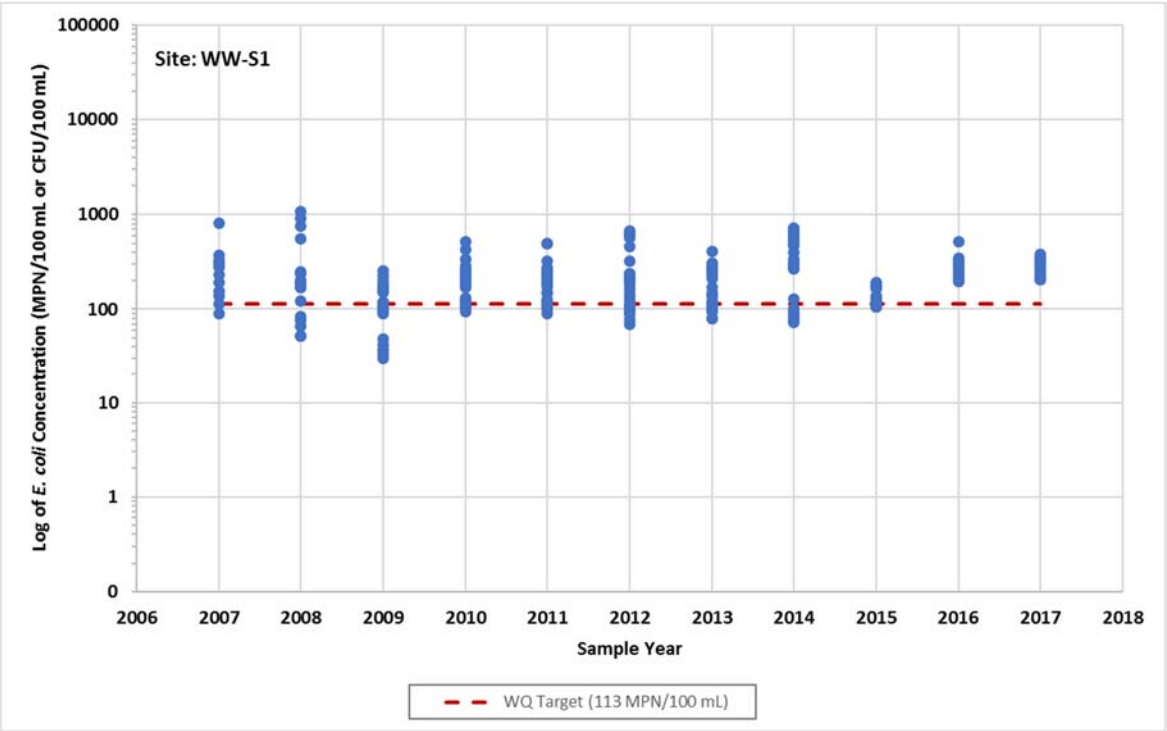

Figure 4-35
Time Series Distribution of *E. coli* Geomean Concentrations at Santa Ana River at MWD Crossing from 2007 through 2017

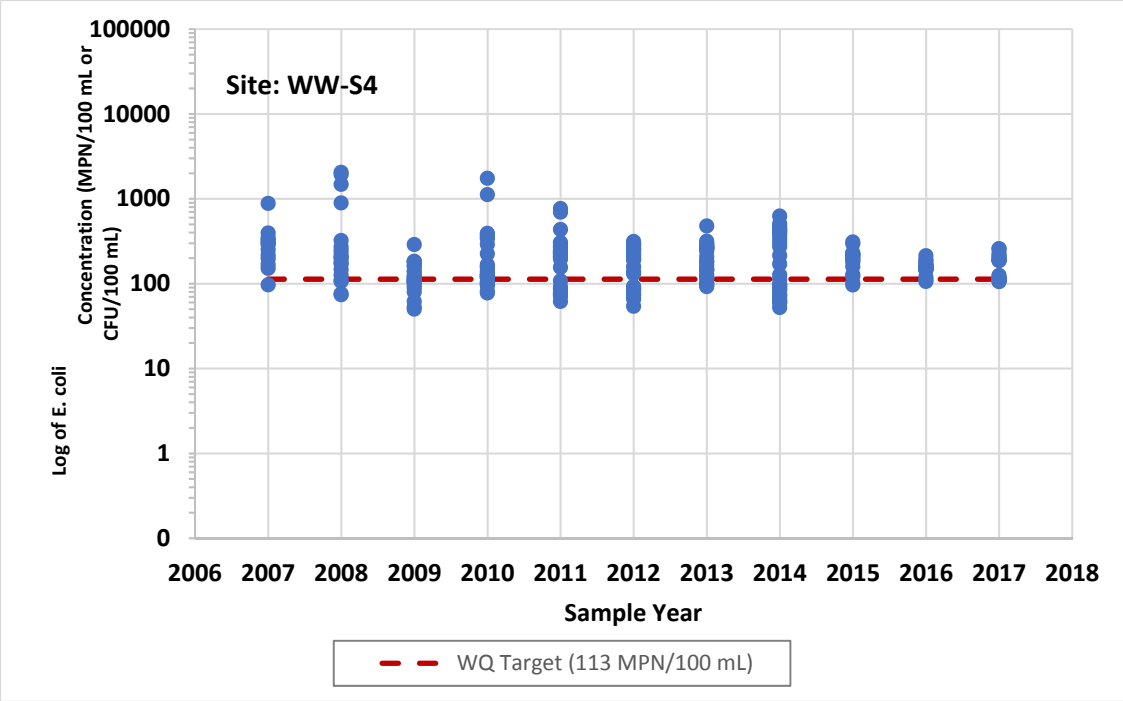

Figure 4-36
Time Series Distribution of *E. coli* Geomean Concentrations at Santa Ana River at Pedley Avenue from 2007 through 2017

4.2.4 Compliance Analysis

The compliance analysis compared the *E. coli* geomeans to the MSAR Bacteria TMDL geomean numeric target of 113 organisms/100 mL for a 5-sample/30-day geomean (see Section 1.2.1). Geometric means were calculated only when at least five sample results were available from the previous 30-day period. All of the Priority 2 sites had geomean exceedances (Table 4-5) with the lowest frequency of 71 percent occurring at SAR at Pedley Avenue (WW-S4). Three sites (Chino Creek, Mill-Cucamonga Creek, and SAR at MWD Crossing) had all geomeans exceeding the TMDL target.

Prado Park Lake (WW-C3) geomeans is shown to have 100 percent exceedance frequency, however this is based only on one geomean. Due to the atypical draining and repair of Prado Park Lake during the beginning of the monitoring season, the sampling location was dry for 18 consecutive weeks during the warm, dry season. Only two samples were collected during the warm, dry season, which is insufficient to calculate a 5-week geomean. Prado Park Lake was successfully sampled during the five weeks in the cool, dry season, which resulted in one 5-week geomean.

Table 4-5 Frequency of Exceedance with MSAR TMDL Numeric Target for *E. coli* During the 2017 Dry Weather Samples (113 MPN/100 mL)

Site ID	Site	Geometric Mean Criterion Exceedance Frequency (%)
WW-C3	Prado Park Lake[1]	100
WW-C7	Chino Creek at Central Avenue	100
WW-M6	Mill-Cucamonga Creek Below Wetlands	100
WW-S1	Santa Ana River Reach 3 at MWD Crossing	100
WW-S4	Santa Ana River Reach 3 at Pedley Avenue	71

[1] Based on one geomean only due to dry conditions for 18 weeks during the monitoring period

4.3 Priority 3

4.3.1 Water Quality Observations

Figures 4-37 through 4-43 summarize water quality field observations at Priority 3 sites (Table 4-6). Key observations are summarized as follows:

- Samples and measurements were not collected from Borrego Creek (P3-OC2) due to dry conditions. As such, Borrego Creek is not included in Figures 4-37 through 4-43.
- Figure 4-37 presents pH measurements. During the cool, wet season pH observations were consistently within the allowable range (6.5 to 8.5). However, during the dry season, pH occasionally exceeded 8.5 s.u.. Fourteen percent of samples from the warm, dry season exceeded 8.5. pH values are generally higher at Peters Canyon Wash (P3-OC7) and San Diego Creek Reaches 1 and 2 (P3-OC8 and P3-OC9, respectively) and are highest at Serrano Creek (P3-OC11).
- Water temperatures generally range from 15 degrees C to 25 degrees C (Figure 4-38). Temperature at Peters Canyon Wash, San Diego Creek Reaches 1 and 2, and Serrano Creek are slightly higher than other sites. Temperatures are highest at SAR Reach 4 (P3-SBC1), with measurements exceeding 27 degrees C.
- Figure 4-39 shows that DO levels at all sites met the WQO for a minimum of 5 mg/L for WARM use. Only Lake Fulmor is designated for COLD that has a WQO of minimum of 6 mg/L. All five DO measurements at Lake Fulmor ranged from 5 to 6 mg/L in the 2017 dry season and therefore did not meet the WQO. DO levels are slightly higher at Peters Canyon Wash, San Diego Creek Reach 2, and Serrano Creek.
- Conductivity ranges from 138 to 8,625 µS/cm at Priority 3 sites (Figure 4-40), with the exception of 6 µS/cm observed at Los Trancos Creek.[25] The lowest conductivity levels were observed at Lake Fulmor (P3-RC2) and conductivity levels at the sites near the coast (Buck Gully Creek [P3-OC3], Los Trancos Creek [P3-OC5], and Morning Canyon Creek [P3-OC6]) are generally higher. At inland sites, conductivity ranges from 138 to 2,547 µS/cm while levels near the coast range from 1,787 to 8,625 µS/cm.

[25] The conductivity measurement at Los Trancos Creek during the week of June 11, 2017 (6 µS/cm) is approximately 3 orders of magnitude lower than measurements from other weeks at that site. This is likely due to a faulty sensor and omitted from analysis.

- Figure 4-41 shows that turbidity levels are generally low with eighty percent of measurements less than 10 NTU, however, 20 percent of the measurements range from 12 to 42 NTU. The higher turbidity levels were all observed at Bolas Chica Channel (P3-OC1), San Diego Creek Reach 1 (P3-OC8), and SAR Reach 2 (P3-OC10) with the highest levels observed at SAR Reach 2.

- Similar to turbidity, Figure 4-42 shows that TSS at Bolsa Chica Channel (P3-OC1), San Diego Creek Reach 1 (P3-OC8), and SAR Reach 2 (P3-OC10) is generally higher than turbidity at the other Priority 3 sites. TSS at Los Trancos Creek (P3-OC5) is also slightly elevated during two of the five monitored weeks.

- Figure 4-43 shows that flow was low at ten of the Priority 3 sites (less than 10 cfs) with six of the sites less than 1 cfs. Flow was not measured at Lake Fulmor (P3-RC2) and shows no data in the figure. Borrego Creek was dry during all monitoring events and is omitted from the figure. Flow at SAR Reach 2 (99 to 118 cfs) and SAR Reach 4 (48 to 110 cfs) were substantially higher than the other sites.

Table 4-6 Priority 3 Monitoring Sites

Site ID	Site Description	County
P3-OC1	Bolsa Chica Channel upstream of Westminster Blvd/Bolsa Chica Rd	Orange
P3-OC2	Borrego Creek upstream of Barranca Parkway	Orange
P3-OC3	Buck Gully Creek Little Corona Beach at Poppy Avenue/Ocean Blvd	Orange
P3-OC5	Los Trancos Creek at Crystal Cove State Park	Orange
P3-OC6	Morning Canyon Creek at Morning Canyon Beach	Orange
P3-OC7	Peters Canyon Wash downstream of Barranca Parkway	Orange
P3-OC8	San Diego Creek downstream of Campus Drive (Reach 1)	Orange
P3-OC9	San Diego Creek at Harvard Avenue (Reach 1)	Orange
P3-0C10	Santa Ana River Reach 2 downstream of Imperial Highway	Orange
P3-OC11	Serrano Creek upstream of Barranca/Alton Parkway	Orange
P3-RC1	Goldenstar Creek at Ridge Canyon Drive	Riverside
P3-RC2	Lake Fulmor at the Lakeside Boardwalk	Riverside
P3-SBC1	Santa Ana River Reach 4 above S. Riverside Avenue Bridge	San Bernardino

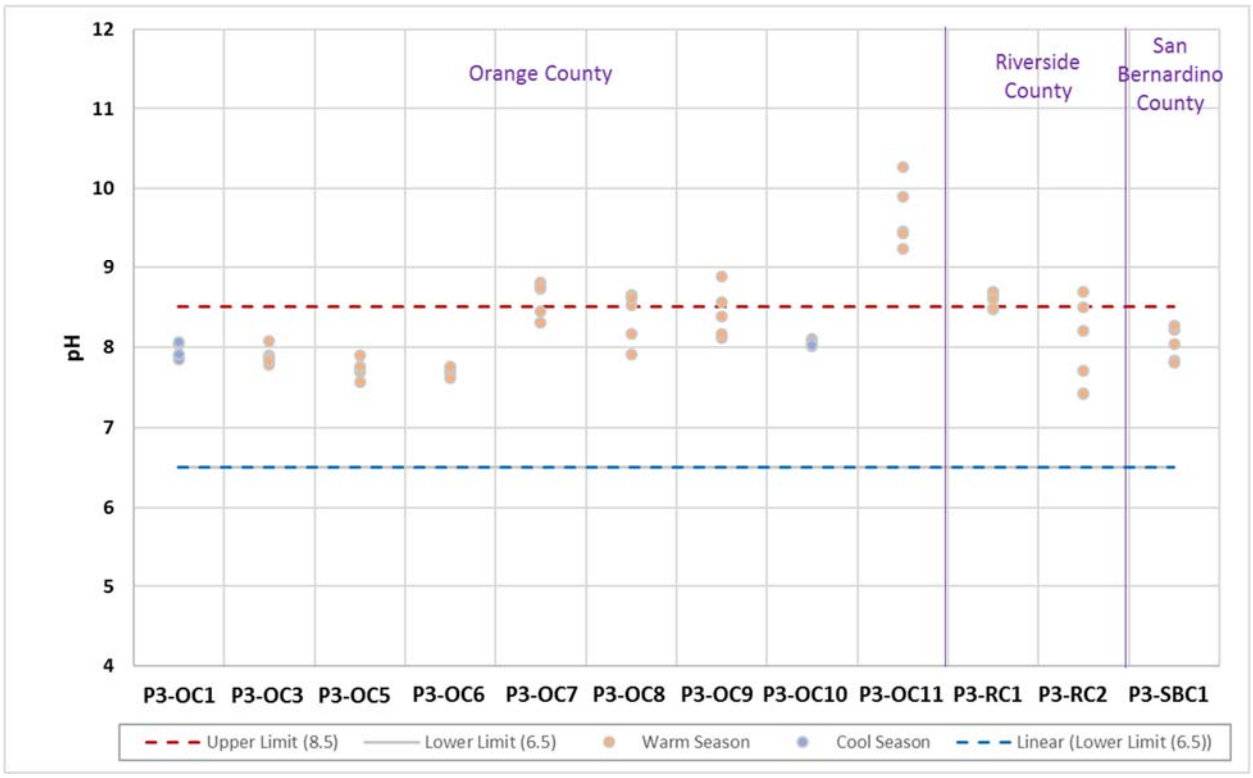

Figure 4-37
Distribution of pH Measurements at Priority 3 Sites

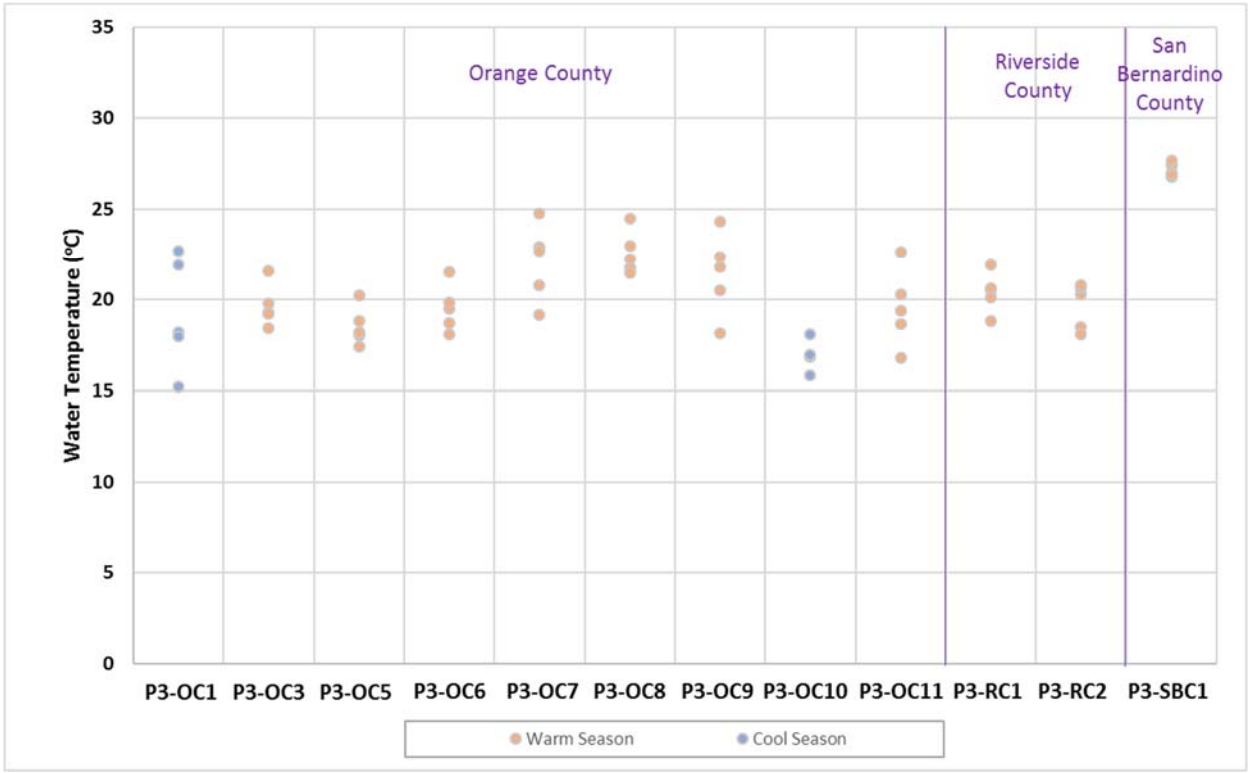

Figure 4-38
Distribution of Water Temperature Measurements at Priority 3 Sites

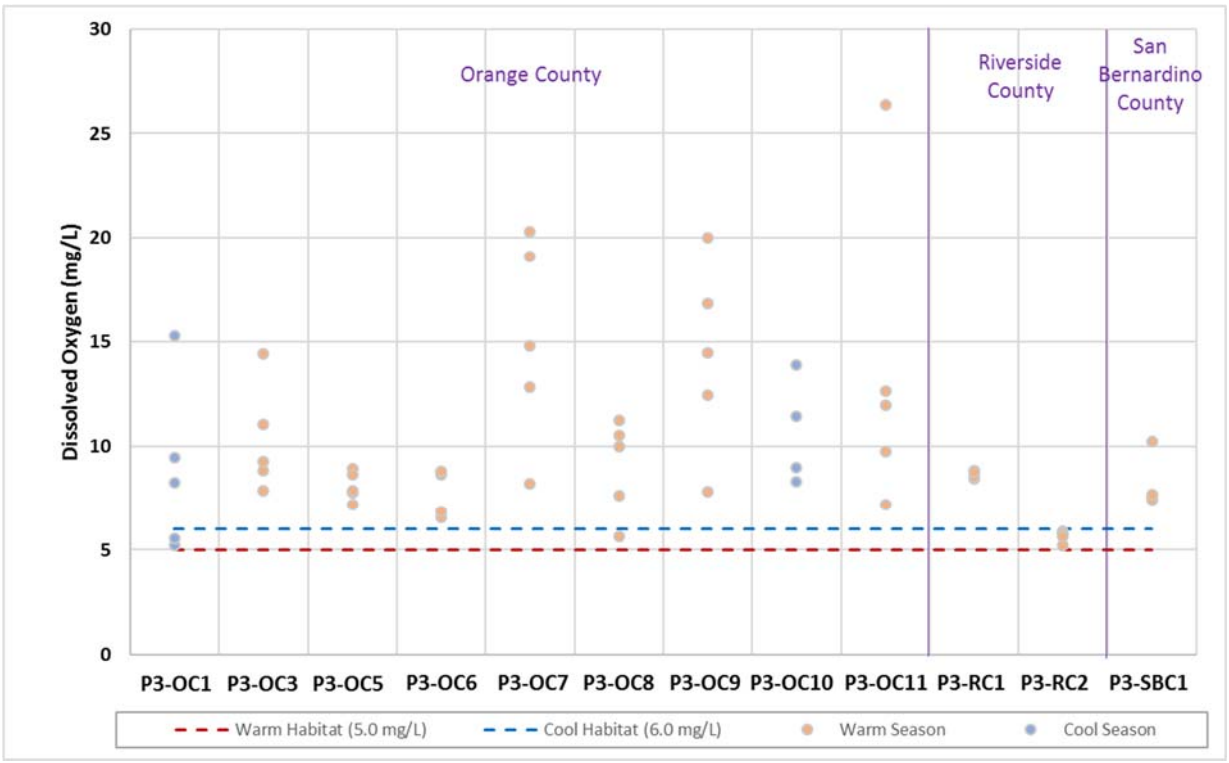

Figure 4-39
Distribution of Dissolved Oxygen Measurements at Priority 3 Sites

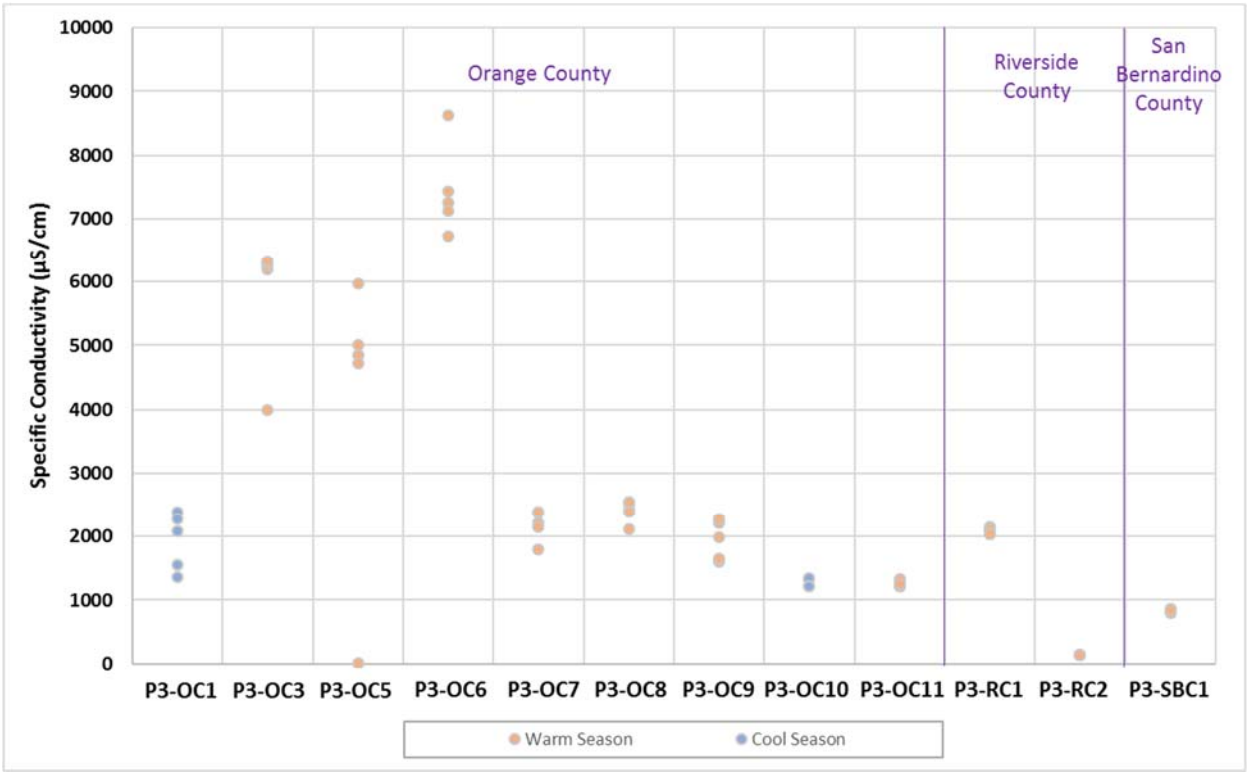

Figure 4-40
Distribution of Specific Conductivity Measurements at Priority 3 Sites

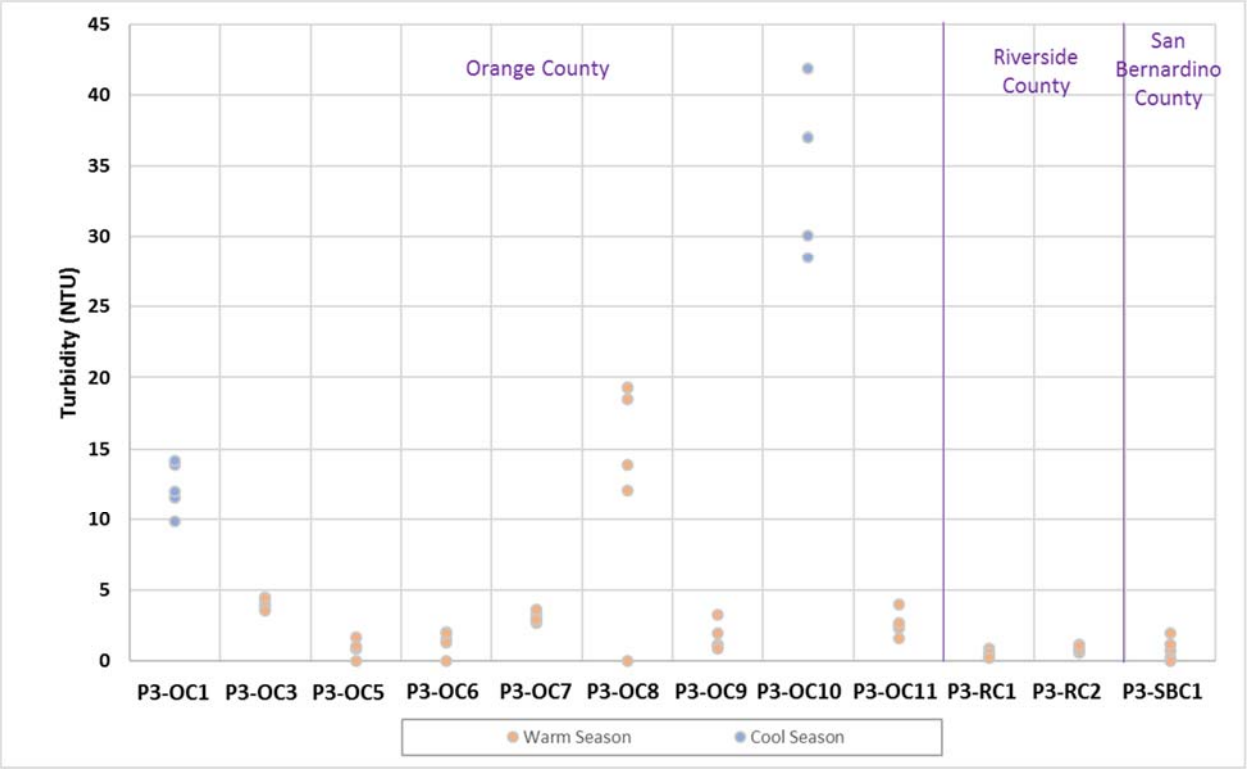

Figure 4-41
Distribution of Turbidity Measurements at Priority 3 Sites

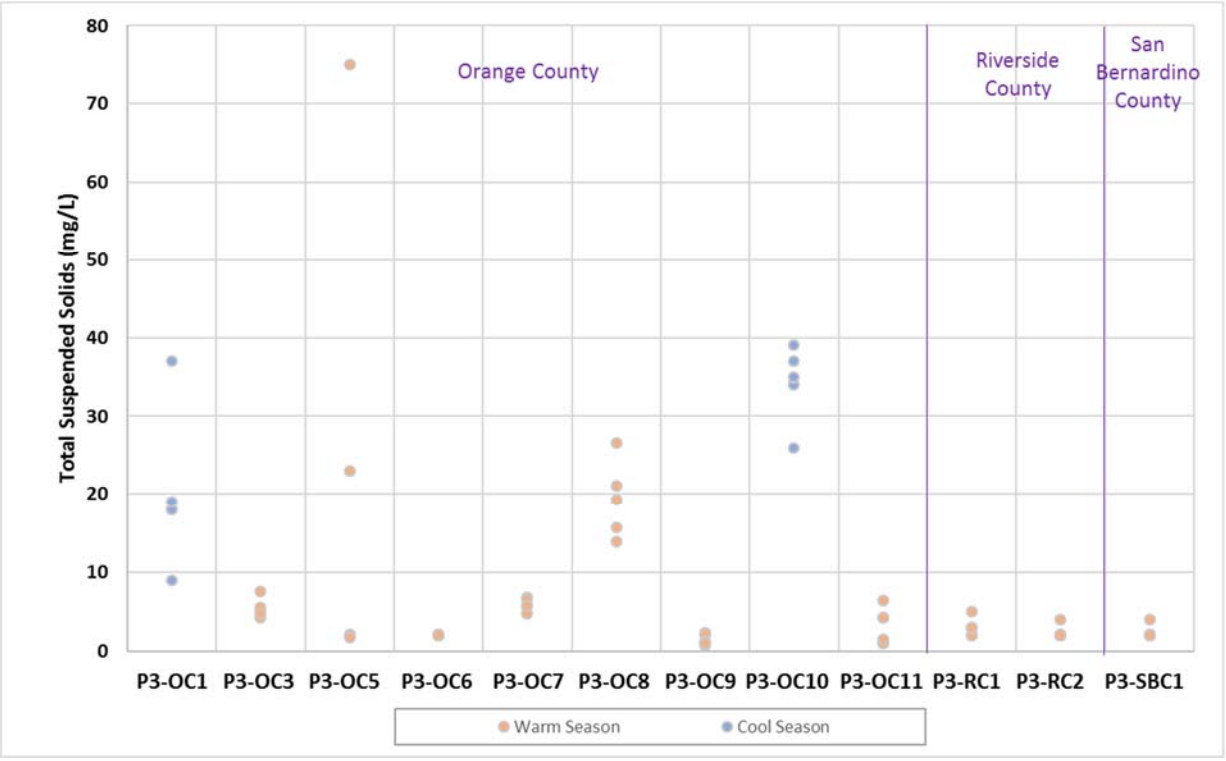

Figure 4-42
Distribution of TSS Measurements at Priority 3 Sites

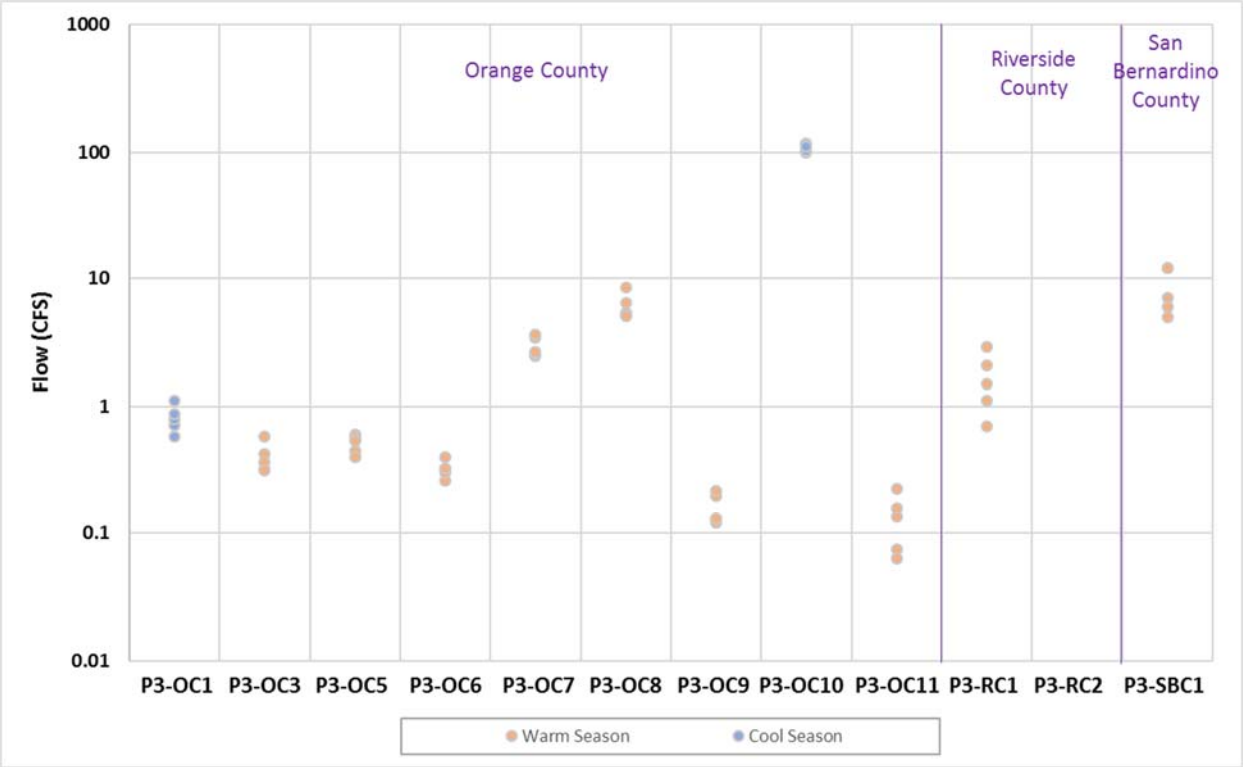

Figure 4-43
Distribution of Flow Measurements at Priority 3 Sites

4.3.2 Bacteria Characterization

Figure 4-44 summarizes the distribution of *E. coli* concentrations observed at Priority 3 sites during dry weather. Figure 4-45 further illustrates the distribution of concentrations. Table 4-7 provides the 5-sample geomean calculated for each site. Key observations are summarized as follows:

- Single sample *E. coli* concentrations from most Priority 3 sites were greater than the Santa Ana Basin Plan geomean WQO of 126 organisms/100 mL. As such, most Priority 3 geomeans exceeded the WQO. The geomean at Buck Gully Creek, San Diego Creek Reach 1, Lake Fulmor, and SAR Reach 4 did not exceed the WQO.
- Concentrations at Morning Canyon Creek (P3-OC6) and Serrano Creek (P3-OC11) are generally greater than concentrations at other Priority 3 sites.
- *E. coli* concentrations at Lake Fulmor (P3-RC2) were particularly low, with four measurements less than 2 MPN/100 mL.
- The highest *E. coli* concentration of 11,199 MPN/100 mL was observed at Bolsa Chica Channel during the week of November 26, 2017 and is significantly greater than the remaining concentrations. This outlier sample was collected during dry weather conditions after the small November storm and caused the Bolsa Chica geomean to be much higher than anticipated.

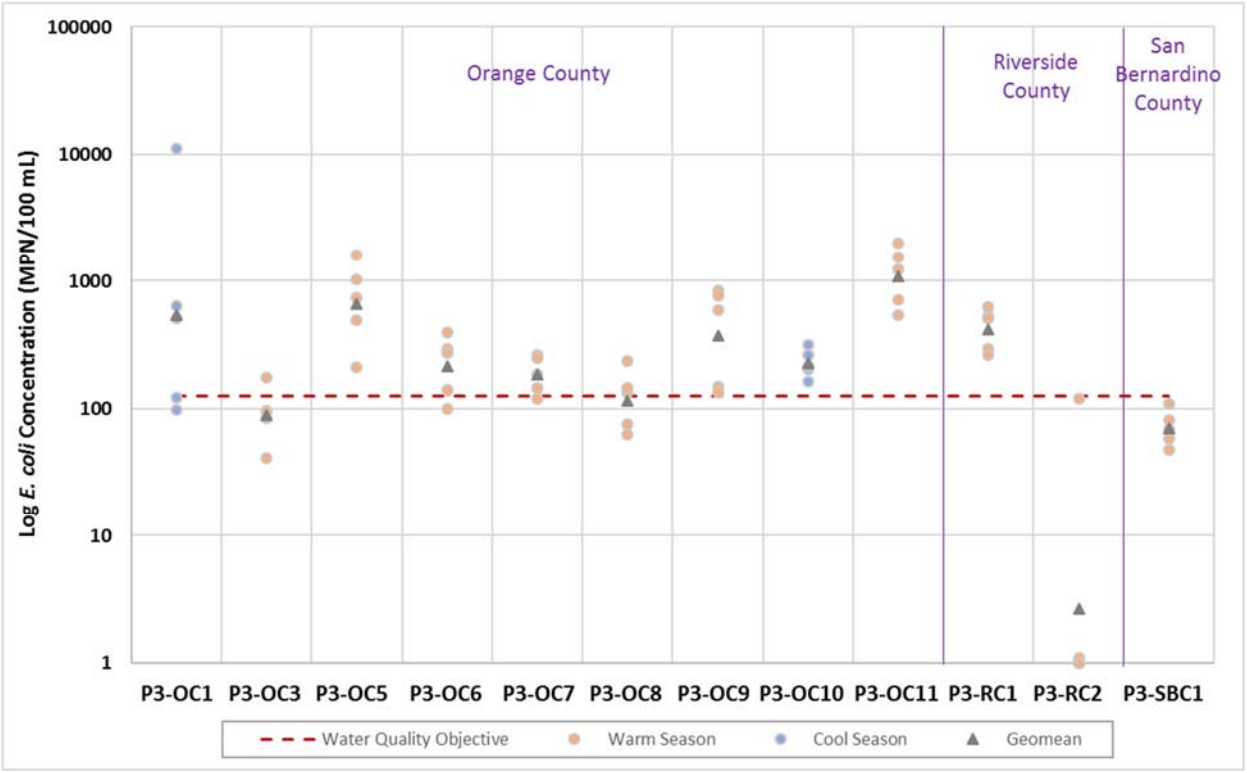

Figure 4-44
Distribution of *E. coli* Concentrations at Priority 3 Sites

Figure 4-45 and Table 4-8 summarize the distribution of historical *E. coli* concentrations from waterbodies monitored under Priority 3 of the RMP. These historical data were used as part of the 303(d) listing process for Priority 3 sites.[26] Note that the historical data are not collected from the same sites as Priority 3 sites in this RMP and that the data reflect results from samples collected from multiple sites within the waterbody. Historical *E. coli* data were not available for Los Trancos Creek, Lake Fulmor, and SAR Reach 4 and are not included in Figure 4-45 and Table 4-8. When compared with 2017 dry weather data, key observations include:

- Borrego Creek (P3-OC2) was dry in 2017; historical data show a three-order magnitude range of *E. coli* concentrations.
- Dry weather *E. coli* geomeans from 2017 are generally lower than historical data at Buck Gully Creek (P3-OC2), Peters Canyon Wash (P3-OC7), San Diego Creek Reaches 1 and 2 (P3-OC8 and P3-OC9, respectively), and Santa Ana River Reach 2 (P3-OC10).
- Dry weather *E. coli* geomeans from 2017 are notably higher than geomeans from 2016 at Bolsa Chica Channel and Serrano Creek. Geomeans from the remaining sites are similar between 2016 and 2017. Higher rates of DWF were recorded at the Bolsa Chica site in November 2017 (~0.8 cfs) compared with May-June 2016 (~0.4 cfs). The differences may be related to seasonality and changes to the relative contributions from groundwater seepage. Alternatively, dramatic fluctuations between 2016 and 2017 could be attributed to

[26] http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/category5_report.shtml

a potential hot spot (e.g. individual property or activity in the watershed). A component of Orange County's stormwater program involves core dry weather monitoring from MS4 facilities, some of which are located upstream of RMP sites. In 2006-2008, flow measurements downstream of the approximately 300-acre drainage area in the headwater subcatchment of the Barber City Channel (Site GGKNOT@BEL) averaged 0.5 cfs and had bacteria concentrations ranging from 500 – 20,000 mpn/100mL fecal coliform. Other core monitoring sites within the Bolsa Chica Channel drainage area generally are dry or involve orders of magnitude lower DWF rates. Additional reconnaissance may be useful to evaluate this potential hot spot during dry weather. Although not apparent from historical data, a similar scenario could explain the dramatic rise in *E. coli* concentration at the Serrano Creek site in 2017.

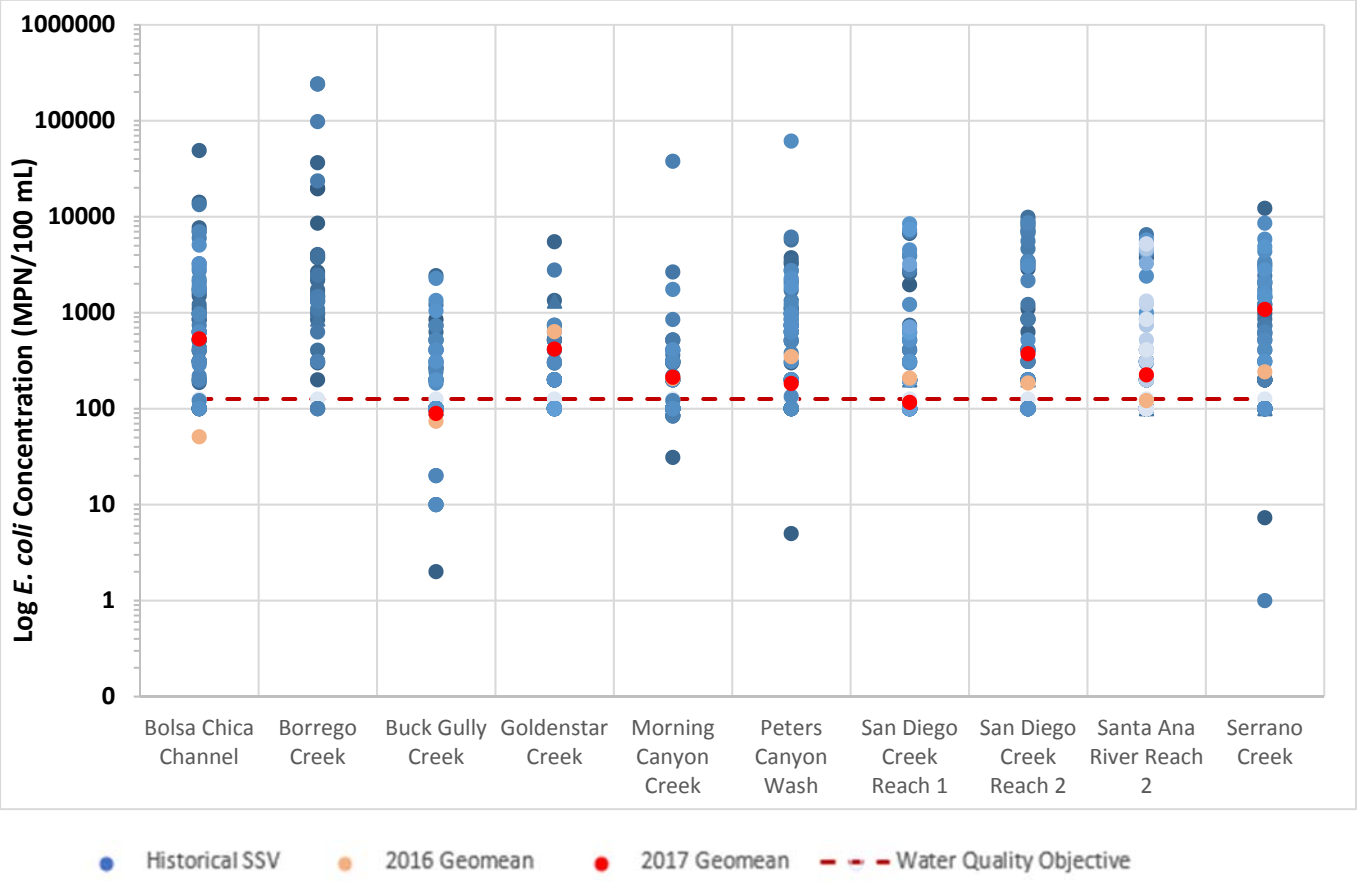

Figure 4-45
Distribution of Historical *E. coli* Concentrations at Priority 3 Waterbodies

Table 4-7 Summary of Historical *E. coli* Concentrations (MPN/100 mL) at Priority 3 Waterbodies

Waterbody	Range of Historical SSV *E. coli* Concentration[1]	Historical Sample Collection Period[3]	Historical Sample Size	2016 Geomean[2]	2017 Geomean[2]
Bolsa Chica Channel	100 – 48,840	03/2004 – 03/2006	65	51	534
Borrego Creek	BDL to 241,920	03/2004 – 03/2006	43	NA (dry)	NA (dry)
Buck Gully Creek	2 – 2,427	03/2004 – 04/2006	68	74	89
Morning Canyon Creek	31 – 37,840	03/2004 – 04/2006	61	633	212
Peters Canyon Wash	BDL – 61,310	03/2004 – 03/2006	66	206	183
San Diego Creek Reach 1	10 – 8,420	10/2002 – 06/2004	84	349	116
San Diego Creek Reach 2	100 – 9,880	10/2002 – 06/2004	64	208	373
Santa Ana River Reach 2	100 – 6,500	10/2002 – 06/2004	150	185	225
Serrano Creek	BDL – 12,230	03/2004 – 03/2006	69	121	1,080
Goldenstar Creek	BDL – 5,480	10/2002 – 06/2004	79	242	417

[1] Historical refers to pre-2016 data collected before the RMP (SSV: single sample value)
[2] Samples used to calculate the geomean are from 5 consecutive weeks monitored during the dry season and are collected from sites that are different than the historical sites
[3] Sample size and range of concentrations from 'historical monitoring' served as the basis for original impairment decisions, which included samples collected year-round and from multiple stations in the same waterbody. No geomean is calculated from the historical data set for comparison with RMP data since the frequency and locations of data are not the same

Results of the *E. coli* geomeans were compared to the Santa Ana Basin Plan WQO of 126 organisms/100 mL for a 5-sample/30-day geomean, described in Section 1.2.1, to assess whether the WQO were attained at these sites. Geometric means were calculated only when at least five sample results were available from the previous 30-day period. As each site was limited to five samples, WQO attainment is assessed based on only one geomean. Eight out of thirteen Priority 3 sites did not meet the WQO (Table 4-8).

Table 4-8 *E. coli* Geometric Means for Priority 3 Sites

Site ID	Site	2016 Geometric Mean (MPN/100 mL)[1]	2017 Geometric Mean (MPN/100 mL)[1]	2017 Compliance with WQO?
P3-OC1	Bolsa Chica Channel	51	534	No
P3-OC2	Borrego Creek	Dry	Dry	Yes
P3-OC3	Buck Gully Creek	74	89	Yes
P3-OC5	Los Trancos Creek	457	658	No
P3-OC6	Morning Canyon Creek	633	212	No
P3-OC7	Peters Canyon Wash	206	183	No
P3-OC8	San Diego Creek Reach 1	349	116	Yes
P3-OC9	San Diego Creek Reach 2	208	373	No
P3-OC10	Santa Ana River Reach 2	185	225	No
P3-OC11	Serrano Creek	121	1080	No
P3-RC1	Goldenstar Creek	242	417	No
P3-RC2	Lake Fulmor	0.9	2.7	Yes
P3-SBC1	Santa Ana River Reach 4	48	70	Yes

[1] Samples used to calculate the geomean are from 5 consecutive weeks during the 2016 and 2017 dry seasons.

4.4 Priority 4

4.4.1 Water Quality Observations

Each Priority 4 site (Table 4-9) is sampled once each year to evaluate compliance with the antidegradation target established for each waterbody. If the bacterial indicator target is exceeded, additional samples are collected as required by the Monitoring Plan (also see discussion Section 3.1.1). Table 4-11 summarizes the water quality observations from each site in 2017.

Table 4-9 Priority 4 Monitoring Sites

Site ID	Site Description	County
P4-RC1	Temescal Creek at Lincoln Avenue	Riverside
P4-OC1	Santa Ana Delhi Channel Upstream of Irvine Avenue	Orange
P4-OC2	Santa Ana Delhi Channel in Tidal Prism	Orange
P4-OC3	Greenville-Banning Channel in Tidal Prism	Orange
P4-SBC1	Cucamonga Creek at Hellman Avenue	San Bernardino

Table 4-10 Summary of Water Quality Data Collected from Priority 4 Sites

Parameter	Santa Ana Delhi Channel (P4-OC1)	Santa Ana Delhi Channel in Tidal Prism (P4-OC2)	Greenville-Banning Channel (P4-OC3)	Temescal Creek at Lincoln Avenue (P4-RC2)	Cucamonga Creek at Hellman Avenue (P4-SBC1)
Sample Date	7/19/2017	7/19/2017	7/19/2017	6/22/2017	6/22/2017
pH	8.36	7.74	8.16	8.65	8.59
Water Temperature (°C)	27.18	26.66	25.5	25.5	18.8
Dissolved Oxygen (mg/L)	13.17	6.11	6.5	5.99	9.71
Conductivity (µS/cm)	2802	17779	50318	1348	902
Turbidity (NTU)	1.87	5.06	5.63	8	1.9
TSS (mg/L)	2.8	7.8	9.7	8	18
Flow (cfs)	3.289	NA	NA	3	2

4.4.2 Bacteria Characterization

Priority 4 water quality sample results were compared to site-specific single sample antidegradation targets (Figure 4-46, Table 4-11). For all sites located in Orange County and Riverside County, indicator bacteria results did not exceed the antidegradation target and monitoring at these four sites was considered complete for the monitoring year. In contrast, results from the sample collected from Cucamonga Creek (P4-SBC1) in San Bernardino County was greater than 2,400 MPN/100 mL, which exceeded the antidegradation target of 1,385 MPN/100 mL. As such, additional sample collection was implemented at Cucamonga Creek per Monitoring Plan requirements. The results of follow up samples are described in Section 4.4.3 below.

Table 4-11 Antidegradation Targets for Priority 4 Sites

Site ID	Site Description	Single Sample Antidegradation Target	Sample Date	Sample Result
P4-OC1	Santa Ana Delhi Channel Upstream of Irvine Avenue	*E. coli*: 1,067 MPN/100 mL	7/19/2017	175
P4-OC2	Santa Ana Delhi Channel in Tidal Prism	*Enterococcus*: 464 MPN/100 mL	7/19/2017	10
P4-OC3	Greenville-Banning Channel in Tidal Prism	*Enterococcus*: 64 MPN/100 mL	7/19/2017	20
P4-RC2	Temescal Creek at Lincoln Avenue	*E. coli*: 725 MPN/100 mL	6/22/2017	26
P4-SBC1	Cucamonga Creek at Hellman Avenue	*E. coli*: 1,385 MPN/100 mL	6/22/2017	> 2,400

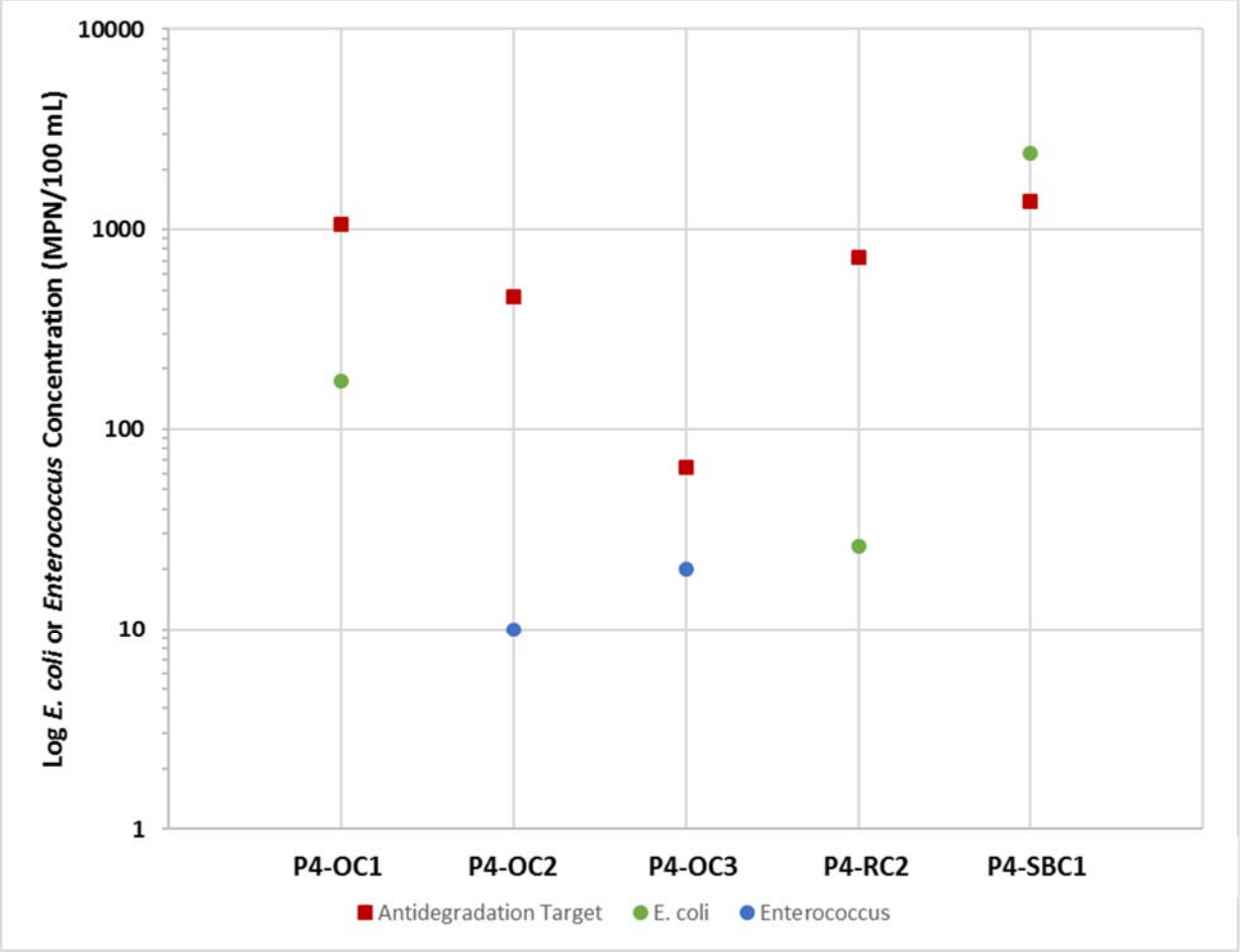

Figure 4-46
Monitoring Results and Antidegradation Targets for Priority 4 Sites

4.4.3 Cucamonga Creek Follow-Up Monitoring

As noted above, the SAR RMP Monitoring Plan requires implementation of a follow-up sampling program if an antidegradation target is exceeded at a Priority 4 site. Following receipt of the Cucamonga Creek results from June 22, 2017, which indicated an exceedance of the antidegradation target, monthly follow-up samples were collected until three consecutive samples did not exceed the antidegradation target, as specified by the Monitoring Plan. Table 4-12 summarizes the *E. coli* results. Additional exceedances of the antidegradation target were observed in the initial three follow up samples. As such, monthly sampling continued through November 2017.

Table 4-12 Monthly Follow-Up Sampling at Cucamonga Creek at Hellman Avenue (Single Sample Antidegradation Target for *E. coli* – 1,385 MPN/100 mL)

Sample Requirement	Sample Date	*E. coli* Concentration (MPN/100 mL)
Original Annual Sample	6/22/2017	> 2400
Required Monthly Follow-up Samples	7/28/2017	2400
	8/31/2017	2000
	9/20/2017	390
	10/31/2017	1100
	11/30/2017	280

4.5 Correlation Analysis

Table 4-13 summarizes the results of correlation analyses between *E. coli* and field parameters for all 2017 dry weather samples. For this dataset the only correlation observed was a weak positive correlation between pH and *E. coli* concentrations. Table 4-14 summarizes the results of correlation analyses between *E. coli* and field parameters from all samples collected from the 2017-2018 storm event. Based on all samples including storm samples, *E. coli* concentrations were not significantly correlated with any of the tested variable which differs from the results presented in the previous year's monitoring report. This analysis will continue to be completed in future iterations of the annual monitoring report to assess what relationships, if any, are consistently seen over time.

Table 4-13 Correlation Analysis Between *E. coli* and Field Parameters for 2017 Dry Weather Samples

Data Subset/Comparison	Pearson's r coefficient	Degrees of freedom (n-2)	Student t-statistic	p-value	Significant?[1]
Conductivity	0.07	364	1.39	0.1645	No
Dissovled Oxygen	-0.01	364	-0.16	0.8698	No
pH	-0.14	364	-2.77	0.0058	Yes+
Total Suspended Solids	-0.02	365	-0.45	0.651	No
Temperature	-0.03	364	-0.55	0.5842	No
Turbidity	-0.05	358	-1.04	0.2748	No

[1]Significance determined by a p-value less than 0.05

Table 4-14 Correlation Analysis Between *E. coli* and Field Parameters for 2017-2018 Wet Weather Samples

Data Subset/Comparison	Pearson's r coefficient	Degrees of freedom (n-2)	Student t-statistic	p-value	Significant?[1]
Conductivity	-0.15	18	-0.63	0.5366	No
Dissolved Oxygen	-0.25	18	-1.10	0.2853	No
pH	-0.17	18	-0.72	0.4808	No
Total Suspended Solids	0.29	18	1.28	0.2168	No
Temperature	0.18	18	0.78	0.4455	No
Turbidity	0.22	18	0.95	0.3547	No

[1] Significance determined by a p-value less than 0.05

4.6 Summary

Key findings from the 2017 dry weather and 2017-2018 storm monitoring are summarized as follows:

- Priority 1: Priority 1 sites, except the two SAR sites with dual designations, were 100 percent compliant with the Basin Plan geomean WQO of 126 MPN/100 mL. For the SAR sites, 100 percent and 53 percent of the geomeans from SAR at MWD Crossing and SAR at Pedley Avenue, respectively, exceeded the WQO.
- Priority 2: *E. coli* geomean concentrations at the Priority 2 sites frequently exceeded the MSAR Bacteria TMDL geomean numeric target of 113 MPN/100 mL. Generally, geomeans were within the range observed in prior years. Given the sharp decline in tertiary treated POTW effluent at these sites, maintaining historical bacteria conditions may indicate some mitigation of tributary sources has been achieved with the implementation of the CBRP.
- Priority 3: One geomean was calculated for each of the Priority 3 sites during the dry season. The geomean of samples collected at eight (out of 13) sites were above the Basin Plan geomean WQO of 126 MPN/100 mL. For the 2017 dry season, Borrego Creek (P3-OC2) was dry, so no data were collected. The four sites with geomeans that met the REC use WQO included San Diego Creek at Campus Drive, Santa Ana River Reach 4, Lake Fulmor, and Buck Gully.
- Priority 4: Indicator bacteria concentrations from all Priority 4 sites except Cucamonga Creek at Hellman Avenue met the site-specific antidegradation targets. The Cucamonga Creek sample (> 2,400 MPN/100 mL) exceeded the single sample antidegradation target (1,385 MPN/100 mL), which led to follow-up samples per Monitoring Plan Requirements. From July 28, 2017, to August 31, 2017, the samples exceeded the antidegradation target, but from September 20, 2017, to November 30, 2017, the samples were below the antidegradation target.

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Section 5
Recommendations for 2018-2019

This section describes recommended updates to the Monitoring Plan for the 2018-2019 monitoring year.

- Santa Ana River (Reach 2) and Fulmor Lake were delisted as impaired for bacteria in the 2014/16 303(d) list. Thus, these waters no longer qualify as Priority 3 and sites P3-OC10 (Santa Ana River Reach 2 downstream of Imperial Highway) and P3-RC2 (Lake Fulmor at the Lakeside Boardwalk) should be eliminated from future sampling activities.

- The current anti-degradation target for Cucamonga Creek is based on data collected in 2004-06 from the Hellman Avenue station downstream of the RP1 discharge. With IEUA's implementation of its recycled water master plan, RP1 discharges of tertiary treated effluent to Cucamonga Creek have declined from near 40 MGD in 2004-06 to approximately 4 MGD in 2015-16. This change represents a new hydrologic condition for the waterbody and warrants a re-computation of the anti-degradation target. As a priority 4 water, sampling frequency for the Cucamonga Creek at Hellman Avenue site is limited to one per dry season (unless the target is triggered and follow up monitoring is required). A larger dataset would be needed to support the development of a revised anti-degradation target for Cucamonga Creek. Thus, it is recommended that sampling frequency be increased at this site for the purpose of developing a new dataset to be used for revision to the anti-degradation target.

- Although not yet finalized, draft statewide bacteria provisions revise the current averaging period for calculation of geomeans (5 samples in 30-day period) to weekly samples collected in six consecutive weeks (see draft at https://www.waterboards.ca.gov/bacterialobjectives/docs/iswebe_bacteria_provisions_revised_proposed.pdf). The current regional bacteria monitoring program for Priority 3 waters involves weekly sampling over five weeks in the dry season. Extending the scheduled weekly monitoring for Priority 3 stations by one week will allow for calculation of geomeans for comparison with the anticipated provisions.

- California's surface water ambient monitoring program (SWAMP) has developed draft standard operating procedures (SOPs) for the collection of microbial samples (see https://mywaterquality.ca.gov/monitoring_council/swim_workgroup/docs/sop_iwscms_052018.pdf.). Once finalized, the QAPP for this RMP should be compared to these SOPs and modifications should be made to be consistent with SWAMP.

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Appendix A
Data Summary

Tables A-1 through A-34 summarize the water quality results obtained for *E. coli*, TSS, and field measurements from Priority 1, Priority 2, and Priority 3 sites during 2017 dry weather sampling activities and 2017-2018 storm event. Data from Priority 4 sites are included in Section 4.4 and are not reproduced in this appendix. Tables A-35 through A-37 summarize the daily mean flow measured at key USGS gages in the SAR watershed.

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Table A-1. *E. coli* (MPN/100 mL) concentrations observed at Priority 1 lake sites during the 2017 dry season (geometric mean based on previous five weekly samples; if reported value has a < or > qualifier, the actual value was used to calculate the geomean)

Week Beginning Date	Canyon Lake (P1-1)		Lake Elsinore (P1-2)		Lake Perris (P1-3)		Big Bear Lake (P1-4)	
	Result	Geomean	Result	Geomean	Result	Geomean	Result	Geomeans
5/7/2017	1	--	11	--	4.1	--	BDL	--
5/14/2017	2	--	6.3	--	110	--	BDL	--
5/21/2017	BDL	--	120	--	BDL	--	3	--
5/28/2017	BDL	--	6.1	--	14	--	BDL	--
6/4/2017	3.1	1.4	8.5	13	BDL	5.8	BDL	1.2
6/11/2017	BDL	1.4	1	8.3	BDL	4.3	BDL	1.2
6/18/2017	BDL	1.3	BDL	5.7	7.4	2.5	BDL	1.2
6/25/2017	1	1.3	2	2.5	5.2	3.5	26	1.9
7/2/2017	2	1.4	3.1	2.2	3	2.6	1	1.9
7/9/2017	BDL	1.1	28	2.8	1	2.6	4.1	2.5
7/16/2017	1	1.1	1	2.8	BDL	2.6	1	2.5
7/23/2017	1	1.1	920	11	1	1.7	45	5.4
7/30/2017	1	1.1	23	18	4.1	1.7	11	4.6
8/6/2017	BDL	1.0	8.4	22	2	1.5	2	5.3
8/13/2017	BDL	1.0	9.8	18	2	1.7	BDL	4.0
8/20/2017	1	1.0	3.1	22	1	1.7	1	4.0
8/27/2017	BDL	1.0	12	9.3	7.4	2.6	BDL	1.9
9/3/2017	1	1.0	29	9.8	170	5.5	1	1.1
9/10/2017	1.1	1.0	2.2	7.5	1.1	4.9	1.1	1.0
9/17/2017	1	1.0	23	8.9	8.5	6.5	2	1.2
10/29/2017	3	--	7.4	--	25	--	8.6	--
11/6/2017	2	--	33	--	36	--	16	--
11/12/2017	1	--	6.3	--	25	--	2	--
11/19/2017	6.3	--	7.3	--	140	--	96	--
11/26/2017	8.6	3.2	16	11	78	48	12	13

Table A-2. *E. coli* (MPN/100 mL) concentrations observed at Priority 1 stream sites during the 2017 dry season (geometric mean based on previous five weekly samples; if reported value has a < or > qualifier, the actual value was used to calculate the geomean)

Week Beginning Date	Mill Creek Reach 2 (P1-5)		Lytle Creek (P1-6)		SAR @ MWD Crossing (WW-S1)		SAR @ Pedley Avenue (WW-S4)	
	Result	Geomean	Result	Geomean	Result	Geomean	Result	Geomean
5/7/2017	BDL	--	1	--	170	--	130	--
5/14/2017	2	--	1	--	210	--	41	--
5/21/2017	1	--	5.2	--	290	--	110	--
5/28/2017	2	--	20	--	130	--	200	--
6/4/2017	5.2	1.8	3.1	3.2	280	207	120	107
6/11/2017	1	1.8	1	3.2	240	221	120	105
6/18/2017	2	1.8	31	6.3	200	219	74	119
6/25/2017	9.6	2.9	15	7.8	210	206	84	112
7/2/2017	8.5	3.9	23	8.0	1900	351	180	110
7/9/2017	BDL	2.8	22	12	160	314	120	110
7/16/2017	9.5	4.3	15	20	180	297	140	113
7/23/2017	5.2	5.3	8.6	16	310	324	120	125
7/30/2017	4.1	4.4	5.2	13	470	380	670	189
8/6/2017	3	3.6	6.3	9.9	240	252	270	205
8/13/2017	23	6.7	7.4	7.9	260	277	190	225
8/20/2017	3.1	5.4	3	5.7	86	239	270	257
8/27/2017	13	6.5	4.1	5.0	660	278	120	257
9/3/2017	2	5.6	11	5.8	680	299	260	212
9/10/2017	16	7.8	3.6	5.1	230	297	160	191
9/17/2017	6.3	6.1	5.2	4.8	170	273	170	187
10/29/2017	17	--	16	--	540	--	390	--
11/6/2017	2	--	1400	--	340	--	190	--
11/12/2017	BDL	--	64	--	260	--	160	--
11/19/2017	BDL	--	59	--	320	--	120	--
11/26/2017	1	2.0	8.6	59	300	341	160	187

Table A-3. *E. coli* (MPN/100 mL) concentrations observed at Priority 2 sites during the 2017 dry season (geometric mean based on previous five weekly samples; if reported value has a < or > qualifier, the actual value was used to calculate the geomean)

Week Beginning Date	Prado Park Lake Outlet (WW-C3)		Chino Creek @ Central Avenue (WW-C7)		Mill-Cucamonga Creek Below Wetlands (WW-M6)		SAR @ MWD Crossing (WW-S1)		SAR @ Pedley Avenue (WW-S4)	
	Result	Geomean	Result	Geomean	Result	Geomean	Result	Geomean	Result	Geomean
5/7/2017	Dry	--	2900	--	220	--	170	--	130	--
5/14/2017	Dry	--	310	--	190	--	210	--	41	--
5/21/2017	Dry	--	160	--	110	--	290	--	110	--
5/28/2017	Dry	--	120	--	150	--	130	--	200	--
6/4/2017	Dry	Dry	960	440	440	198	280	207	120	107
6/11/2017	Dry	Dry	280	276	220	198	240	221	120	105
6/18/2017	Dry	Dry	120	228	720	258	200	219	74	119
6/25/2017	Dry	Dry	120	215	230	299	210	206	84	112
7/2/2017	Dry	Dry	440	279	63	252	1900	351	180	110
7/9/2017	Dry	Dry	200	204	160	206	160	314	120	110
7/16/2017	Dry	Dry	110	169	430	235	180	297	140	113
7/23/2017	Dry	Dry	1100	264	86	154	310	324	120	125
7/30/2017	Dry	Dry	520	354	130	137	470	380	670	189
8/6/2017	Dry	Dry	260	318	190	171	240	252	270	205
8/13/2017	Dry	Dry	110	283	2000	283	260	277	190	225
8/20/2017	Dry	Dry	210	322	230	250	86	239	270	257
8/27/2017	Dry	Dry	97	198	200	296	660	278	120	257
9/3/2017	Dry	Dry	770	214	200	323	680	299	260	212
9/10/2017	690	690	230	209	120	294	230	297	160	191
9/17/2017	85	242	1100	331	1200	266	170	273	170	187
10/29/2017	130	--	240	--	150	--	540	--	390	--
11/6/2017	190	--	500	--	230	--	340	--	190	--
11/12/2017	180	--	160	--	450	--	260	--	160	--
11/19/2017	1100	--	20	--	96	--	320	--	120	--
11/26/2017	370	283	440	176	440	231	300	341	160	187

Table A-4. *E. coli* (MPN/100 mL) concentrations observed at Priority 3 Orange County sites during the 2017 dry season (geometric mean based on previous five weekly samples ["SSV"]; if reported value has a < or > qualifier, the actual value was used to calculate the geomean ["GM"]) (Note: Borrego Creek was dry during all sample events; [1]Units are CFU/100 mL)

Week Beginning Date	Bolsa Chica Channel (P3-OC1)		Buck Gully Creek (P3-OC3)		Los Trancos Creek (P3-OC5) [1]		Morning Canyon Creek (P3-OC6)[1]		Peters Canyon Wash (P3-OC7)		San Diego Creek Reach 1 (P3-OC8)		San Diego Creek Reach 2 (P3-OC9)		SAR Reach 2 (P3-OC10)		Serrano Creek (P3-OC11)	
	SSV	GM	SSV	GM	SSV	GM	SSV	GM	SSV	GM	SSV	GM	SSV	GM	SSV	GM	SSV	GM
5/7/2017	--	--	--	--	--	--	--	--	145	--	233	--	833	--	--	--	1236	--
5/14/2017	--	--	--	--	--	--	--	--	121	--	75	--	146	--	--	--	537	--
5/21/2017	--	--	--	--	--	--	--	--	183	--	134	--	134	--	--	--	1551	--
5/28/2017	--	--	--	--	--	--	--	--	262	--	145	--	586	--	--	--	708	--
6/4/2017	--	--	--	--	--	--	--	--	246	183	63	116	759	373	--	--	2014	1080
6/11/2017	--	--	41	--	1030	--	140	--	--	--	--	--	--	--	--	--	--	--
6/18/2017	--	--	97	--	730	--	290	--	--	--	--	--	--	--	--	--	--	--
6/25/2017	--	--	97	--	1590	--	270	--	--	--	--	--	--	--	--	--	--	--
7/2/2017	--	--	173	--	490	--	99	--	--	--	--	--	--	--	--	--	--	--
7/9/2017	--	--	85	89	210	658	390	212	--	--	--	--	--	--	--	--	--	--
7/16/2017	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7/23/2017	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7/30/2017	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
8/6/2017	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
8/13/2017	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
8/20/2017	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
8/27/2017	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9/3/2017	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9/10/2017	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9/17/2017	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
10/29/2017	122	--	--	--	--	--	--	--	--	--	--	--	--	--	203	--	--	--
11/6/2017	98	--	--	--	--	--	--	--	--	--	--	--	--	--	213	--	--	--
11/12/2017	631	--	--	--	--	--	--	--	--	--	--	--	--	--	262	--	--	--
11/19/2017	512	--	--	--	--	--	--	--	--	--	--	--	--	--	161	--	--	--
11/26/2017	11199	534	--	--	--	--	--	--	--	--	--	--	--	--	313	225	--	--

Table A-5. *E. coli* (MPN/100 mL) concentrations observed at Priority 3 Riverside County and San Bernardino County sites during the 2017 dry season (geometric mean based on previous five weekly samples; if reported value has a < or > qualifier, the actual value was used to calculate the geomean)

Week Beginning Date	SAR Reach 4 (P3-SBC1)		Goldenstar Creek (P3-RC1)		Lake Fulmor (P3-RC2)	
	Result	Geomeans	Result	Geomeans	Result	Geomeans
5/7/2017	--	--	--	--	--	--
5/14/2017	--	--	--	--	--	--
5/21/2017	--	--	--	--	--	--
5/28/2017	--	--	--	--	--	--
6/4/2017	--	--	--	--	--	--
6/11/2017	--	--	--	--	--	--
6/18/2017	--	--	--	--	--	--
6/25/2017	--	--	--	--	--	--
7/2/2017	--	--	--	--	--	--
7/9/2017	--	--	--	--	--	--
7/16/2017	81	--	--	--	--	--
7/23/2017	110	--	--	--	--	--
7/30/2017	58	--	--	--	--	--
8/6/2017	69	--	--	--	--	--
8/13/2017	48	70	--	--	--	--
8/20/2017	--	--	530	--	BDL	--
8/27/2017	--	--	620	--	1	--
9/3/2017	--	--	290	--	120	--
9/10/2017	--	--	510	--	1	--
9/17/2017	--	--	260	417	1	2.7
10/29/2017	--	--	--	--	--	--
11/6/2017	--	--	--	--	--	--
11/12/2017	--	--	--	--	--	--
11/19/2017	--	--	--	--	--	--
11/26/2017	--	--	--	--	--	--

Table A-6. Total suspended solids (mg/L) concentrations observed at Priority 1 sites during the 2017 dry season

Week Beginning Date	Canyon Lake (P1-1)	Lake Elsinore (P1-2)	Lake Perris (P1-3)	Big Bear Lake (P1-4)	Mill Creek Reach 2 (P1-5)	Lytle Creek (P1-6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/7/2017	2	30	2	12	2	BDL	18	18
5/14/2017	BDL	28	10	6	BDL	BDL	11	12
5/21/2017	4	48	2	13	BDL	BDL	10	10
5/28/2017	BDL	35	8	12	BDL	10	10	9
6/4/2017	2	36	2	40	BDL	2	11	10
6/11/2017	2	36	BDL	130	BDL	4	5	6
6/18/2017	2	35	9	18	BDL	BDL	6	11
6/25/2017	2	32	BDL	130	BDL	BDL	8	8
7/2/2017	6	42	23	100	4	BDL	5	10
7/9/2017	6	26	2	160	BDL	BDL	4	8
7/16/2017	BDL	28	20	50	16	BDL	8	8
7/23/2017	BDL	53	3	160	7	BDL	28	8
7/30/2017	2	16	36	64	3	BDL	9	7
8/6/2017	4	16	3	160	4	BDL	10	9
8/13/2017	4	52	BDL	39	BDL	BDL	7	6
8/20/2017	6	31	3	14	2	BDL	17	4
8/27/2017	2	26	2	6	BDL	BDL	5	2
9/3/2017	2	31	BDL	11	BDL	BDL	8	10
9/10/2017	4	29	BDL	6	BDL	BDL	6	6
9/17/2017	2	51	11	32	BDL	BDL	4	2
10/29/2017	7	54	14	3	BDL	2	8	5
11/6/2017	4	44	2	26	4	2	2	2
11/12/2017	4	50	8	22	BDL	BDL	2	2
11/19/2017	5	42	10	76	BDL	BDL	4	2
11/26/2017	4	45	9	30	BDL	BDL	27	6

Table A-7. Total suspended solids (mg/L) concentrations observed at Priority 2 sites during the 2017 dry season

Week Beginning Date	Prado Park Lake Outlet (WW-C3)	Chino Creek @ Central Avenue (WW-C7)	Mill-Cucamonga Creek Below Wetlands (WW-M6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/7/2017	Dry	BDL	9	18	18
5/14/2017	Dry	5	4	11	12
5/21/2017	Dry	2	4	10	10
5/28/2017	Dry	2	2	10	9
6/4/2017	Dry	2	4	11	10
6/11/2017	Dry	4	2	5	6
6/18/2017	Dry	4	2	6	11
6/25/2017	Dry	4	2	8	8
7/2/2017	Dry	4	3	5	10
7/9/2017	Dry	3	6	4	8
7/16/2017	Dry	2	11	8	8
7/23/2017	Dry	5	2	28	8
7/30/2017	Dry	BDL	2	9	7
8/6/2017	Dry	3	4	10	9
8/13/2017	Dry	2	16	7	6
8/20/2017	Dry	2	4	17	4
8/27/2017	Dry	BDL	2	5	2
9/3/2017	Dry	BDL	BDL	8	10
9/10/2017	13	6	BDL	6	6
9/17/2017	10	2	BDL	4	2
10/29/2017	6	BDL	2	8	5
11/6/2017	10	4	6	2	2
11/12/2017	12	2	3	2	2
11/19/2017	12	2	4	4	2
11/26/2017	17	2	3	27	6

Table A-8. Total suspended solids (mg/L) concentrations observed at Priority 3 sites in Orange County during the 2017 dry season

Week Beginning Date	Bolsa Chica Channel (P3-OC1)	Borrego Creek (P3-OC2)	Buck Gully Creek (P3-OC3)	Los Trancos Creek (P3-OC5)	Morning Canyon Creek (P3-OC6)	Peters Canyon Wash (P3-OC7)	San Diego Creek Reach 1 (P3-OC8)	San Diego Creek Reach 1 (P3-OC9)	SAR Reach 2 (P3-OC10)	Serrano Creek (P3-OC11)
5/7/2017	--	Dry	--	--	--	5.6	19.2	2.3	--	1
5/14/2017	--	Dry	--	--	--	4.8	21	2.2	--	1.5
5/21/2017	--	Dry	--	--	--	6.8	13.9	1.3	--	4.2
5/28/2017	--	Dry	--	--	--	6.6	15.7	0.7	--	4.2
6/4/2017	--	Dry	--	--	--	5.8	26.6	1	--	6.4
6/11/2017	--	--	5	75	BDL	--	--	--	--	--
6/18/2017	--	--	4.2	BDL	BDL	--	--	--	--	--
6/25/2017	--	--	7.6	23	BDL	--	--	--	--	--
7/2/2017	--	--	5.5	BDL	BDL	--	--	--	--	--
7/9/2017	--	--	4.8	1.7	BDL	--	--	--	--	--
7/16/2017	--	--	--	--	--	--	--	--	--	--
7/23/2017	--	--	--	--	--	--	--	--	--	--
7/30/2017	--	--	--	--	--	--	--	--	--	--
8/6/2017	--	--	--	--	--	--	--	--	--	--
8/13/2017	--	--	--	--	--	--	--	--	--	--
8/20/2017	--	--	--	--	--	--	--	--	--	--
8/27/2017	--	--	--	--	--	--	--	--	--	--
9/3/2017	--	--	--	--	--	--	--	--	--	--
9/10/2017	--	--	--	--	--	--	--	--	--	--
9/17/2017	--	--	--	--	--	--	--	--	--	--
10/29/2017	9	--	--	--	--	--	--	--	34	--
11/6/2017	18	--	--	--	--	--	--	--	39	--
11/12/2017	18	--	--	--	--	--	--	--	37	--
11/19/2017	37	--	--	--	--	--	--	--	35	--
11/26/2017	19	--	--	--	--	--	--	--	26	--

Table A-9. Total suspended solids (mg/L) concentrations observed at Priority 3 sites in Riverside County and San Bernardino County during the 2017 dry season

Week Beginning Date	SAR Reach 4 (P3-SBC1)	Goldenstar Creek (P3-RC1)	Lake Fulmor (P3-RC2)
5/7/2017	--	--	--
5/14/2017	--	--	--
5/21/2017	--	--	--
5/28/2017	--	--	--
6/4/2017	--	--	--
6/11/2017	--	--	--
6/18/2017	--	--	--
6/25/2017	--	--	--
7/2/2017	--	--	--
7/9/2017	--	--	--
7/16/2017	2	--	--
7/23/2017	2	--	--
7/30/2017	BDL	--	--
8/6/2017	4	--	--
8/13/2017	BDL	--	--
8/20/2017	--	3	4
8/27/2017	--	2	BDL
9/3/2017	--	BDL	BDL
9/10/2017	--	3	2
9/17/2017	--	5	2

Table A-10. Dissolved oxygen (mg/L) concentrations observed at Priority 1 sites during the 2017 dry season

Week Beginning Date	Canyon Lake (P1-1)	Lake Elsinore (P1-2)	Lake Perris (P1-3)	Big Bear Lake (P1-4)	Mill Creek Reach 2 (P1-5)	Lytle Creek (P1-6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/7/2017	8.6	9.0	9.1	8.3	9.5	9.6	8.1	8.1
5/14/2017	8.5	9.3	9.1	9.9	9.1	9.7	8.0	8.0
5/21/2017	13.4	9.3	8.9	9.3	8.5	9.4	8.6	8.3
5/28/2017	8.0	8.1	8.7	8.7	8.8	9.5	8.6	8.3
6/4/2017	8.4	6.7	8.2	8.9	8.3	9.5	8.5	8.2
6/11/2017	9.5	10.6	8.3	10.6	8.5	9.6	8.4	8.1
6/18/2017	10.3	10.0	8.6	9.6	8.1	9.4	7.5	7.0
6/25/2017	9.0	7.5	8.3	9.4	8.4	9.5	8.3	8.1
7/2/2017	9.7	5.3	9.7	10.6	9.5	10.5	9.4	9.1
7/9/2017	9.4	4.9	8.5	9.4	8.0	9.3	7.8	7.6
7/16/2017	8.1	7.1	8.3	7.5	7.8	9.3	7.9	7.5
7/23/2017	8.3	6.7	7.8	8.9	8.0	9.5	8.1	7.9
7/30/2017	11.3	6.1	11.1	11.2	10.0	12.0	7.4	7.3
8/6/2017	8.0	3.2	8.2	10.6	8.1	9.3	8.1	7.7
8/13/2017	8.3	6.3	7.4	9.3	9.0	9.4	8.1	7.9
8/20/2017	9.4	7.5	7.7	8.9	7.9	9.4	8.1	7.9
8/27/2017	8.0	4.2	8.4	7.8	8.0	9.5	8.0	7.6
9/3/2017	7.0	5.0	7.9	7.7	8.2	9.5	8.0	7.7
9/10/2017	6.8	7.0	6.4	8.3	8.9	9.6	8.1	7.7
9/17/2017	6.6	11.4	8.3	9.4	8.7	9.3	8.2	8.1
10/29/2017	5.8	9.1	8.2	8.0	9.5	9.5	8.2	8.2
11/6/2017	4.9	9.3	7.9	8.7	9.0	9.6	8.6	8.4
11/12/2017	4.6	9.7	8.0	9.2	9.3	9.7	8.7	8.6
11/19/2017	5.9	10.1	9.2	8.6	9.4	9.5	9.0	8.8
11/26/2017	5.4	11.1	9.8	8.1	9.9	9.6	8.8	8.8

Table A-11. Dissolved oxygen (mg/L) concentrations observed at Priority 2 sites during the 2017 dry season

Week Beginning Date	Prado Park Lake Outlet (WW-C3)	Chino Creek @ Central Avenue (WW-C7)	Mill-Cucamonga Creek Below Wetlands (WW-M6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/7/2017	Dry	7.3	7.1	8.1	8.1
5/14/2017	Dry	7.3	6.8	8.0	8.0
5/21/2017	Dry	6.3	7.1	8.6	8.3
5/28/2017	Dry	4.9	6.6	8.6	8.3
6/4/2017	Dry	5.3	6.6	8.5	8.2
6/11/2017	Dry	6.2	7.2	8.4	8.1
6/18/2017	Dry	4.8	6.5	7.5	7.0
6/25/2017	Dry	6.5	7.3	8.3	8.1
7/2/2017	Dry	7.2	7.9	9.4	9.1
7/9/2017	Dry	5.0	6.1	7.8	7.6
7/16/2017	Dry	4.7	7.2	7.9	7.5
7/23/2017	Dry	6.1	6.7	8.1	7.9
7/30/2017	Dry	NA	NA	7.4	7.3
8/6/2017	Dry	3.9	6.3	8.1	7.7
8/13/2017	Dry	3.9	6.8	8.1	7.9
8/20/2017	Dry	3.6	6.6	8.1	7.9
8/27/2017	Dry	3.4	6.2	8.0	7.6
9/3/2017	Dry	2.4	5.3	8.0	7.7
9/10/2017	8.8	4.9	7.6	8.1	7.7
9/17/2017	7.1	3.0	6.4	8.2	8.1
10/29/2017	7.3	6.5	7.0	8.2	8.2
11/6/2017	8.3	7.2	7.9	8.6	8.4
11/12/2017	9.5	7.4	8.2	8.7	8.6
11/19/2017	9.6	7.8	8.0	9.0	8.8
11/26/2017	10.3	8.3	8.8	8.8	8.8

Table A-12. Dissolved oxygen (mg/L) concentrations observed at Priority 3 sites in Orange County during the 2017 dry season (Note: Borrego Creek was dry during all sample events)

Week Beginning Date	Bolsa Chica Channel	Buck Gully Creek	Los Trancos Creek	Morning Canyon Creek	Peters Canyon Wash	San Diego Cr. Reach 1	San Diego Cr. Reach 2	SAR Reach 2	Serrano Creek
	(P3-OC1)	(P3-OC3)	(P3-OC5)	(P3-OC6)	(P3-OC7)	(P3-OC8)	(P3-OC9)	(P3-OC10)	(P3-OC11)
5/7/2017	--	--	--	--	14.8	10.5	14.5	--	12.6
5/14/2017	--	--	--	--	20.3	11.3	16.8	--	26.4
5/21/2017	--	--	--	--	19.1	10.0	20.0	--	12.0
5/28/2017	--	--	--	--	12.8	7.6	12.5	--	9.7
6/4/2017	--	--	--	--	8.2	5.7	7.8	--	7.2
6/11/2017	--	11.1	8.9	8.7	--	--	--	--	--
6/18/2017	--	7.9	7.2	6.6	--	--	--	--	--
6/25/2017	--	8.8	8.6	8.8	--	--	--	--	--
7/2/2017	--	9.3	7.8	8.8	--	--	--	--	--
7/9/2017	--	14.4	7.8	6.8	--	--	--	--	--
10/29/2017	5.2	--	--	--	--	--	--	8.3	--
11/6/2017	5.5	--	--	--	--	--	--	9.0	--
11/12/2017	9.5	--	--	--	--	--	--	13.9	--
11/19/2017	15.3	--	--	--	--	--	--	11.5	--
11/26/2017	8.2	--	--	--	--	--	--	NA	--

Table A-13. Dissolved oxygen (mg/L) concentrations observed at Priority 3 sites in Riverside County and San Bernardino County during the 2017 dry season

Week Beginning Date	SAR Reach 4	Goldenstar Creek	Lake Fulmor
	(P3-SBC1)	(P3-RC1)	(P3-RC2)
7/16/2017	7.5	--	--
7/23/2017	7.7	--	--
7/30/2017	10.2	--	--
8/6/2017	7.4	--	--
8/13/2017	7.7	--	--
8/20/2017	--	8.8	5.9
8/27/2017	--	8.4	5.7
9/3/2017	--	8.5	5.2
9/10/2017	--	8.8	5.8
9/17/2017	--	8.8	5.6

Table A-14. pH (standard units) observed at Priority 1 sites during the 2017 dry season

Week Beginning Date	Canyon Lake (P1-1)	Lake Elsinore (P1-2)	Lake Perris (P1-3)	Big Bear Lake (P1-4)	Mill Creek Reach 2 (P1-5)	Lytle Creek (P1-6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/7/2017	8.5	9.0	8.4	8.3	8.3	7.9	8.1	8.1
5/14/2017	8.3	8.8	8.2	8.6	8.9	8.0	8.1	8.2
5/21/2017	9.2	9.2	8.4	8.5	8.3	8.1	8.2	8.2
5/28/2017	8.7	9.1	8.4	8.5	8.1	8.0	8.1	8.2
6/4/2017	8.6	9.1	8.2	8.7	8.1	8.0	8.0	8.1
6/11/2017	8.9	9.2	8.4	9.0	8.2	8.1	8.1	8.2
6/18/2017	9.2	9.1	8.5	8.9	8.1	8.1	8.1	8.2
6/25/2017	9.0	9.0	8.5	9.0	8.1	8.2	8.1	8.3
7/2/2017	8.9	8.8	8.5	9.1	7.9	8.1	8.2	8.3
7/9/2017	9.0	8.8	8.5	9.0	8.2	8.1	8.1	8.2
7/16/2017	8.9	8.9	8.6	8.7	8.3	8.0	8.1	8.2
7/23/2017	8.8	8.9	8.4	9.0	8.2	8.0	8.2	7.9
7/30/2017	9.1	8.6	8.8	8.9	8.1	7.7	8.3	6.8
8/6/2017	9.4	8.5	9.0	9.2	8.5	8.3	8.4	8.2
8/13/2017	9.1	8.6	8.8	8.8	8.6	8.5	8.2	8.1
8/20/2017	9.4	8.9	8.9	9.2	9.1	8.8	8.4	8.2
8/27/2017	9.2	8.8	8.8	8.6	8.6	8.4	8.4	8.2
9/3/2017	9.0	8.7	8.8	8.9	8.7	8.6	8.4	8.2
9/10/2017	8.6	8.9	8.1	8.6	8.6	8.6	8.2	8.2
9/17/2017	8.4	9.0	8.4	8.8	8.8	8.5	8.3	8.5
10/29/2017	9.3	8.8	8.2	8.3	8.7	8.8	8.2	8.2
11/6/2017	9.1	8.2	8.4	8.4	8.7	8.2	8.2	8.1
11/12/2017	9.2	9.1	8.7	8.4	8.8	8.0	8.1	8.0
11/19/2017	10.0	9.1	8.5	8.5	9.3	9.3	8.6	8.5
11/26/2017	8.7	8.7	8.1	8.0	8.4	8.2	8.0	8.3

Table A-15. pH (standard units) observed at Priority 2 sites during the 2017 dry season

Week Beginning Date	Prado Park Lake Outlet	Chino Creek @ Central Avenue	Mill-Cucamonga Creek Below Wetlands	SAR @ MWD Crossing	SAR @ Pedley Avenue
	(WW-C3)	(WW-C7)	(WW-M6)	(WW-S1)	(WW-S4)
5/7/2017	Dry	7.6	7.6	8.1	8.1
5/14/2017	Dry	7.6	7.5	8.1	8.2
5/21/2017	Dry	7.6	7.5	8.2	8.2
5/28/2017	Dry	7.5	7.5	8.1	8.2
6/4/2017	Dry	7.4	7.5	8.0	8.1
6/11/2017	Dry	7.6	7.6	8.1	8.2
6/18/2017	Dry	7.6	7.7	8.1	8.2
6/25/2017	Dry	7.6	7.7	8.1	8.3
7/2/2017	Dry	7.7	7.7	8.2	8.3
7/9/2017	Dry	7.5	7.6	8.1	8.2
7/16/2017	Dry	7.6	7.6	8.1	8.2
7/23/2017	Dry	7.5	7.7	8.2	7.9
7/30/2017	Dry	7.5	7.6	8.3	6.8
8/6/2017	Dry	7.6	7.7	8.4	8.2
8/13/2017	Dry	7.9	7.7	8.2	8.1
8/20/2017	Dry	7.8	7.8	8.4	8.2
8/27/2017	Dry	7.9	7.9	8.4	8.2
9/3/2017	Dry	7.8	7.8	8.4	8.2
9/10/2017	8.0	7.7	7.9	8.2	8.2
9/17/2017	7.8	7.4	7.8	8.3	8.5
10/29/2017	7.6	7.5	7.7	8.2	8.2
11/6/2017	7.9	7.6	7.9	8.2	8.1
11/12/2017	7.9	7.8	7.9	8.1	8.0
11/19/2017	8.1	8.0	8.0	8.6	8.5
11/26/2017	8.0	7.6	7.8	8.0	8.3

Table A-16. pH (standard units) observed at Priority 3 sites in Orange County during the 2017 dry season (Note: Borrego Creek was dry during all sample events)

Week Beginning Date	Bolsa Chica Channel	Buck Gully Creek	Los Trancos Creek	Morning Canyon Creek	Peters Canyon Wash	San Diego Creek Reach 1	San Diego Creek Reach 1	SAR Reach 2	Serrano Creek
	(P3-OC1)	(P3-OC3)	(P3-OC5)	(P3-OC6)	(P3-OC7)	(P3-OC8)	(P3-OC9)	(P3-OC10)	(P3-OC11)
5/7/2017	--	--	--	--	8.3	8.2	8.1	--	9.5
5/14/2017	--	--	--	--	8.7	8.7	8.9	--	10.3
5/21/2017	--	--	--	--	8.5	7.9	8.2	--	9.2
5/28/2017	--	--	--	--	8.8	8.5	8.6	--	9.9
6/4/2017	--	--	--	--	8.7	8.6	8.4	--	9.4
6/11/2017	--	7.8	7.7	7.7	--	--	--	--	--
6/18/2017	--	8.1	7.6	7.7	--	--	--	--	--
6/25/2017	--	7.9	7.9	7.7	--	--	--	--	--
7/2/2017	--	7.9	7.7	7.8	--	--	--	--	--
7/9/2017	--	7.8	7.8	7.6	--	--	--	--	--
10/29/2017	7.9	--	--	--	--	--	--	8.0	--
11/6/2017	7.8	--	--	--	--	--	--	8.1	--
11/12/2017	8.0	--	--	--	--	--	--	8.1	--
11/19/2017	8.1	--	--	--	--	--	--	8.0	--
11/26/2017	7.9	--	--	--	--	--	--	NA	--

Table A-17. pH (standard units) observed at Priority 3 sites in Riverside County and San Bernardino County during the 2017 dry season

Week Beginning Date	SAR Reach 4	Goldenstar Creek	Lake Fulmor
	(P3-SBC1)	(P3-RC1)	(P3-RC2)
7/16/2017	7.8	--	--
7/23/2017	7.8	--	--
7/30/2017	8.0	--	--
8/6/2017	8.2	--	--
8/13/2017	8.3	--	--
8/20/2017	--	8.7	8.7
8/27/2017	--	8.7	8.5
9/3/2017	--	8.6	8.2
9/10/2017	--	8.5	7.4
9/17/2017	--	8.5	7.7

Table A-18. Turbidity (NTU) observed at Priority 1 sites during the 2017 dry season

Week Beginning Date	Canyon Lake (P1-1)	Lake Elsinore (P1-2)	Lake Perris (P1-3)	Big Bear Lake (P1-4)	Mill Creek Reach 2 (P1-5)	Lytle Creek (P1-6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/7/2017	2.3	25	1.5	3.7	1.5	0.3	7.0	8.1
5/14/2017	0.9	28	3.9	5.7	2.3	1.1	2.0	3.2
5/21/2017	1.3	44	1.1	11	5.8	0.2	4.8	5.5
5/28/2017	2.6	36	1.6	5.9	1.8	3.0	4.5	3.3
6/4/2017	0.5	42	0.6	15	0.2	0.3	2.2	1.1
6/11/2017	2.3	49	1.1	83	0.7	0.7	2.9	3.0
6/18/2017	0.3	43	1.8	7.6	1.8	0.5	0.5	2.6
6/25/2017	2.9	31	2.0	83	0.3	0.3	3.4	3.5
7/2/2017	1.1	14	0.4	8.8	0.7	0.1	0.9	1.1
7/9/2017	2.7	25	1.6	53	1.0	0.9	3.4	3.1
7/16/2017	1.8	28	4.7	17	12	0.0	3.2	2.6
7/23/2017	0.3	24	2.5	40	0.4	0.1	7.4	2.9
7/30/2017	NA	NA	NA	28	0.4	0.5	7.2	4.4
8/6/2017	2.2	25	2.2	97	0.5	0.4	3.4	3.1
8/13/2017	4.0	101	1.4	16	1.2	0.6	3.0	2.6
8/20/2017	0.5	31	0.1	6.1	1.3	0.3	0.8	0.4
8/27/2017	2.3	36	4.1	5.0	1.4	0.5	3.5	2.1
9/3/2017	2.2	62	2.3	7.8	0.6	0.1	4.7	3.5
9/10/2017	1.6	49	1.6	7.6	0.1	0.1	1.8	1.4
9/17/2017	1.9	84	4.0	11	0.1	0.2	2.5	1.7
10/29/2017	3.0	72	1.7	5.7	1.3	0.7	2.9	2.4
11/6/2017	2.8	74	2.0	9.3	0.6	0.4	2.0	1.5
11/12/2017	2.9	61	0.8	9.1	0.4	0.1	1.6	1.2
11/19/2017	2.2	55	1.8	30	0.5	0.2	1.8	1.3
11/26/2017	2.3	57	2.9	13	0.6	0.4	6.4	1.5

Table A-19. Turbidity (NTU) observed at Priority 2 sites during the 2017 dry season

Week Beginning Date	Prado Park Lake Outlet	Chino Creek @ Central Avenue	Mill-Cucamonga Creek Below Wetlands	SAR @ MWD Crossing	SAR @ Pedley Avenue
	(WW-C3)	(WW-C7)	(WW-M6)	(WW-S1)	(WW-S4)
5/7/2017	Dry	2.0	5.2	7.0	8.1
5/14/2017	Dry	1.8	2.0	2.0	3.2
5/21/2017	Dry	0.4	3.1	4.8	5.5
5/28/2017	Dry	0.9	0.7	4.5	3.3
6/4/2017	Dry	0.4	1.6	2.2	1.1
6/11/2017	Dry	2.3	1.6	2.9	3.0
6/18/2017	Dry	0.5	0.9	0.5	2.6
6/25/2017	Dry	1.4	0.4	3.4	3.5
7/2/2017	Dry	0.4	0.3	0.9	1.1
7/9/2017	Dry	2.4	2.7	3.4	3.1
7/16/2017	Dry	1.5	8.9	3.2	2.6
7/23/2017	Dry	2.0	2.5	7.4	2.9
7/30/2017	Dry	2.5	0.5	7.2	4.4
8/6/2017	Dry	1.9	0.4	3.4	3.1
8/13/2017	Dry	1.5	6.7	3.0	2.6
8/20/2017	Dry	0.8	1.0	0.8	0.4
8/27/2017	Dry	2.8	2.5	3.5	2.1
9/3/2017	Dry	1.9	0.9	4.7	3.5
9/10/2017	6.0	1.6	0.3	1.8	1.4
9/17/2017	5.3	1.3	0.2	2.5	1.7
10/29/2017	5.0	1.0	1.0	2.9	2.4
11/6/2017	3.1	1.2	1.5	2.0	1.5
11/12/2017	4.2	0.9	1.8	1.6	1.2
11/19/2017	4.9	0.7	1.5	1.8	1.3
11/26/2017	6.9	1.0	0.6	6.4	1.5

Table A-20. Turbidity (NTU) observed at Priority 3 sites in Orange County during the 2017 dry season (Note: Borrego Creek was dry during all sample events)

Week Beginning Date	Bolsa Chica Channel (P3-OC1)	Buck Gully Creek (P3-OC3)	Los Trancos Creek (P3-OC5)	Morning Canyon Creek (P3-OC6)	Peters Canyon Wash (P3-OC7)	San Diego Cr. Reach 1 (P3-OC8)	San Diego Cr. Reach 2 (P3-OC9)	SAR Reach 2 (P3-OC10)	Serrano Creek (P3-OC11)
5/7/2017	--	--	--	--	2.9	NA	3.3	--	2.5
5/14/2017	--	--	--	--	2.7	19	2.0	--	1.6
5/21/2017	--	--	--	--	3.3	14	1.2	--	2.3
5/28/2017	--	--	--	--	3.6	12	1.1	--	4.0
6/4/2017	--	--	--	--	2.9	19	0.9	--	2.7
6/11/2017	--	4.1	NA	NA	--	--	--	--	--
6/18/2017	--	4.5	1.6	1.5	--	--	--	--	--
6/25/2017	--	4.4	0.9	2.1	--	--	--	--	--
7/2/2017	--	3.8	0.9	1.3	--	--	--	--	--
7/9/2017	--	3.6	1.0	1.9	--	--	--	--	--
10/29/2017	9.8	--	--	--	--	--	--	42	--
11/6/2017	14	--	--	--	--	--	--	37	--
11/12/2017	12	--	--	--	--	--	--	30	--
11/19/2017	14	--	--	--	--	--	--	29	--
11/26/2017	12	--	--	--	--	--	--	NA	--

Table A-21. Turbidity (NTU) observed at Priority 3 sites in Riverside County and San Bernardino County during the 2017 dry season

Week Beginning Date	SAR Reach 4	Goldenstar Creek	Lake Fulmor
	(P3-SBC1)	(P3-RC1)	(P3-RC2)
7/16/2017	0.7	--	--
7/23/2017	0.2	--	--
7/30/2017	NA	--	--
8/6/2017	1.2	--	--
8/13/2017	2.0	--	--
8/20/2017	--	0.4	0.6
8/27/2017	--	0.9	0.9
9/3/2017	--	0.6	1.2
9/10/2017	--	0.2	0.8
9/17/2017	--	0.2	1.1

Table A-22. Water temperature (°C) concentrations observed at Priority 1 sites during the 2017 dry season

Week Beginning Date	Canyon Lake (P1-1)	Lake Elsinore (P1-2)	Lake Perris (P1-3)	Big Bear Lake (P1-4)	Mill Creek Reach 2 (P1-5)	Lytle Creek (P1-6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/7/2017	21.9	21.3	21.1	14.1	9.8	12.1	25.0	24.4
5/14/2017	20.7	20.2	19.9	13.9	12.2	12.1	25.5	23.9
5/21/2017	23.4	21.5	20.3	19.6	15.4	13.0	21.5	21.9
5/28/2017	23.6	22.7	21.1	17.6	13.2	12.7	19.8	21.3
6/4/2017	25.3	24.5	23.3	19.5	16.0	12.7	21.1	22.1
6/11/2017	25.0	24.1	23.5	19.0	14.6	12.5	23.5	24.2
6/18/2017	28.3	27.7	27.4	20.9	16.6	13.1	29.7	30.8
6/25/2017	26.5	26.0	25.6	18.1	15.4	13.2	23.7	24.0
7/2/2017	27.1	25.8	25.5	23.6	16.2	14.2	25.1	25.7
7/9/2017	28.8	26.8	26.2	21.5	18.4	13.8	26.9	26.9
7/16/2017	28.4	27.1	27.0	23.6	20.0	14.7	25.7	27.1
7/23/2017	28.7	26.9	27.1	21.5	18.0	13.2	24.7	25.4
7/30/2017	28.6	27.8	27.9	21.9	18.7	13.3	24.7	25.9
8/6/2017	28.3	26.8	27.0	21.1	16.7	13.3	23.3	24.1
8/13/2017	27.0	24.6	26.3	19.5	12.0	13.5	23.5	23.9
8/20/2017	26.9	25.5	25.7	21.3	18.5	13.6	23.6	24.2
8/27/2017	28.0	26.2	26.6	19.9	18.8	14.2	24.9	26.1
9/3/2017	27.6	25.9	25.8	19.5	16.5	13.4	23.3	24.2
9/10/2017	26.0	25.0	25.3	16.0	14.0	13.2	23.9	26.1
9/17/2017	23.6	23.1	23.1	13.0	13.9	13.5	22.0	22.5
10/29/2017	19.7	19.4	19.9	10.4	10.8	12.5	20.5	20.9
11/6/2017	19.0	17.5	19.0	10.0	12.5	12.4	19.6	20.7
11/12/2017	17.8	16.5	18.5	8.6	11.5	12.8	19.1	19.5
11/19/2017	18.2	16.2	18.5	8.9	10.8	12.3	18.0	19.0
11/26/2017	17.5	16.9	18.2	6.0	9.0	11.8	18.6	19.7

Table A-23. Water temperature (°C) concentrations observed at Priority 2 sites during the 2017 dry season

Week Beginning Date	Prado Park Lake Outlet (WW-C3)	Chino Creek @ Central Avenue (WW-C7)	Mill-Cucamonga Creek Below Wetlands (WW-M6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/7/2017	Dry	17.8	18.9	25.0	24.4
5/14/2017	Dry	17.3	18.4	25.5	23.9
5/21/2017	Dry	19.5	19.9	21.5	21.9
5/28/2017	Dry	20.5	20.3	19.8	21.3
6/4/2017	Dry	21.0	21.8	21.1	22.1
6/11/2017	Dry	19.1	19.3	23.5	24.2
6/18/2017	Dry	22.2	22.5	29.7	30.8
6/25/2017	Dry	20.3	20.3	23.7	24.0
7/2/2017	Dry	21.9	21.5	25.1	25.7
7/9/2017	Dry	22.5	22.7	26.9	26.9
7/16/2017	Dry	23.1	22.3	25.7	27.1
7/23/2017	Dry	21.7	21.5	24.7	25.4
7/30/2017	Dry	22.7	23.1	24.7	25.9
8/6/2017	Dry	22.3	21.3	23.3	24.1
8/13/2017	Dry	21.1	21.9	23.5	23.9
8/20/2017	Dry	22.2	21.7	23.6	24.2
8/27/2017	Dry	24.7	24.1	24.9	26.1
9/3/2017	Dry	23.8	22.4	23.3	24.2
9/10/2017	25.6	21.7	22.0	23.9	26.1
9/17/2017	23.2	21.4	20.5	22.0	22.5
10/29/2017	19.8	19.1	18.6	20.5	20.9
11/6/2017	19.3	16.8	17.0	19.6	20.7
11/12/2017	17.6	17.1	16.4	19.1	19.5
11/19/2017	17.1	16.1	15.3	18.0	19.0
11/26/2017	16.7	15.7	14.5	18.6	19.7

Table A-24. Water temperature (°C) concentrations observed at Priority 3 sites in Orange County during the 2017 dry season (Note: Borrego Creek was dry during all sample events)

Week Beginning Date	Bolsa Chica Channel	Buck Gully Creek	Los Trancos Creek	Morning Canyon Creek	Peters Canyon Wash	San Diego Cr. Reach 1	San Diego Cr. Reach 2	SAR Reach 2	Serrano Creek
	(P3-OC1)	(P3-OC3)	(P3-OC5)	(P3-OC6)	(P3-OC7)	(P3-OC8)	(P3-OC9)	(P3-OC10)	(P3-OC11)
5/7/2017	--	--	--	--	20.8	21.7	20.5	--	18.6
5/14/2017	--	--	--	--	19.2	21.5	18.2	--	16.8
5/21/2017	--	--	--	--	24.8	24.5	24.4	--	22.6
5/28/2017	--	--	--	--	22.9	22.3	22.3	--	19.4
6/4/2017	--	--	--	--	22.7	23.0	21.8	--	20.3
6/11/2017	--	19.3	17.4	18.1	--	--	--	--	--
6/18/2017	--	19.2	18.0	18.7	--	--	--	--	--
6/25/2017	--	18.4	18.8	19.5	--	--	--	--	--
7/2/2017	--	19.8	18.2	19.8	--	--	--	--	--
7/9/2017	--	21.6	20.2	21.5	--	--	--	--	--
10/29/2017	18.2	--	--	--	--	--	--	18.1	--
11/6/2017	18.0	--	--	--	--	--	--	16.8	--
11/12/2017	21.9	--	--	--	--	--	--	17.0	--
11/19/2017	22.7	--	--	--	--	--	--	15.9	--
11/26/2017	15.2	--	--	--	--	--	--	NA	--

Table A-25. Water temperature (°C) concentrations observed at Priority 3 sites in Riverside County and San Bernardino County during the 2017 dry season

Week Beginning Date	SAR Reach 4	Goldenstar Creek	Lake Fulmor
	(P3-SBC1)	(P3-RC1)	(P3-RC2)
7/16/2017	26.8	--	--
7/23/2017	27.4	--	--
7/30/2017	27.7	--	--
8/6/2017	27.0	--	--
8/13/2017	26.9	--	--
8/20/2017	--	20.5	20.3
8/27/2017	--	21.9	20.6
9/3/2017	--	20.6	20.8
9/10/2017	--	20.1	18.5
9/17/2017	--	18.8	18.1

Table A-26. Conductivity (µS/cm) observed at Priority 1 sites during the 2017 dry season

Week Beginning Date	Canyon Lake (P1-1)	Lake Elsinore (P1-2)	Lake Perris (P1-3)	Big Bear Lake (P1-4)	Mill Creek Reach 2 (P1-5)	Lytle Creek (P1-6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/7/2017	625	3573	608	419	187	266	1056	1046
5/14/2017	642	3630	603	429	191	269	1084	1054
5/21/2017	638	3665	591	436	193	270	1111	1060
5/28/2017	661	3691	594	426	192	270	1096	1074
6/4/2017	673	3751	606	427	195	270	1054	1079
6/11/2017	675	3721	595	422	193	269	1125	1075
6/18/2017	688	3755	601	422	173	268	1103	1081
6/25/2017	688	3779	595	421	195	269	1119	1067
7/2/2017	648	3623	570	412	191	266	1080	858
7/9/2017	696	3897	605	437	197	273	1075	1094
7/16/2017	700	3855	596	430	209	274	1069	1068
7/23/2017	701	3914	601	429	197	266	1105	1067
7/30/2017	683	3723	563	412	187	266	1079	1028
8/6/2017	729	3969	580	419	191	271	1067	1061
8/13/2017	726	3298	594	432	189	274	1052	1068
8/20/2017	719	4028	588	423	188	272	1068	1055
8/27/2017	737	4053	588	437	187	276	1080	1078
9/3/2017	738	4053	587	433	184	272	1056	1040
9/10/2017	740	4062	566	423	177	267	1025	1020
9/17/2017	750	4138	573	428	178	271	1045	1055
10/29/2017	782	4188	551	452	171	273	971	1016
11/6/2017	782	4184	549	464	166	270	1022	1042
11/12/2017	789	4221	551	463	167	272	1004	1023
11/19/2017	798	4237	553	479	167	273	1057	1051
11/26/2017	793	4179	544	475	164	269	1044	1040

Table A-27. Conductivity (µS/cm) observed at Priority 2 sites during the 2017 dry season

Week Beginning Date	Prado Park Lake Outlet	Chino Creek @ Central Avenue	Mill-Cucamonga Creek Below Wetlands	SAR @ MWD Crossing	SAR @ Pedley Avenue
	(WW-C3)	(WW-C7)	(WW-M6)	(WW-S1)	(WW-S4)
5/7/2017	Dry	1115	1077	1056	1046
5/14/2017	Dry	1103	1726	1084	1054
5/21/2017	Dry	1105	1670	1111	1060
5/28/2017	Dry	1132	1850	1096	1074
6/4/2017	Dry	1178	1346	1054	1079
6/11/2017	Dry	1063	1954	1125	1075
6/18/2017	Dry	1117	1943	1103	1081
6/25/2017	Dry	1060	2245	1119	1067
7/2/2017	Dry	864	1872	1080	858
7/9/2017	Dry	1026	1960	1075	1094
7/16/2017	Dry	1010	845	1069	1068
7/23/2017	Dry	1051	1571	1105	1067
7/30/2017	Dry	1122	1326	1079	1028
8/6/2017	Dry	1241	1637	1067	1061
8/13/2017	Dry	1258	945	1052	1068
8/20/2017	Dry	1273	1007	1068	1055
8/27/2017	Dry	1251	857	1080	1078
9/3/2017	Dry	1211	1254	1056	1040
9/10/2017	1119	1153	1606	1025	1020
9/17/2017	1325	1145	1336	1045	1055
10/29/2017	957	976	1097	971	1016
11/6/2017	1203	996	968	1022	1042
11/12/2017	942	971	985	1004	1023
11/19/2017	940	970	1006	1057	1051
11/26/2017	924	1006	1013	1044	1040

Table A-28. Conductivity (µS/cm) observed at Priority 3 sites in Orange County during the 2017 dry season (Note: Borrego Creek was dry during all sample events)

Week Beginning Date	Bolsa Chica Channel	Buck Gully Creek	Los Trancos Creek	Morning Canyon Creek	Peters Canyon Wash	San Diego Creek Reach 1	San Diego Creek Reach 1	SAR Reach 2	Serrano Creek
	(P3-OC1)	(P3-OC3)	(P3-OC5)	(P3-OC6)	(P3-OC7)	(P3-OC8)	(P3-OC9)	(P3-OC10)	(P3-OC11)
5/7/2017	--	--	--	--	2205	2515	1595	--	1219
5/14/2017	--	--	--	--	1787	2416	1653	--	1214
5/21/2017	--	--	--	--	2372	2547	2204	--	1303
5/28/2017	--	--	--	--	2395	2108	2280	--	1330
6/4/2017	--	--	--	--	2141	2388	1988	--	1252
6/11/2017	--	6196	5.9	7261	--	--	--	--	--
6/18/2017	--	6263	5001	8625	--	--	--	--	--
6/25/2017	--	3987	5973	7124	--	--	--	--	--
7/2/2017	--	6311	4841	6731	--	--	--	--	--
7/9/2017	--	6331	4714	7430	--	--	--	--	--
10/29/2017	1551	--	--	--	--	--	--	1324	--
11/6/2017	2394	--	--	--	--	--	--	1336	--
11/12/2017	1358	--	--	--	--	--	--	1216	--
11/19/2017	2270	--	--	--	--	--	--	1211	--
11/26/2017	2084	--	--	--	--	--	--	NA	--

Table A-29. Conductivity (µS/cm) observed at Priority 3 sites in Riverside County and San Bernardino County during the 2017 dry season

Week Beginning Date	SAR Reach 4 (P3-SBC1)	Goldenstar Creek (P3-RC1)	Lake Fulmor (P3-RC2)
7/16/2017	841	--	--
7/23/2017	855	--	--
7/30/2017	796	--	--
8/6/2017	847	--	--
8/13/2017	848	--	--
8/20/2017	--	2069	140
8/27/2017	--	2145	138
9/3/2017	--	2122	139
9/10/2017	--	2031	138
9/17/2017	--	2034	145

Table A-30. Flow (cfs) observed at Priority 1 sites during the 2017 dry season

Week Beginning Date	Canyon Lake (P1-1)	Lake Elsinore (P1-2)	Lake Perris (P1-3)	Big Bear Lake (P1-4)	Mill Creek Reach 2 (P1-5)	Lytle Creek (P1-6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/7/2017	--	--	--	--	57	14	41	91
5/14/2017	--	--	--	--	14	11	48	120
5/21/2017	--	--	--	--	24	13	52	165
5/28/2017	--	--	--	--	22	15	19	94
6/4/2017	--	--	--	--	39	13	55	11
6/11/2017	--	--	--	--	20	13	41	123
6/18/2017	--	--	--	--	11	10	45	140
6/25/2017	--	--	--	--	13	12	39	218
7/2/2017	--	--	--	--	8.8	8.2	30	100
7/9/2017	--	--	--	--	8.0	6.1	28	120
7/16/2017	--	--	--	--	18	2.2	20	36
7/23/2017	--	--	--	--	12	6.3	28	145
7/30/2017	--	--	--	--	8.7	10	47	120
8/6/2017	--	--	--	--	11	8.6	74	140
8/13/2017	--	--	--	--	16	10	13	55
8/20/2017	--	--	--	--	8.0	8.1	48	90
8/27/2017	--	--	--	--	5.4	3.6	41	75
9/3/2017	--	--	--	--	7.8	8.4	33	83
9/10/2017	--	--	--	--	4.9	2.8	22	49
9/17/2017	--	--	--	--	6.5	5.4	64	140
10/29/2017	--	--	--	--	9.2	4.1	29	67
11/6/2017	--	--	--	--	8.7	4.4	44	118
11/12/2017	--	--	--	--	4.3	2.0	23	42
11/19/2017	--	--	--	--	8.5	3.9	39	59
11/26/2017	--	--	--	--	5.2	3.8	44	79

Table A-31. Flow (cfs) observed at Priority 2 sites during the 2017 dry season

Week Beginning Date	Prado Park Lake Outlet (WW-C3)	Chino Creek @ Central Avenue (WW-C7)	Mill-Cucamonga Creek Below Wetlands (WW-M6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/7/2017	Dry	6.9	22	41	91
5/14/2017	Dry	8.9	5.7	48	120
5/21/2017	Dry	8.6	7.3	52	165
5/28/2017	Dry	6.9	6.2	19	94
6/4/2017	Dry	7.1	3.7	55	11
6/11/2017	Dry	15	4.3	41	123
6/18/2017	Dry	5.8	3.1	45	140
6/25/2017	Dry	12	2.7	39	218
7/2/2017	Dry	5.1	7.3	30	100
7/9/2017	Dry	4.5	3.3	28	120
7/16/2017	Dry	4.7	19	20	36
7/23/2017	Dry	13	4.5	28	145
7/30/2017	Dry	3.2	9.3	47	120
8/6/2017	Dry	3.0	3.5	74	140
8/13/2017	Dry	1.6	20	13	55
8/20/2017	Dry	4.9	14	48	90
8/27/2017	Dry	5.9	12	41	75
9/3/2017	Dry	4.1	9.1	33	83
9/10/2017	2.4	6.2	1.5	22	49
9/17/2017	2.5	3.9	8.8	64	140
10/29/2017	4.7	3.9	6.8	29	67
11/6/2017	7.5	6.7	24	44	118
11/12/2017	NA	6.4	12	23	42
11/19/2017	4.3	7.8	20	39	59
11/26/2017	6.7	6.3	24	44	79

Table A-32. Flow (cfs) observed at Priority 3 sites in Orange County during the 2017 dry season (Note: Borrego Creek was dry during all sample events)

Week Beginning Date	Bolsa Chica Channel	Buck Gully Creek	Los Trancos Creek	Morning Canyon Creek	Peters Canyon Wash	San Diego Creek Reach 1	San Diego Creek Reach 1	SAR Reach 2	Serrano Creek
	(P3-OC1)	(P3-OC3)	(P3-OC5)	(P3-OC6)	(P3-OC7)	(P3-OC8)	(P3-OC9)	(P3-OC10)	(P3-OC11)
5/7/2017	--	--	--	--	2.5	5.2	0.2	--	0.1
5/14/2017	--	--	--	--	2.6	5.3	0.1	--	0.1
5/21/2017	--	--	--	--	2.6	6.4	0.2	--	0.2
5/28/2017	--	--	--	--	3.5	5.1	0.1	--	0.1
6/4/2017	--	--	--	--	3.6	8.5	0.1	--	0.2
6/11/2017	--	0.4	0.5	0.3	--	--	--	--	--
6/18/2017	--	0.6	0.4	0.3	--	--	--	--	--
6/25/2017	--	0.3	0.6	0.4	--	--	--	--	--
7/2/2017	--	0.4	0.6	0.3	--	--	--	--	--
7/9/2017	--	0.3	0.5	0.3	--	--	--	--	--
10/29/2017	1.1	--	--	--	--	--	--	99	--
11/6/2017	0.7	--	--	--	--	--	--	104	--
11/12/2017	0.8	--	--	--	--	--	--	118	--
11/19/2017	0.9	--	--	--	--	--	--	116	--
11/26/2017	0.6	--	--	--	--	--	--	111	--

Table A-33. Flow (cfs) observed at Priority 3 sites in Riverside County and San Bernardino County during the 2017 dry season

Week Beginning Date	SAR Reach 4	Goldenstar Creek	Lake Fulmor
	(P3-SBC1)	(P3-RC1)	(P3-RC2)
7/16/2017	7.0	--	--
7/23/2017	6.0	--	--
7/30/2017	5.0	--	--
8/6/2017	12	--	--
8/13/2017	12	--	--
8/20/2017	--	2.1	NA
8/27/2017	--	1.5	NA
9/3/2017	--	0.7	NA
9/10/2017	--	1.1	NA
9/17/2017	--	2.9	NA

Table A-34. Water Quality Data from Priority 2 Sites during the 2017-2018 Storm Event

Date	*E. coli* (MPN/100 mL)	TSS (mg/L)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Flow (cfs)	pH	Water Temperature (°C)	Turbidity (NTU)
Prado Park Lake (WW-C3)								
2/27/2018	220	14	1112	11.4	6.0	8.2	14.6	9
3/1/2018	52	13	1083	11.8	4.0	8.4	14.8	7
3/2/2018	52	12	871	12.5	3.0	8.9	15.1	12
3/3/2018	110	16	824	11.3	4.3	8.4	15.2	8
Chino Creek at Central Avenue (WW-C7)								
2/27/2018	2500	8	260	11.0	--	8.4	9.8	10
3/1/2018	310	2	954	8.9	5.0	7.5	12.9	0
3/2/2018	550	2	971	8.2	5.0	7.8	14.8	1
3/3/2018	1000	24	321	9.9	--	8.1	13.2	18
Mill-Cucamonga Creek below Treatment Wetlands (WW-M6)								
2/27/2018	1000	53	465	9.9	--	8.3	12.2	25
3/1/2018	110	6	903	9.0	36.0	8.1	14.4	1
3/2/2018	130	5	936	8.8	55.0	8.1	15.8	4
3/3/2018	680	10	836	8.7	47.0	8.0	16.1	4
SAR at MWD Crossing (WW-S1)								
2/27/2018	4900	560	524	8.9	177.0	7.8	13.7	365
3/1/2018	120	6	989	9.1	5.0	8.1	16.7	5
3/2/2018	230	13	985	8.9	69.0	8.1	17.6	4
3/3/2018	1300	160	787	8.3	60	7.8	16.7	70
SAR at Pedley Avenue (WW-S4)								
2/27/2018	730	110	613	8.8	--	7.8	14.3	40
3/1/2018	280	24	990	9.3	2.0	8.1	16.0	10
3/2/2018	240	10	1000	9.1	193.0	8.2	17.3	7
3/3/2018	20000	94	829	8.4	193.0	8.0	17.4	29

Table A-35. 2017 Daily mean flow (cfs), Chino Creek at Schaeffer Avenue, as measured by the USGS (Data are provisional)

Date	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	1.0	0.7	0.6	0.4	0.4	0.3	0.2	0.5	0.3	0.2	0.3	0.2
2	0.6	0.6	0.7	0.4	0.4	0.3	0.2	0.4	0.3	0.2	0.2	0.2
3	0.6	0.6	0.6	0.4	0.4	0.3	0.2	0.5	1.5	0.2	0.2	0.2
4	0.6	0.6	0.6	0.4	0.4	0.2	0.2	0.6	0.3	0.2	0.2	0.2
5	45	0.6	0.6	0.4	0.4	0.3	0.2	0.3	0.3	0.2	0.2	0.2
6	0.9	29	0.6	0.5	0.9	0.3	0.2	0.3	0.3	0.2	0.2	0.2
7	1.6	14	0.5	0.4	14	0.3	0.3	0.3	0.3	0.2	0.2	0.2
8	0.7	3.6	0.6	0.9	0.4	0.3	0.2	0.3	0.3	0.2	0.2	0.5
9	112	0.7	0.6	0.4	0.4	0.3	0.2	0.4	0.3	0.2	0.2	0.5
10	1.5	12	0.6	0.4	0.4	0.3	0.2	0.3	0.3	0.2	0.2	0.5
11	87	12	0.6	0.4	0.4	0.3	0.3	0.3	0.4	0.2	0.2	0.5
12	190	0.8	0.5	0.4	0.4	0.2	0.3	0.3	0.3	0.2	0.2	0.3
13	4.2	0.7	0.6	0.5	0.4	0.2	0.3	0.2	0.3	0.2	0.2	0.3
14	1.5	0.6	0.6	0.5	0.3	0.2	0.3	0.3	0.3	0.2	0.2	0.3
15	1.1	0.6	0.5	0.4	1.1	0.2	0.3	0.3	0.3	0.2	0.2	0.3
16	0.9	0.6	0.7	0.5	0.3	0.2	0.2	0.3	0.4	0.2	0.2	0.3
17	0.7	299	0.5	0.4	0.3	0.2	0.2	0.3	0.4	0.2	0.2	0.3
18	0.6	27	0.4	0.5	0.3	0.2	0.2	0.3	0.4	0.3	0.2	0.3
19	149	1.5	0.4	0.5	0.3	0.2	0.2	0.4	0.2	0.3	0.2	0.3
20	466	1.0	0.5	0.5	0.3	0.2	0.2	0.9	0.3	0.3	0.2	0.3
21	4.6	0.9	4.0	0.5	0.3	0.2	0.2	0.6	0.3	0.2	0.2	0.3
22	682	0.8	1.3	0.5	0.4	0.2	0.2	0.3	0.2	0.3	0.2	0.3
23	133	1.0	0.5	0.4	0.4	0.2	0.2	0.3	0.2	0.3	0.2	0.3
24	4.9	0.7	0.4	0.4	0.3	0.2	0.4	0.2	0.2	0.3	0.2	0.3
25	1.9	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.3	0.2	0.3
26	1.5	6.2	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.3	0.2	0.4
27	1.2	5.7	0.4	0.5	0.3	0.2	0.2	0.2	0.3	0.3	0.2	0.3
28	1.0	0.7	0.5	0.4	0.3	0.2	0.2	0.3	0.3	0.2	0.2	0.3
29	0.8		0.5	0.4	0.3	0.2	0.2	0.3	0.3	0.3	0.2	0.3
30	0.8		0.5	0.4	0.3	0.2	0.2	0.3	0.2	0.3	0.2	0.3
31	0.7		0.4		0.3		0.2	0.3		0.2		0.4
COUNT	31	28	31	30	31	30	31	31	30	31	30	31
MAX	682	299	4.0	0.9	13.5	0.3	0.4	0.9	1.5	0.3	0.3	0.5
MIN	0.6	0.6	0.4	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table A-36. 2017 Daily mean flow (cfs), Cucamonga Creek near Mira Loma, as measured by the USGS (Data are provisional)

Date	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	15	77	24	8.8	18	5.1	1.5	1.9	11	6.3	16	9.1
2	23	85	22	9.8	18	4.5	2.4	0.3	5.8	3.8	19	9.4
3	19	106	20	13	28	5.1	1.9	2.2	8.6	4.5	17	12
4	19	72	20	6.7	18	5.2	1.4	0.6	11	6.6	25	16
5	61	93	19	4.5	25	3.5	0.4	0.1	16	6.9	27	15
6	27	182	12	9.4	8.9	16	0.5	1.1	8.8	8.3	9.2	8.1
7	30	171	18	13	35	6.1	0.2	0.5	3.9	15	13	6.2
8	29	149	16	15	6.9	3.7	1.4	0.1	2.7	15	15	13
9	240	117	17	8.1	8.9	2.4	2.5	0.7	8.6	11	16	14
10	26	126	13	14	7.5	3.0	0.5	7.6	11	8.4	21	20
11	440	146	8.9	1.0	5.4	5.3	0.4	5.0	10	8.1	24	13
12	868	129	12	3.6	2.1	1.6	0.3	5.6	5.4	7.6	21	8.7
13	52	117	7.1	4.3	1.7	1.0	2.0	9.0	1.4	6.0	21	20
14	25.3	96	8.3	2.2	4.7	1.5	4.3	3.9	6.1	15	25	20
15	21	102	5.1	2.9	14	1.2	4.2	6.6	9.2	20	21	11
16	28	151	5.4	9.0	5.2	1.5	5.8	8.3	9.2	9.3	26	21
17	32	825	4.7	4.4	2.5	1.3	4.6	6.8	9.0	7.0	20	30
18	48	278	5.8	3.5	2.4	1.1	4.9	3.4	5.1	11	21	16
19	269	69	7.6	3.8	2.3	0.7	7.3	10	2.0	17	22	14
20	1190	72	9.3	5.4	2.8	0.9	3.7	18	2.0	8.3	17	4.5
21	111	62	32	7.8	6.3	0.6	0.3	10	2.6	9.4	18	24
22	1380	53	20	10	4.9	1.0	0.2	5.3	1.9	11	16	25
23	637	41	14	7.1	5.3	0.6	2.2	6.1	3.3	8.8	18	42
24	85	36	9.3	6.2	4.3	0.7	5.6	5.0	2.7	5.4	14	54
25	74	31	5.1	5.5	3.7	0.7	4.5	2.6	1.4	3.2	10	48
26	71	62	7.3	19	3.2	0.5	4.0	6.1	1.6	4.0	16	45
27	70	87	7.9	13	2.9	0.4	0.4	8.9	1.8	11	22	43
28	65	35	5.4	10	7.6	0.4	0.0	7.3	4.3	16	20	30
29	52		4.8	27	4.4	0.5	0.4	4.6	1.6	24	12	42
30	65		6.5	17	2.5	0.6	0.8	7.1	1.8	17	13	41
31	69		8.0		5.7		0.7	12		21		28
COUNT	31	28	31	30	31	30	31	31	30	31	30	31
MAX	1380	825	32	27	35	16	7	18	16	24	27	54
MIN	15	31	4.7	1.0	1.7	0.4	0.0	0.1	1.4	3.2	9.2	4.5

Table A-37. 2017 Daily mean flow (cfs), Santa Ana River at MWD Crossing, as measured by the USGS (Data are provisional)

Date	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
1	436	77	76	53	49	38	26	36	49	27	34	36
2	104	76	64	52	50	39	28	36	44	28	34	34
3	66	77	62	55	46	39	28	35	51	28	33	36
4	64	78	63	53	46	36	28	35	52	28	34	34
5	156	76	62	52	43	36	31	35	43	28	34	35
6	78	90	65	52	44	38	30	35	41	27	35	34
7	72	105	64	50	55	37	30	36	42	27	34	35
8	76	99	63	50	52	37	31	33	40	28	35	34
9	543	85	64	48	46	36	31	35	42	28	37	35
10	145	86	63	47	46	34	30	37	41	25	38	36
11	558	106	62	48	44	34	30	32	37	28	38	37
12	1830	102	64	48	41	34	31	33	39	29	40	38
13	859	90	62	51	42	33	32	35	37	29	41	38
14	263	92	65	62	42	31	30	36	37	30	41	36
15	146	92	63	61	40	31	30	37	35	30	42	36
16	104	95	64	51	42	29	30	34	34	30	41	37
17	82	597	61	52	45	29	32	35	33	31	42	35
18	78	1710	60	53	40	28	35	31	33	30	39	39
19	391	198	59	51	42	28	34	33	32	30	35	41
20	2850	119	59	54	38	28	34	34	31	31	35	40
21	532	85	60	53	37	26	34	36	32	31	35	42
22	3180	76	71	53	39	26	33	35	32	30	33	42
23	3820	71	64	49	39	25	30	36	32	30	33	43
24	328	70	64	54	40	25	34	35	31	28	34	42
25	156	69	61	53	37	25	33	35	29	30	35	42
26	136	103	61	56	39	24	33	34	28	31	35	37
27	134	130	60	55	41	23	33	33	27	31	36	37
28	101	111	59	57	40	23	33	34	28	31	36	33
29	89		59	54	39	23	31	32	26	30	38	87
30	86		57	54	39	24	32	32	26	46	36	89
31	81		56		40		33	65		42		55
COUNT	31	28	31	30	31	30	31	31	30	31	30	31
MAX	3820	1710	76	62	55	39	35	65	52	46	42	89
MIN	64	69	56	47	37	23	26	31	26	25	33	33

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Appendix B
QA/QC Summary

Introduction

This section provides the Quality Assurance/Quality Control (QA/QC) evaluation for samples and data collected during the period covered by this report, which includes the 2017 dry weather monitoring and 2017-2018 storm monitoring. The basis for this evaluation is the approved QAPP.[27]

Field measurements were made for the following constituents: conductivity, dissolved oxygen, pH, turbidity, water temperature, and flow. Field data were checked to ensure that all required data were gathered and recorded. This check included a data review to ensure correct units of measurements were reported and that reported values were within expected ranges.

Laboratory analyses were conducted for two constituents: *E. coli*, *Enterococcus*, and TSS. Data validation included a check to ensure that samples were delivered to laboratories within required holding times and that all sample handling and custody protocols were followed. Field/equipment blank and duplicate results were evaluated against various reporting requirements and data were checked to ensure correct units of measurement were reported.

The following sections summarize the results of the QA/QC evaluation for the period covered by this report.

Field Measured Parameters

Completeness

Table B-1 shows number of the dry weather field measurements collected for 2017. Completeness is summarized as follows:

- Prado Park Lake was drained for repairs prior to the start of the 2017 dry weather monitoring season. As a result, the Prado Park Lake Priority 1 and 2 (WW-C3) monitoring site was dry (no flow over the spillway) for 18 of the 25 monitoring weeks. As such, there were no samples collected or field measurements during those 18 weeks.
- Due to dry conditions at Borrego Creek during the monitoring events, no field measurements or water quality samples were collected, resulting in 5 uncollected measurements for each parameter.
- Turbidity was not measured at Los Trancos Creek and Morning Canyon Creek. The Santa Ana Water Board conducted dry weather monitoring at these two sites and did not have the capability to measure turbidity.

[27] SAR RMP QAPP, Version 1.0, February 2016

- There are fewer planned flow measurements as flow is measured in stream sites only. As five sites are located in lakes (four Priority 1 and one Priority 3 sites) and two Priority 4 sites are located in the tidal zone, there are 288 planned flow measurements (107 less than other field parameters). Twenty-three flow measurements were not collected due to dry conditions and one was not collected due to impeded flow conditions.

Table B-1. Dry weather field parameter completeness summary

Parameter	Planned[1]	Collected	% Complete
Conductivity	345	326	94.5%
Dissolved Oxygen	345	324	93.9%
Flow[2]	288	264	91.7%
pH	345	326	94.5%
Temperature	345	326	94.5%
Turbidity	345	320	92.8%

[1] Planned represents the number of samples planned based on SAR RMP Monitoring Plan and does not include special investigations that arise based on results of the routing monitoring program.
[2] Flow is not measured at lake sites and sites located in tides.

Accuracy and Precision

Field staff used a Horiba multi-parameter probe (or equivalent) to collect in situ field measurements for conductivity, dissolved oxygen, pH, and water temperature at all sample locations during each sample event. Turbidity and flow were measured with a Hach Turbidity meter and Marsh-McBirney Flo-Mate meter with top-setting rod, respectively. Field staff calibrated each of the water quality meters prior to each sample event to ensure accuracy and precision of the measurements. Table B-2 summarizes the accuracy and repeatability associated with the use of each meter.

Table B-2. Summary of accuracy and repeatability expectations for field measurement meters

Water Quality Constituent	Accuracy	Repeatability
Dissolved Oxygen	± 0.2 mg/L	± 0.1 mg/L
pH	± 0.1 units	± 0.05 units
Conductivity	± 1%	± 0.05%
Water Temperature	± 0.3 °C	±0.1 °C
Turbidity	± 2%	± 1%
Flow	± 2%	N/A

Laboratory Constituents

Table B-3 describes the number of grab water samples planned versus actual samples collected. During the 2017 dry weather season, 25 weeks of sampling at eight Priority 1 sites and five Priority 2 sites was planned from the week of May 7, 2017, through the week of November 26, 2017. During the same period, 5 weeks of sampling, at thirteen Priority 3 sites and one week of sampling at five Priority 4 sites are also planned. This results in 345 dry weather samples. This Annual Report also encompasses monitoring of a wet weather storm events at the five Priority 2 sites. This results in 20 wet weather samples (5 sites/event and 4 samples per site) for a total of 365 samples during the entire monitoring period covered in this 2017-2018 Annual Report.

As previously discussed, samples were not collected from Prado Park Lake for 18 weeks and Borrego Creek for 5 weeks, while additional samples were collected from Cucamonga Creek at Hellman Avenue due to an exceedance of the antidegradation target.

Holding time requirements for TSS (7 days) and *E. coli* (6 hours) were met for all samples.

Field/Equipment Blanks

The QAPP calls for a field/equipment blank to be collected during each sample event. A sample event is defined as one week for dry weather sampling, during which multiple days of sampling may occur. One field/equipment blank sample is also required during each storm event. Accordingly, the QAPP requires a total of 27 field/equipment blanks, however, 47 field/equipment blanks were collected as multiple blanks were collected during some weeks. This results in a frequency of 12 percent, well above the typically required frequency. Per the QAPP, the reporting target limits for TSS and bacterial indicators were 1.0 mg/L and 10 cfu/100 mL, respectively. These method sensitivity guidelines were met. Field/equipment blank results were all below detectable counts (< 9 MPN/100 mL) for *E. coli*. For TSS, all field/equipment blank results were reported below the target reporting limit.

Field Duplicates

The QAPP requires the collection of a field duplicate at a minimum frequency of at least 5 percent of the total samples collected. Field staff collected at least one field duplicate during each sample event for a total of 43 TSS field duplicates and 43 indicator bacteria field duplicates (42 *E. coli* and 1 *Enterococcus*). As a result, the frequency of field duplicate collection was 12 percent, well above the required frequency.

Table B-3. Summary of grab sample collection activity for dry and wet weather sample events and regularly sampled sites

Sample ID	Sample Location	Planned	Collected	Missed
P1-1	Canyon Lake at Holiday Harbor	25	25	0
P1-2	Lake Elsinore	25	25	0
P1-3	Lake Perris	25	25	0
P1-4	Big Bear Lake at Swim Beach	25	25	0
P1-5	Mill Creek Reach 2	25	25	0
P1-6	Lytle Creek (Middle Fork)	25	25	0
WW-M6	Mil-Cucamonga Creek below Wetlands	29	29	0
WW-C7	Chino Creek at Central Avenue	29	29	0
WW-C3	Prado Park Lake [1]	29	11	18
WW-S1	Santa Ana River Reach 3 at MWD Crossing	29	29	0
WW-S4	Santa Ana River Reach 3 at Pedley Avenue	29	29	0
P3-OC1	Bolsa Chica Channel	5	5	0
P3-OC2	Borrego Creek [2]	5	0	5
P3-OC3	Buck Gully Creek	5	5	0
P3-OC5	Los Trancos Creek	5	5	0
P3-OC6	Morning Canyon Creek	5	5	0
P3-OC7	Peters Canyon Wash	5	6	0
P3-OC8	San Diego Creek Reach 1	5	6	0
P3-OC9	San Diego Creek Reach 1	5	6	0
P3-0C10	Santa Ana River Reach 2	5	5	0
P3-OC11	Serrano Creek	5	6	0
P3-RC1	Goldenstar Creek	5	5	0
P3-RC2	Lake Fulmor	5	5	0
P3-SBC1	Santa Ana River Reach 4	5	5	0
P4-RC2	Temescal Creek at Lincoln Avenue	1	1	0
P4-OC1	Santa Ana Delhi Channel Upstream of Irvine Avenue	1	1	0
P4-OC2	Santa Ana Delhi Channel in Tidal Prism	1	1	0
P4-OC3	Greenville-Banning Channel in Tidal Prism	1	1	0
P4-SBC1	Cucamonga Creek at Hellman Avenue [3]	1	6	0
Total		365	351	23

[1] Prado Park Lake was dry for 18 out of 25 dry weather sample events.
[2] Borrego Creek was dry during all five sample events.
[3] Additional samples were collected at the Priority 4 Cucamonga Creek site due to antidegradation target exceedances

Each duplicate sample was analyzed for the same parameters as its paired field sample. Results of the field duplicate analyses can be used to assess adherence to field sampling collection protocols and laboratory precision. Table B-4 summarizes the field duplicate analysis results for TSS. Sixteen duplicate pairs exceeded the QAPP's relative percent difference (RPD) goal of ± 25 percent. Two pairs, collected from SAR Reach 4 on the week of September 14, 2017 and Buck Gully Creek on the week of June 22, 2017, has a significant RPD resulting from a large difference in concentrations (one order of magnitude). This is 5 percent of all QA/QC samples and is within a normal frequency. Thirteen pairs with RPD exceeding ± 25 percent are due to low TSS values; maximum TSS concentration in those pairs is 27 mg/L and the maximum difference in the twelve pairs is 10.1 mg/L. Dividing by the low TSS values artificially results in high RPD values. While one pair has a maximum TSS concentration of 45 mg/L, the difference in the pair is 11 mg/L.

To determine the precision of the duplicate analysis for each bacterial indicator the following method was used:[28]

- Calculate the logarithm of each sample and associated duplicate ("laboratory pair")
- Determine the range for each laboratory pair (R_{log})
- Calculate the mean of the ranges (Mean R_{log})
- Calculate the precision criterion, where the precision criteria = 3.27 * Mean R_{log}
- Compare R_{log} for each duplicate pair with the calculated precision criterion for the data set to determine if R_{log} is less than the precision criterion.

Tables B-5 summarizes the field duplicate analysis results for *E. coli*, respectively. Three duplicate pairs for *E. coli* exceeded the calculated precision criterion. This is 7 percent of the QA/QC pairs and is comparable with historical data. Two of the pairs have an *E. coli* concentration below detection limit or 1 MPN/100 mL in either the original or duplicate sample, with the corresponding paired concentration ranging from 5.2 to 540 MPN/100 mL. Approximately one order of magnitude difference in replicate bacteria samples is common and within reason. One pair has less than one order of magnitude difference in paired concentrations with the paired concentration ranging from 110 to 510 MPN/100 mL.

[28] Standard Methods, Section 9020B, 18th, 19th, or 20th Editions

Table B-4. Results of field duplicate analysis for TSS

Sample Date	Site ID	Site Location	Duplicate Result (mg/L)	Sample Result (mg/L)	RPD (%)
5/12/2017	P1-1	Canyon Lake	BDL	2	0%
5/19/2017	P1-2	Lake Elsinore	28	28	0%
5/25/2017	P1-3	Lake Perris	BDL	2	0%
5/30/2017	P1-4	Big Bear Lake	10	12	18%
6/6/2017	P1-5	Mill Creek Reach 2	BDL	BDL	0%
6/13/2017	P1-6	Lytle Creek	2	4	67%
6/21/2017	WW-S1	SAR at MWD Crossing	6	6	0%
6/28/2017	WW-S4	SAR at Pedley Avenue	8	8	0%
7/6/2017	WW-M6	Mill-Cucamonga Creek	3	3	0%
7/12/2017	WW-C7	Chino Creek	2	3	40%
7/20/2017	P3-SBC1	SAR Reach 4	BDL	2	0%
7/28/2017	P1-1	Canyon Lake	2	BDL	0%
8/5/2017	P1-2	Lake Elsinore	20	16	22%
8/10/2017	P1-3	Lake Perris	2	3	40%
8/15/2017	P1-4	Big Bear Lake	36	39	8%
8/22/2017	P1-5	Mill Creek Reach 2	3	2	40%
8/29/2017	P1-6	Lytle Creek	BDL	BDL	0%
9/8/2017	WW-S1	SAR at MWD Crossing	8	8	0%
9/14/2017	P3-RC1	SAR Reach 4	20	3	148%
9/20/2017	WW-C3	Chino Creek	20	10	67%
10/31/2017	WW-S1	SAR at MWD Crossing	7	8	13%
11/8/2017	WW-S4	SAR at Pedley Avenue	4	2	67%
11/15/2017	WW-M6	Mill-Cucamonga Creek	4	3	29%
11/21/2017	WW-C7	Prado Park Lake	2	2	0%
11/30/2017	WW-S1	SAR at MWD Crossing	19	27	35%
7/13/2017	P3-OC5	Los Trancos Creek	1	1.73	53%
7/13/20/17	P3-OC6	Morning Canyon Creek	1.72	BDL	15%
5/10/2017	P3-OC11	Serrano Creek	0.7	1	35%
5/17/2017	P3-OC9	San Diego Creek Reach 2	1.8	2.2	20%
5/24/2017	P3-OC7	Peters Canyon Wash	7.3	6.8	7%
6/1/2017	P3-OC8	San Diego Creek Reach 1	14.6	15.7	7%
6/6/2017	P3-OC9	San Diego Creek Reach 2	0.9	1	11%
6/14/2017	P3-OC3	Buck Gully Creek	3.6	5	33%
6/22/2017	P3-OC3	Buck Gully Creek	14.3	4.2	109%
6/28/2017	P3-OC3	Buck Gully Creek	7.7	7.6	1%
7/6/2017	P3-OC3	Buck Gully Creek	7.4	5.5	29%
7/11/2017	P3-OC3	Buck Gully Creek	6	4.8	22%
7/19/2017	P4-OC3	Greenville-Banning Channel	7.5	9.7	26%
11/1/2017	P3-OC10	SAR Reach 2	45	34	28%
11/8/2017	P3-OC1	Bolsa Chica Channel	18	18	0%
11/16/2017	P3-OC10	SAR Reach 2	36	37	3%
11/21/2017	P3-OC1	Bolsa Chica Channel	31	37	18%
11/29/2017	P3-OC10	SAR Reach 2	26	26	0%

For calculation purposes, BDL was represented by the detection limit.

Table B-5. Results of field duplicate analysis for *E. coli*

Sample Date	Site ID	Site Location	Duplicate Result (cfu/100 mL)	Sample Result (cfu/100 mL)	Log of Duplicate Result (L_1)	Log of Sample Result (L_2)	Range of Logs (L_1 - L_2) or (R_{log})
5/12/2017	P1-1	Canyon Lake	BDL	1	0.0000	0.0000	0.0000
5/19/2017	P1-2	Lake Elsinore	5.2	6.3	0.7160	0.7993	0.0833
5/25/2017	P1-3	Lake Perris	1	BDL	0.0000	0.0000	0.0000
5/30/2017	P1-4	Big Bear Lake	BDL	BDL	0.0000	0.0000	0.0000
6/6/2017	P1-5	Mill Creek Reach 2	4.1	5.2	0.6128	0.7160	0.1032
6/13/2017	P1-6	Lytle Creek	5.2	1	0.7160	0.0000	0.7160
6/21/2017	WW-S1	SAR at MWD Crossing	370	200	2.5682	2.3010	0.2672
6/28/2017	WW-S4	SAR at Pedley Avenue	63	84	1.7993	1.9243	0.1249
7/6/2017	WW-M6	Mill-Cucamonga Creek	160	63	2.2041	1.7993	0.4048
7/12/2017	WW-C7	Chino Creek	120	200	2.0792	2.3010	0.2218
7/20/2017	P3-SBC1	SAR Reach 4	91	81	1.9590	1.9085	0.0506
7/28/2017	P1-1	Canyon Lake	BDL	1	0.0000	0.0000	0.0000
8/5/2017	P1-2	Lake Elsinore	22	23	1.3424	1.3617	0.0193
8/10/2017	P1-3	Lake Perris	BDL	2	0.0000	0.3010	0.3010
8/15/2017	P1-4	Big Bear Lake	BDL	BDL	0.0000	0.0000	0.0000
8/22/2017	P1-5	Mill Creek Reach 2	4.1	3.1	0.6128	0.4914	0.1214
8/29/2017	P1-6	Lytle Creek	6.3	4.1	0.7993	0.6128	0.1866
9/8/2017	WW-S1	SAR at MWD Crossing	680	680	2.8325	2.8325	0.0000
9/14/2017	P3-RC1	SAR Reach 4	110	510	2.0414	2.7076	0.6662
9/20/2017	WW-C3	Chino Creek	63	85	1.7993	1.9294	0.1301
10/31/2017	WW-S1	SAR at MWD Crossing	BDL	540	1.0000	2.7324	1.7324
11/8/2017	WW-S4	SAR at Pedley Avenue	200	190	2.3010	2.2788	0.0223
11/15/2017	WW-M6	Mill-Cucamonga Creek	570	450	2.7559	2.6532	0.1027
11/21/2017	WW-C7	Prado Park Lake	60	20	1.7782	1.3010	0.4771
11/30/2017	WW-S1	SAR at MWD Crossing	480	300	2.6812	2.4771	0.2041
7/13/2017	P3-OC5	Los Trancos Creek	400	390	2.6021	2.5911	0.0110
7/13/20/17	P3-OC6	Morning Canyon Creek	310	210	2.4914	2.3222	0.1691
5/10/2017	P3-OC11	Serrano Creek	1374	1236	3.1380	3.0920	0.0460

Sample Date	Site ID	Site Location	Duplicate Result (cfu/100 mL)	Sample Result (cfu/100 mL)	Log of Duplicate Result (L_1)	Log of Sample Result (L_2)	Range of Logs (L_1 - L_2) or (R_{log})
5/17/2017	P3-OC9	San Diego Creek Reach 2	171	146	2.2330	2.1644	0.0686
5/24/2017	P3-OC7	Peters Canyon Wash	183	183	2.2625	2.2625	0.0000
6/1/2017	P3-OC8	San Diego Creek Reach 1	161	145	2.2068	2.1614	0.0455
6/6/2017	P3-OC9	San Diego Creek Reach 2	712	759	2.8525	2.8802	0.0278
6/14/2017	P3-OC3	Buck Gully Creek	41	41	1.6128	1.6128	0.0000
6/22/2017	P3-OC3	Buck Gully Creek	52	97	1.7160	1.9868	0.2708
6/28/2017	P3-OC3	Buck Gully Creek	169	97	2.2279	1.9868	0.2411
7/6/2017	P3-OC3	Buck Gully Creek	84	173	1.9243	2.2380	0.3138
7/11/2017	P3-OC3	Buck Gully Creek	146	85	2.1644	1.9294	0.2349
7/19/2017	P4-OC3	Greenville-Banning Channel	10	20	1.0000	1.3010	0.3010
11/1/2017	P3-OC10	SAR Reach 2	235	203	2.3711	2.3075	0.0636
11/8/2017	P3-OC1	Bolsa Chica Channel	97	98	1.9868	1.9912	0.0045
11/16/2017	P3-OC10	SAR Reach 2	262	262	2.4183	2.4183	0.0000
11/21/2017	P3-OC1	Bolsa Chica Channel	496	512	2.6955	2.7093	0.0138
11/29/2017	P3-OC10	SAR Reach 2	313	313	2.4955	2.4955	0.0000
						Sum of R_{log}	7.7464
						Mean R_{log}	0.1801
						Precision Criterion (3.27*Mean R_{log})	0.5891

[1] For data values with > qualifier, the data values shown were used for duplicate precision calculations.

Appendix C

Laboratory QA/QC Reports

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Quality Assurance / Certification Statement

CDM Smith – SAR Monitoring Program

There were a total of 329 samples submitted, which includes 279 site samples, 25 field duplicate samples and 25 field blanks. Samples were analyzed for Total Suspended Solids, Total Coliform and *E. coli*. The sampling period spanned May 2017 through December 2017.

All samples were received in good condition, meeting temperature guidelines of <10 ° C, or having been sampled and placed on ice immediately for transport and received within 6 hours.

All samples were received within acceptable holding times for the analyses requested.

The samples received under this project were analyzed with Good Laboratory Practices. The following items listed pertain to all samples submitted to our laboratory.

1) The method specified QC was performed on all batches containing project samples.
2) All sample parameters requested were reported, unless otherwise notified.
3) All batch acceptance criteria was met prior to reporting results, except as noted below.

Exceptions to Standard Quality Control Procedures

This report is organized into three sections:

Section I details Batch QC failures. An analytical batch includes the analysis of Method Blanks and Blank Spikes as applicable, also knowns as Laboratory Control Samples. If a batch has been qualified due to this type of failure, the end user should weigh the results associated with the batch according to its intended use. Often, the presence of trace contamination will have little to no effect on the usefulness of the reported result. Failed Blank Spikes are flagged with "Data Suspect".

Section II lists the qualifiers associated with samples that have been fortified with known quantities of target and/or non-target surrogate compounds, whose purpose is to monitor analyte recovery in "real-world' samples and to note any matrix interference. Also included in this section is precision information provided by duplicate analyses and/or fortified-sample duplicate analyses. Since the information included in this section is unique to each individual sample, the acceptance of the analytical batch is not controlled by the results of these bias and precision parameters.

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Section III of the report identifies individual samples that have been qualified for various reasons. Missed holding times, improper sample preservation, etc. must carefully be evaluated using professional judgement regarding the acceptability of the data for its intended use.

Section 1

All Method Blanks and Laboratory Control Samples analyzed for Total Suspended Solids were within acceptance criteria.

All Method Blanks analyzed for Total Coliform and *E. coli* were within acceptance criteria.

Section II

QRPDI: Analyte concentration of source or duplicate was below range for valid RPD determination.

Total Suspended Solids Batch 7H01101, source sample B7G2622-04

All other project source samples used for duplicates met acceptance criteria for precision.

Field Blanks

The following field blank samples were above the detection limit for the associated analytical method:

Sample 20171108SAWPAFB for Total Suspended Solids 4 mg/l

Sample 20171121SAWPAFB for Total Coliform 150 MPN/100 ml

Field Duplicates

Field duplicate precision was not calculated, due to source samples not identified.

Section III

All sample holding times were met. All samples were received with proper preservation. No other sample or data qualifiers were necessary for project samples.

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Note:

The qualifiers contained in the reported results are for informational use. The results associated have been evaluated and believed to be useful in the decision-making process.

All reports were prepared, and all analyses were performed in accordance with a system designed to assure that qualified personnel perform the analyses, use specified EPA approved methods and review the data before it is reported.

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Amanda Porter, Project Manager

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Date: **April 23, 2018**

To: **Orange County Public Works – OC Watersheds**

From: **Joseph A. Guzman,**
Orange County Public Health Laboratory

Subject: **SAR Watershed-wide Monitoring**
QA/QC *E. coli* and Enterococcus analysis
Season: May 2017 – November 2017

There were 16 sampling events for the 2017 SAR monitoring. A total of 71 water samples were submitted, including 38 site samples (36 for *E. coli* and 2 for Enterococcus), 17 field blanks, and 16 field replicates.

I. Cooler Temperature during sample transport

Acceptable transport temperature for this monitoring program per Standard Methods is <10°C for each sampling event.

Transport temperatures were noted on the chain of custody (COC) form at the time samples were received in the laboratory. All documented transport temperatures were below 10°C meeting the established transport conditions.

II. Transport times

Samples for regulatory monitoring should be submitted to the lab within 6 hours of collection.

The time the samples were received in the lab was noted on the COC form for each sampling event. All documented transport times were within the allotted 6-hour transport time.

III. Method Blanks

A. Field/Equipment Blanks: 17 field blanks were collected over the dry season sampling effort. 13 field blanks were tested for other monitoring programs over the same dry season timeframe.

B. Laboratory Blanks: 134 blank samples were tested on the days that SAR samples were tested. The lab ran blank samples at a rate of 22% (134/597) during SAR sampling events.

For *E. coli* and Enterococcus, the 17 field blanks that were collected for SAR monitoring all showed no growth with results reported below the reporting limit of <10 MPN/100ml for SM 9223B and SM 9230D methods. The 13 field blanks collected for other monitoring programs also showed no growth for all bacterial indicators tested. Results for all 134 laboratory blanks showed no growth or <1 CFU/100ml which met the established acceptance criteria.

IV. Field Replicates/Lab Duplicates:

A. Field Replicates

Field replicates for the SAR sampling were collected at a frequency of 42% (15/36) for *E. coli* and 50% (1/2) for Enterococcus. The replicate samples were analyzed for the same parameters as its paired field sample. 22 field replicate analysis for other monitoring programs were submitted on the same days that SAR samples were tested. Results of the field replicate analyses can be used to assess field adherence to sample collection protocols. Also, laboratory precision can be assessed by examining the results from the field sample and its replicate pair. Precision of replicate analysis was determined using Standard Methods, 20th Ed. 9020 B section 8.

1. For field replicate samples submitted for *E. coli* by SM 9223B analysis (Colilert-18), a precision criteria of 0.3547 (3.27 x 0.1085) was established. Of the 16 replicate samples included, all samples were within the established precision criteria.

2. Only one replicate sample was submitted for Enterococcus by SM 9230D analysis (Enterolert). Precision criteria was not calculated as there were too few replicates submitted, but the results from the replicate results for the one sample submitted was within the 95% confidence level for the test method.

3. For the 22 field replicates submitted for other monitoring programs, a precision criteria of 0.3484 (3.27 x 0.1065) was established. One sample was above the precision criteria. See Table 1 for summary of samples not meeting precision.

B. Laboratory Duplicates

Laboratory duplicates were analyzed on 13% (76/597) of total samples received on the days SAR samples were tested. The results of duplicate analyses are used to assess laboratory precision during analysis. Precision of duplicate analysis was determined using Standard Methods, 20th Ed. 9020 B section 8.

1. For the 76 laboratory duplicates tested, a precision criteria of 0.3123 (3.27 x 0.0955) was established. Six samples had a difference in results outside the established precision criteria. See Table 1 for summary of samples not meeting precision.

Table 1.

Date Collect	Time Collect	Site	Accession	Parameter	Type	Result
11/01/17	9:46	TBOD02	WR283492	Fecal Coliform	Grab	40 CFU/100ml
	9:46		WR283494		Other Field Replicate	9 CFU/100ml
06/01/17	9:24	MHH07	WL-17-03257	Total Coliform	Grab	30 CFU/100ml
					Lab Duplicate	<9 CFU/100ml
06/22/17	8:07	TBOD02	WL-17-03891	Total Coliform	Grab	20 CFU/100ml
					Lab Duplicate	9 CFU/100ml
07/06/17	10:50	BNB10	WL-17-4160	Total Coliform	Grab	20 CFU/100ml
					Lab Duplicate	<9 CFU/100ml
07/06/17	9:27	BNB31	WL-17-04172	Total Coliform	Grab	20 CFU/100ml
					Lab Duplicate	9 CFU/100ml
07/11/17	7:58	BNB24N	WL-17-04335	Total Coliform	Grab	≥9 CFU/100ml
					Lab Duplicate	≥20 CFU/100ml
11/08/17	9:45	CSBMP 1z	WL-17-07467	Total Coliform	Grab	<9 CFU/100ml
					Lab Duplicate	30 CFU/100ml

Although there was 1 field replicate and 6 laboratory duplicates outside the established precision criteria values, the imprecision is determined to be acceptable. The imprecision represented low count samples where there was only a 1 to 3 colony difference between the sample and the replicate/duplicate.

V. Laboratory Control Samples:

A. *E. coli* with Colilert-18 media (SM 9223B)

2 lots of Idexx Colilert-18 media were used during the SAR monitoring. There are 4 parameters tested for with each new lot:

1 – *Escherichia coli* culture is used as a positive control with positive reactions for both yellow color production and apple green fluorescence.
2 – *Klebsiella pneumoniae* culture is used as a positive control for yellow color production, but negative control for apple green fluorescence.
3 – *Psuedomonas aeruginosa* culture used as a negative control, for both yellow color production and apple green fluorescence.
4 – 1 packet per new lot of media is set up as a sterility control and to check for auto fluorescence.

3 lots of sterile 90ml dilution blank water were used to test for *E. coli* by SM 9223B. There are 2 parameters tested for with each new lot:

1 – 8 ml of the water blank is inoculated into TSB and incubated to check for sterility.
2 – the entire contents of the dilution blank is poured into a calibrated graduated cylinder to check that the 90ml aliquot is accurate.

B. Enterococcus with Enterolert media (SM 9230D)

1 lot of Idexx Enterolert media was used during the SAR monitoring. There are 4 parameters tested for with each new lot:

1 – *Enterococcus faecalis* culture is used as a positive control with positive reaction for blue fluorescence.
2 – *Aerococcus viridans* culture is used as a negative control for blue fluorescence.
3 – *Serratia marcescens* culture is used as a negative control for blue fluorescence.
4 – 1 packet per new lot of media is set up as a sterility control and to check for auto fluorescence.

1 lot of sterile 90ml dilution blank water was used to test for Enterococcus by SM 9230D. There are 2 parameters tested for with each new lot:

1 – 8 ml of the water blank is inoculated into TSB and incubated to check for sterility.
2 – the entire contents of the dilution blank is poured into a calibrated graduated cylinder to check that the 90ml aliquot is accurate.

All lots of Colilert-18 media, Enterolert media, and sterile 90ml dilution water used for the SAR monitoring had acceptable quality control results for all parameters tested.

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Summary of Orange County TSS QA/QC

A total of 447 Total Suspended Solids (TSS) samples were submitted during the 2017 dry season, including 67 Field QA/QC samples and 37 Lab QA/QC Samples. Out of the QA/QC Samples, 33 TSS samples were submitted to and processed by Enthalpy Analytical, 19 were submitted to and processed by Weck Labs, and 52 were submitted to and processed by Babcock. A summary of the laboratory and field quality assurance/quality control (QA/QC) samples is provided in Tables 1 and 2, respectively.

I. Cooler Temperature

Cooler temperatures were documented on the chain of custody (COC) form or a laboratory sample receiving checklist at the time samples were received by the laboratories. All temperatures were less than 10°C.

II. Transport times

The time the samples were received by the labs was noted on the COC or checklist for each sampling event. All samples were received within 6 hours of sample collection.

III. Method Blanks

- Field Blanks: 25 field blanks were collected during the 2017 dry season at a rate of 6% (25/447). All samples were tested by Babcock Labs.
- Laboratory Blanks: 16 blank samples were tested during the 2017 dry season at a rate of 4% (16/447). 11 samples were tested by Enthalpy Analytical and 5 were tested by Weck Labs.

IV. Field Replicates/Lab Duplicates:

- Field Replicates: 42 field replicates were collected during the 2017 dry season at a rate of 9% (42/447). 4 samples were tested by Weck Labs, 11 samples were tested by Enthalpy Analytical, and 27 samples were tested by Babcock Labs.
- Laboratory Duplicates: 21 laboratory duplicates were tested during the 2017 dry season at a rate of 5% (21/447). 11 samples were tested by Enthalpy Analytical and 10 were tested by Weck Labs.

Table 1 Laboratory QA/QC Samples

Analysis Date	Lab Sample ID	Sample Type	Result	Units	Lab
5/12/2017	QC1178548MB1	Blank	ND	mg/L	Enthalpy
	QC1178548DUP1	Duplicate	820	mg/L	Enthalpy
5/18/2017	QC1178746MB1	Blank	ND	mg/L	Enthalpy
	QC1178746DUP1	Duplicate	3180	mg/L	Enthalpy
5/26/2017	QC1179036MB1	Blank	ND	mg/L	Enthalpy
	QC1179036DUP1	Duplicate	314	mg/L	Enthalpy
6/5/2017	QC1179242MB1	Blank	ND	mg/L	Enthalpy
	QC1179242DUP1	Duplicate	264	mg/L	Enthalpy
6/7/2017	QC1179311MB1	Blank	ND	mg/L	Enthalpy
	QC1179311DUP1	Duplicate	220	mg/L	Enthalpy
6/16/2017	QC1179710MB1	Blank	ND	mg/L	Enthalpy
	QC1179710DUP1	Duplicate	542	mg/L	Enthalpy
6/29/2017	QC1180185MB1	Blank	ND	mg/L	Enthalpy
	QC1180185DUP1	Duplicate	128	mg/L	Enthalpy
7/5/2017	QC1180297MB1	Blank	ND	mg/L	Enthalpy
	QC1180297DUP1	Duplicate	5150	mg/L	Enthalpy
7/10/2017	QC1180428MB1	Blank	ND	mg/L	Enthalpy
	QC1180428DUP1	Duplicate	384	mg/L	Enthalpy
7/13/2017	QC1180558MB1	Blank	ND	mg/L	Enthalpy
	QC1180558DUP1	Duplicate	2320	mg/L	Enthalpy
7/21/2017	QC1180872MB1	Blank	ND	mg/L	Enthalpy
	QC1180872DUP1	Duplicate	2940	mg/L	Enthalpy
11/3/2017	W7K0105-BLK1	Blank	ND	mg/L	Weck
	W7K0105-DUP1	Duplicate	3	mg/L	Weck
	W7K0105-DUP2	Duplicate	2	mg/L	Weck
11/13/2017	W7K0596-BLK1	Blank	ND	mg/L	Weck
	W7K0596-DUP1	Duplicate	2	mg/L	Weck
	W7K0596-DUP2	Duplicate	14	mg/L	Weck
11/20/2017	W7K1176-BLK1	Blank	ND	mg/L	Weck
	W7K1176-DUP1	Duplicate	35	mg/L	Weck
	W7K1176-DUP2	Duplicate	2	mg/L	Weck
11/22/2017	W7K1291-BLK1	Blank	ND	mg/L	Weck
	W7K1291-DUP1	Duplicate	2	mg/L	Weck
	W7K1291-DUP2	Duplicate	453	mg/L	Weck
12/1/2017	W7L0023-BLK1	Blank	ND	mg/L	Weck
	W7L0023-DUP1	Duplicate	1060	mg/L	Weck
	W7L0023-DUP2	Duplicate	3	mg/L	Weck

Table 2 Field QA/QC Samples

Sample Date	Sample Time	Site ID	Sample Type	Result	Units	Lab
5/10/2017	09:52	P3-OC11	Duplicate	0.7	mg/L	Enthalpy
5/12/2017	09:20	P1-1	Blank	ND	mg/L	Babcock
	09:20	P1-1	Duplicate	ND	mg/L	Babcock
5/19/2017	07:50	P1-2	Blank	ND	mg/L	Babcock
	07:50	P1-2	Duplicate	28	mg/L	Babcock
5/17/2017	10:41	P3-OC9	Duplicate	1.8	mg/L	Enthalpy
5/24/2017	11:33	P3-OC7	Duplicate	7.3	mg/L	Enthalpy
5/25/2017	09:34	P1-3	Blank	ND	mg/L	Babcock
	09:48	P1-3	Duplicate	ND	mg/L	Babcock
5/30/2017	09:15	P1-4	Blank	ND	mg/L	Babcock
	09:15	P1-4	Duplicate	10	mg/L	Babcock
6/1/2017	13:22	P3-OC8	Duplicate	14.6	mg/L	Enthalpy
6/6/2017	11:00	P1-5	Blank	ND	mg/L	Babcock
	11:00	P1-5	Duplicate	ND	mg/L	Babcock
	11:52	P3-OC9	Duplicate	0.9	mg/L	Enthalpy
6/13/2017	08:04	P1-6	Blank	ND	mg/L	Babcock
	08:30	P1-6	Duplicate	2	mg/L	Babcock
6/14/2017	11:55	P3-OC3	Duplicate	3.6	mg/L	Enthalpy
6/21/2017	12:15	WW-S1	Blank	ND	mg/L	Babcock
	12:15	WW-S1	Duplicate	6	mg/L	Babcock
6/22/2017	10:52	P3-OC3	Duplicate	14.3	mg/L	Enthalpy
6/28/2017	09:17	WW-S4	Blank	ND	mg/L	Babcock
	09:34	WW-S4	Duplicate	8	mg/L	Babcock
6/28/2017	10:41	P3-OC3	Duplicate	7.7	mg/L	Enthalpy
7/6/2017	08:27	WW-M6	Blank	ND	mg/L	Babcock
	08:35	WW-M6	Duplicate	3	mg/L	Babcock
	11:02	P3-OC3	Duplicate	7.4	mg/L	Enthalpy
7/12/2017	07:37	WW-C7	Blank	ND	mg/L	Babcock
	07:37	WW-C7	Duplicate	2	mg/L	Babcock
7/13/2017	10:06	P3-OC6	Duplicate	<1	mg/L	Babcock
	11:19	P3-OC5	Duplicate	1.72	mg/L	Babcock
7/11/2017	10:55	P3-OC3	Duplicate	6	mg/L	Enthalpy
7/19/2017	10:01	P4-OC3	Duplicate	7.5	mg/L	Enthalpy
7/20/2017	09:40	P3-SBC1	Blank	ND	mg/L	Babcock
	09:40	P3-SBC1	Duplicate	ND	mg/L	Babcock
7/28/2017	09:00	P1-1	Blank	ND	mg/L	Babcock

Sample Date	Sample Time	Site ID	Sample Type	Result	Units	Lab
	09:10	P1-1	Duplicate	2	mg/L	Babcock
8/5/2017	08:45	P1-2	Blank	ND	mg/L	Babcock
	08:45	P1-2	Duplicate	20	mg/L	Babcock
8/10/2017	08:25	P1-3	Blank	ND	mg/L	Babcock
	08:33	P1-3	Duplicate	2	mg/L	Babcock
8/15/2017	10:38	P1-4	Blank	ND	mg/L	Babcock
	10:47	P1-4	Duplicate	36	mg/L	Babcock
8/22/2017	12:20	P1-5	Blank	ND	mg/L	Babcock
	12:15	P1-5	Duplicate	3	mg/L	Babcock
8/29/2017	08:30	P1-6	Blank	ND	mg/L	Babcock
	08:30	P1-6	Duplicate	ND	mg/L	Babcock
9/8/2017	09:45	WW-S1	Blank	ND	mg/L	Babcock
	09:45	WW-S1	Duplicate	8	mg/L	Babcock
9/14/2017	16:00	P3-RC1	Blank	ND	mg/L	Babcock
	16:00	P3-RC1	Duplicate	20	mg/L	Babcock
9/20/2017	07:55	WW-C3	Blank	ND	mg/L	Babcock
	08:05	WW-C3	Duplicate	20	mg/L	Babcock
10/31/2017	09:50	WW-S1	Duplicate	7	mg/L	Babcock
	09:50	WW-S1	Blank	ND	mg/L	Babcock
11/1/2017	07:54	P3-OC10	Duplicate	45	mg/L	Weck
11/8/2017	09:40	WW-S4	Blank	4	mg/L	Babcock
	09:40	WW-S4	Duplicate	4	mg/L	Babcock
11/8/2017	08:58	P3-OC1	Duplicate	18	mg/L	Weck
11/15/2017	09:30	WW-M6	Blank	ND	mg/L	Babcock
	09:30	WW-M6	Duplicate	4	mg/L	Babcock
11/16/2017	10:31	P3-OC10	Duplicate	36	mg/L	Weck
11/21/2017	07:15	WW-C7	Blank	ND	mg/L	Babcock
	07:00	WW-C7	Duplicate	2	mg/L	Babcock
11/21/2017	11:15	P3-OC1	Duplicate	31	mg/L	Weck
11/30/2017	12:40	WW-S1	Blank	ND	mg/L	Babcock
	12:50	WW-S1	Duplicate	19	mg/L	Babcock

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