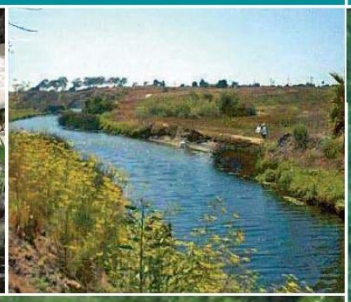
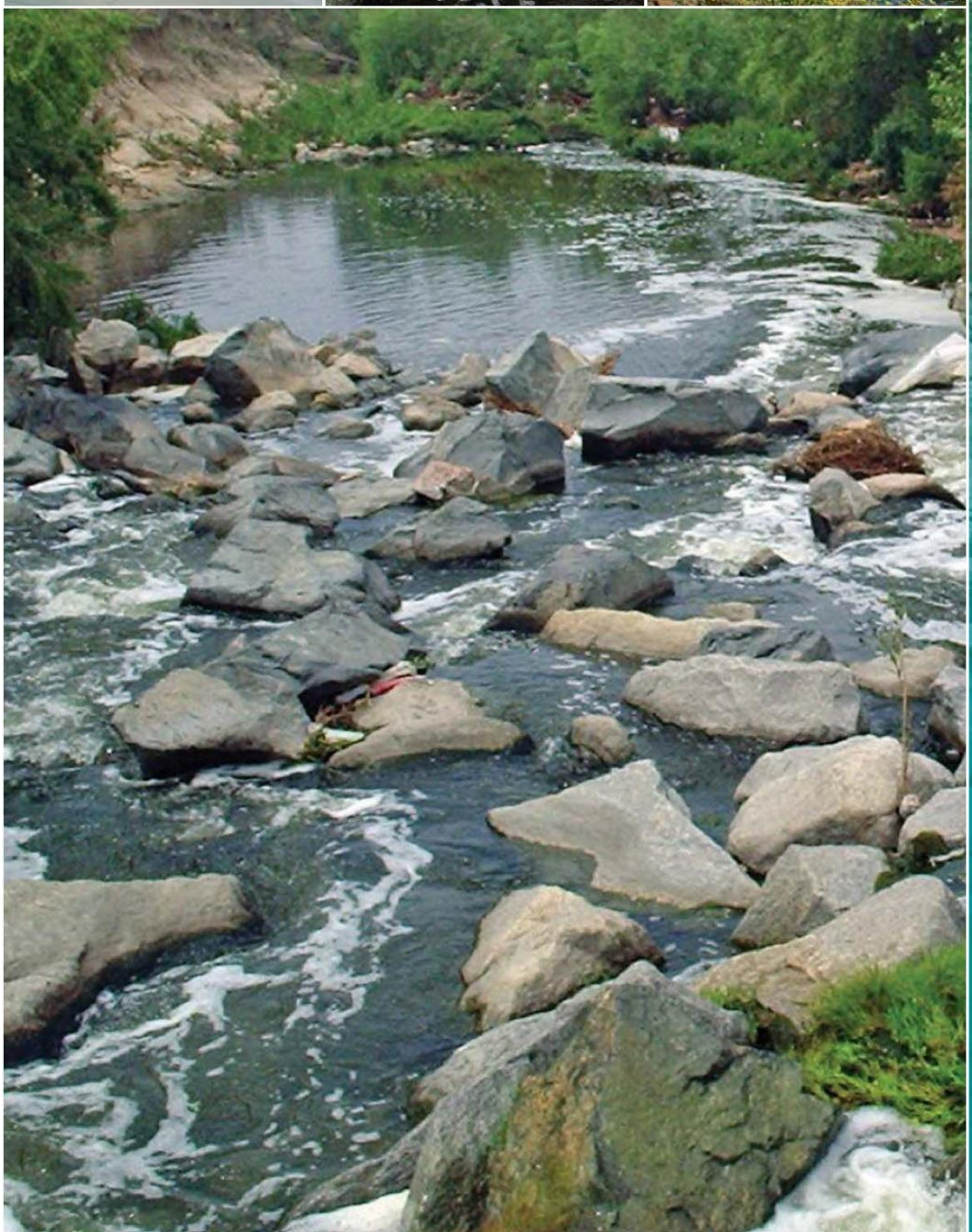
SANTA ANA WATERSHED PROJECT AUTHORITY





Santa Ana River Watershed Bacteria Monitoring Program Annual Report: 2019-2020

June 2020
Final

CDM Smith

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Acronyms and Abbreviations

AgSEP	Agricultural Source Evaluation Plan
Babcock	Babcock Laboratories, Inc.
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
MGD	Million Gallons Per Day
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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Executive Summary

The Stormwater Quality Standards Study (SQSS) Task Force was formed in 2002 to embark upon a deliberate and measured approach to protect recreational uses in inland surface waters in the Santa Ana Basin. At the time, there were few examples of such a group including water quality regulators and watershed stakeholders spread across three counties, and encompassing a mix of MS4s, agricultural groups, state lands, and POTWs coalescing together for common values. The SQSS Task Force collaborated for over a decade on a Basin Plan Amendment (BPA) that pulled from 17 recreational use surveys, six use attainability analyses (UAAs), economic feasibility assessments, hydrologic analysis, CEQA analysis, and many other special studies. Changes to the Basin Plan were approved by EPA Region 9 in April 2015 and allowed for the watershed stakeholders to focus resources on areas of highest priority to protect public health.

In 2016, the Regional Monitoring Program (RMP) was developed to supersede the SQSS. The goal of the RMP was to collect the routine bacteriological data needed to meet requirements contained in the BPA, as follows:

- Priority 1: Monitor fecal bacteria conditions in the areas of greatest risk of exposure including lakes and streams with designated beaches and active recreational use to ensure water quality objectives (WQOs) are being met or actively addressed.
- Priority 2: Evaluate effectiveness of implementation actions taken to comply with the Middle Santa Ana River (MSAR) bacteria TMDL.
- Priority 3: Collect data to evaluate status and trends in other bacteria impaired waters throughout the Santa Ana Basin.

- Priority 4: Ensure that waters re-designated as 'REC2 only' meet anti-degradation requirements in the absence of a numeric WQO.

For each of these priority categories, data are synthesized at a summary level and key interpretive findings are highlighted from this 2019-20 annual report in the following sections.

Priority 1 – Waterbody Segments with Greatest Risk of Exposure

Figure ES-1 shows that *E. coli* concentrations in Priority 1 waters remain generally low and support recreational use. Two outliers were identified from samples collected on October 30, 2019; *E. coli* in Lake Perris (2,000 MPN/100 mL) and *Enterococcus* in Lake Elsinore (2,400 MPN/100 mL – *Enterococcus* data not shown in Figure ES-1). Results in the upcoming monitoring year will be evaluated to determine if these outliers remain as such or if an intermittent source or condition may exist.

Reach 3 of the Santa Ana River is the only waterbody segment included in two priority categories; it is in Priority 1 as a result of consistent patterns of water contact recreational use by the public

(surveys from multiple swimming holes showed counts in 100s during summer months). The reach was listed as an impaired water due to fecal coliform bacteria in 1998 that led to the adoption of a TMDL for this reach in 2005. Monitoring requirements specific to this TMDL for Santa Ana River Reach 3 and other applicable waters are covered under Priority 2.

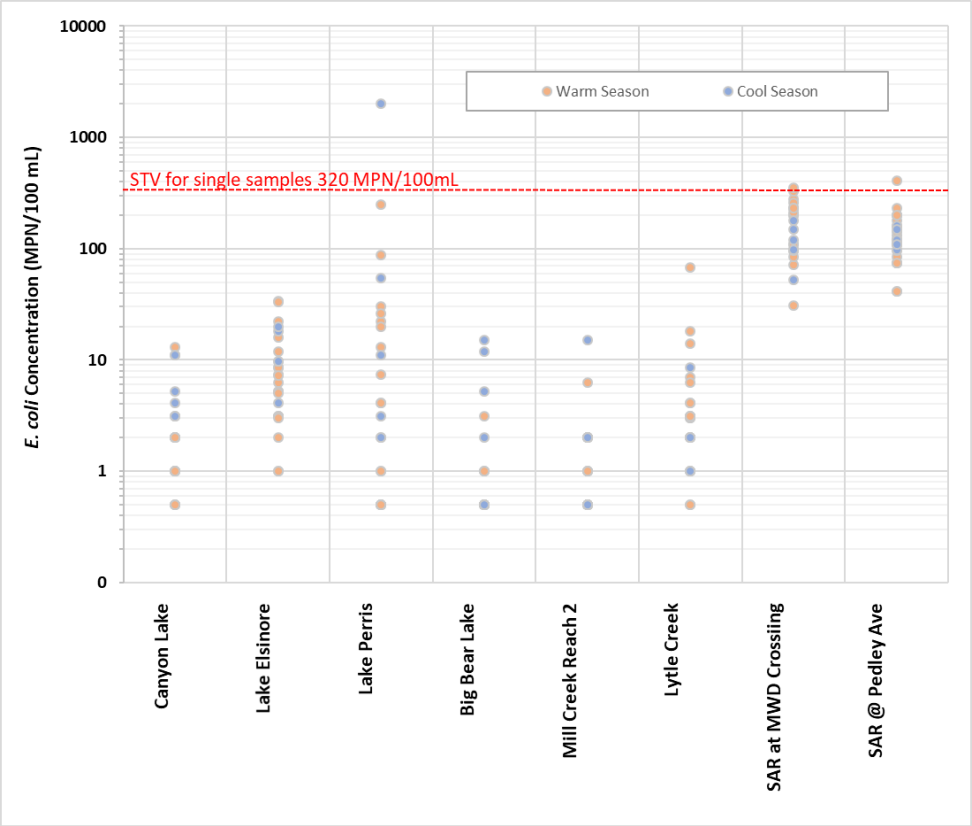

Figure ES-1. *E. coli* Concentrations during Dry Weather in Warm and Cool Seasons in 2019-2020

Priority 2 – Waters Subject to an Existing TMDL

This RMP annual report characterizes fecal bacteria conditions within the MSAR TMDL waters: Santa Ana River Reach 3, Mill-Cucamonga Creek, and Chino Creek. Concurrent to the conduct of the RMP in the 2019 dry season, a Synoptic Study was conducted to expand the Task Force's understanding of sources of fecal bacteria in the MSAR watershed. Findings from the Synoptic Study into watershed scale sources are presented in this data report to support interpretive findings focused on the receiving waters. The reader is referred to the Middle Santa Ana River Synoptic Study and TMDL Triennial Report (SAWPA, 2020) that drew several key findings regarding fecal bacteria sources, and also provided a comprehensive background on previous work by the MSAR TMDL Task Force since TMDL adoption.

The TMDL sets concentration based wasteload and load allocations (WLAs/LAs) and describes actions to be taken to reduce fecal bacteria in the Santa Ana River Reach 3 as well as Mill-Cucamonga Creek and Chino Creek. Starting in 2005, extensive efforts have been taken by the MSAR bacteria TMDL Task Force to meet the TMDL requirements, including development and ongoing implementation of watershed control plans for urban and agricultural sources. The MSAR bacteria TMDL Task Force conducted comprehensive bacteria loading analyses in 2007,

2012, and 2019 that have shown inflows of *E. coli* to the TMDL waters have declined since the TMDL was adopted. However, there has not been a proportional reduction of *E. coli* concentrations within the TMDL waters to meet numeric targets at the compliance monitoring locations (Figure ES-2).

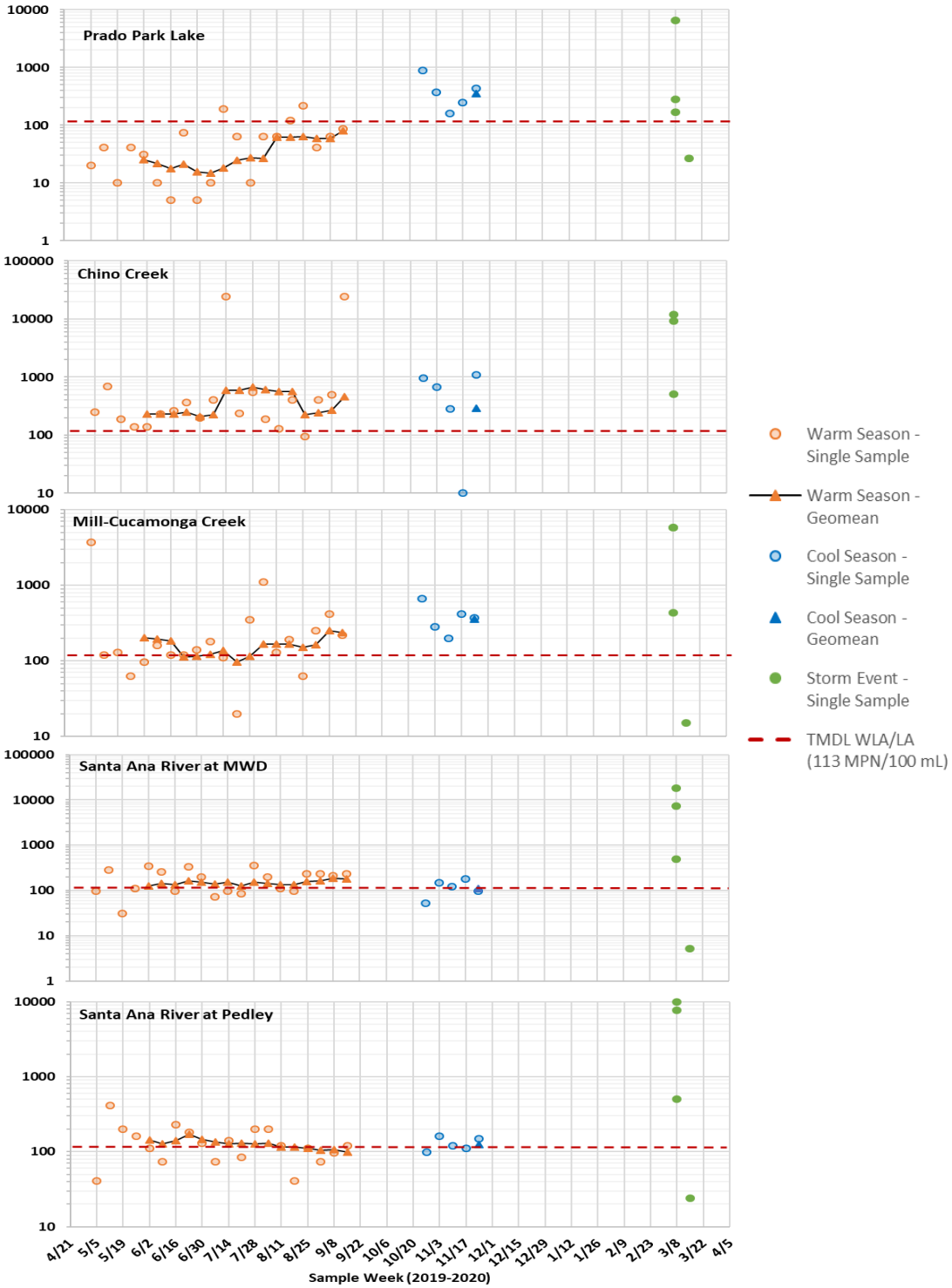

Figure ES-2. *E. coli* (MPN/100 mL) and Geomeans for Priority 2 Waters in 2019-2020

The Task Force and individual stakeholders have also implemented multiple special studies to better understand the key drivers for *E. coli* within the receiving waters (see Section 2.1.3 of the 2020 TMDL Triennial Report for comprehensive review). This collective body of work has identified several key factors that challenge the watershed stakeholders in their ability to influence *E. coli* concentrations within the TMDL waters:

- *Dynamic dry weather hydrology* - Reduction in POTW discharges from 2007 through 2019 with expansion of recycled water in the region has dramatically reduced dilution within the TMDL waters from levels that were present at the time of TMDL adoption. Over this same period, Tier 1 and 2 source investigation studies have shown that outdoor water conservation BMPs and IDDE programs have reduced dry weather flow rates and *E. coli* loads from MS4 tributaries to the TMDL waters. The dynamics of these dry weather hydrologic trends have diminished the expected water quality improvements from implementation actions.
- *Uncontrollable in-stream sources* – Uncontrollable sources that are not conveyed through the MS4 have been shown to account for the majority (77%) of the total bacteria load in the Reach 3 of the Santa Ana River. Furthermore, the 2019 study showed no relationship between *E. coli* concentration and presence of human HF 183 marker within the receiving waters. This finding strongly suggests that more of the *E. coli* observed in the Santa Ana River is coming from natural or uncontrollable sources (sediment, biofilms, wildlife) than controllable sources (MS4 discharges).

The monitoring program for Priority 2 waters also involves collection of one wet weather event per year with samples collected on day 1 of a wet weather event, followed by samples at intervals of 48, 72, and 96 hours to evaluate post-storm bacteria concentrations. *E. coli* loads during a typical wet weather sampling event were found to be comparable to the total *E. coli* load during dry weather over the entire year. In this 2019-2020 RMP data report, 12 years of storm event data were analyzed to assess how long bacteria concentrations are elevated following a wet weather event in the TMDL waters. Results showed *E. coli* concentrations return to pre-event levels generally within 24 hours from runoff returning to pre-event rates (Figure ES-3).

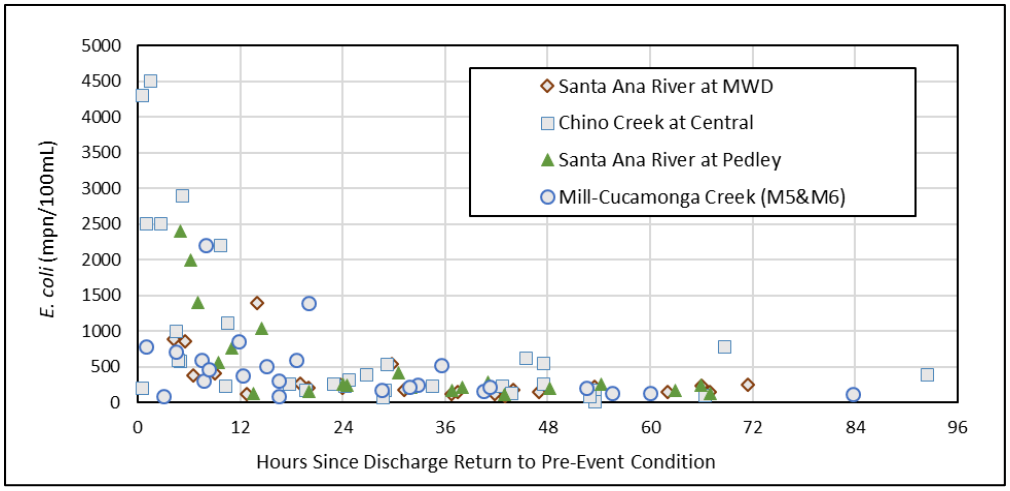

Figure ES-3. Post-storm Event Samples from MSAR TMDL Waters Plotted against the Time Since the Flow Returned to Pre-event Flow Conditions

Priority 3 – Bacteria Impaired Waters Without an Existing TMDL

The Task Force has collaborated with the Regional Board to collect five samples (collected in consecutive weeks) each dry season to characterize current fecal bacteria concentrations in waters that were added to the 303(d) list but do not have a TMDL to date. In some cases, the basis for original 303(d) listing involved data collected over 15 years ago and new monitoring data collected through this RMP has provided updated information. *E. coli* concentrations from Priority 3 waters for the 2016-19 dry seasons are compared to the dataset used for original listing decisions in Table ES-1 below.

Following the 2020 dry season sampling, the Task Force will consider next step regulatory approaches based on patterns observed over the then five-year monitoring period. Alternatives to development of new TMDLs will be assessed for each water such as non-TMDL watershed specific action plans, coverage under implementation plan for a downstream TMDL (e.g. Newport Bay), or re-designation to REC2 only with support of use attainability analyses (UAAs). Some sites may be recommended to the Regional Board for potential delisting. For example, Priority 3 monitoring data was used by the Regional Board as a basis for delisting of the Santa Ana River Reach 2 in 2016-18. Further, the 2018-19 annual report identified Santa Ana River Reach 4 as another potential candidate waterbody for delisting. Prior to the 2019-2020 monitoring period, the Task Force came to a consensus decision to increase the frequency of sampling at site P3-SBC1 (Santa Ana River at Riverside Avenue) to extend over 30 consecutive weeks in 2019-2020 to gather a sufficient dataset to compute at least 26 rolling 6-week geomeans per guidance from State Water Quality Control Board delisting policy. Results are plotted in Figure ES-4 and suggest that a delisting decision would be consistent with the guidance.

While the Santa Ana River Reach 2 was delisted in 2018-19, three new waterbody segments were determined to be impaired for fecal bacteria and added to the 303(d) list: San Timoteo Creek Reaches 1a and 2 and Warm Creek. New sites were added into the RMP for sampling beginning in 2020-21 to collect data on these waters.

Table ES-1. Comparison of the 25th and 75th Percentiles of *E. coli* Concentrations between Datasets used in Original 303(d) Listing Decision and 2016-2019 RMP in Priority 3 Waters

Waterbody	25th and 75th Quartile *E. coli* Concentration (MPN/100 mL)	
	Basis for Listing (2002-04)	Regional Monitoring Program (2016-19)
Bolsa Chica Channel	310 – 1750	20 – 168
Borrego Creek	518 – 3755	Dry
Buck Gully Creek	100 – 335	30 – 134
Morning Canyon Creek	100 – 300	240 – 1461
Peters Canyon Wash	100 – 1100	179 – 428
San Diego Creek Reach 1	100 – 520	135 – 350
San Diego Creek Reach 2	100 – 1455	75 – 270
Serrano Creek	100 – 1460	161 – 1582
Goldenstar Creek	100 – 200	110 – 515

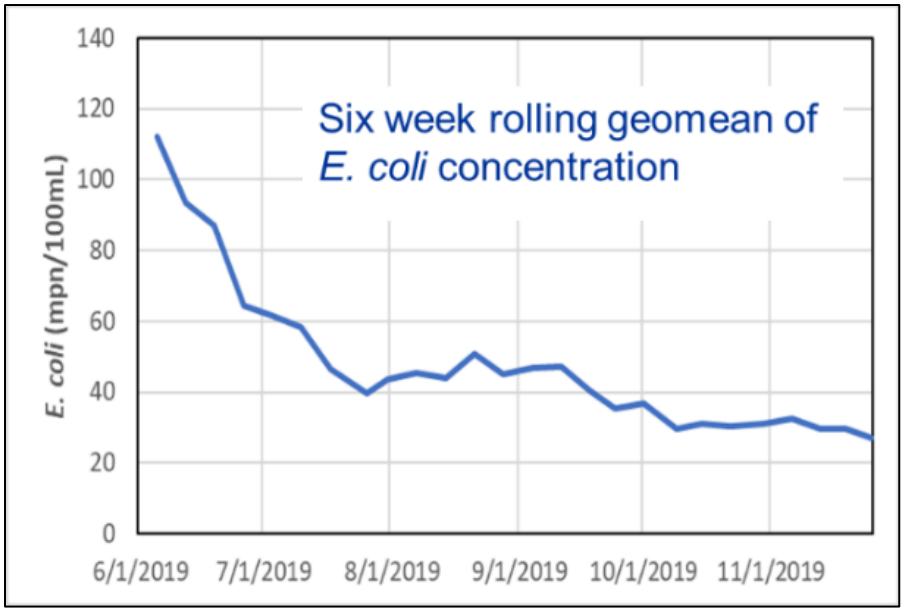

Figure ES-4. Rolling 6-week Geometric Means of E. coli Concentration in the Santa Ana River Reach 4 at Riverside Avenue

Priority 4 – Waters Re-Designated as REC2 Only

A key component to the 2012 BPA involved the completion of six use attainability analyses (UAAs) that served as the basis for EPA approval of changes to the beneficial use from REC1 and REC2 to REC2 only in six waterbodies: Cucamonga Creek Reach 1, Temescal Creek Reach 1a and 1b, Santa Ana Delhi Channel Reaches 1 and 2, Greenville-Banning Channel Reach 1, and tidal prisms for Greenville-Banning and Santa Ana Delhi Channels. The Basin Plan describes REC2 only waters as having "…relatively brief incidental or accidental water contact that is limited primarily to the body extremities (e.g., hands or feet) is generally deemed REC 2 because ingestion is not considered reasonably possible." Numeric water quality objectives included in the Basin Plan for REC2-only waters serve to meet antidegradation policy requirements. Statistical analysis of historical datasets on the re-designated waters was performed to derive an anti-degradation target as a statistical threshold value set at the 75th percentile of the data distribution. Each year, the RMP specifies a single sample in these waters to be compared with the site-specific thresholds. If there is an exceedance, follow up samples are collected to ensure that the event falls within the natural variability of the historical data (i.e. there is a 1 in 4 chance that a sample may exceed the 75th percentile without indicating any antidegradation is occurring). In the 2019-2020 monitoring period, an exceedance of the threshold value occurred in the Santa Ana Delhi Channel (*Enterococcus*: 464 MPN/100 mL). Follow up sampling over three consecutive months fell below the threshold indicating that no evidence of degradation (Table ES-2).

Table ES-2. *E. coli* Concentrations in Samples Collected to Meet Anti-degradation Target in Santa Ana Delhi Channel in 2019-2020

Sample Requirement	Sample Date	*Enterococcus* Concentration (MPN/100 mL)
Annual Sample	9/23/2019	988
Required Monthly Follow-up Samples	10/21/2019	31
	11/18/2019	10
	12/15/2019	185

The Task Force has showed that changing hydrologic conditions warrant a change to the anti-degradation target for Cucamonga Creek Reach 1. Historical review of data from USGS gauge 11073495, Cucamonga Creek at Merrill Avenue, shows that typical dry weather flow rates in Cucamonga Creek Reach 1 in the early 2000s ranged from 25-50 cfs. Currently, dry weather flow rates have declined by an order of magnitude (typically <10 cfs) in this segment of Cucamonga Creek due to increased recycled water use. Thus, changes to fecal bacteria concentrations may have resulted from a change to hydrologic condition, which is largely attributable to IEUA's expansion of recycled water use over this same time period. To support an update to anti-degradation target using the same statistical method employed in the 2013 calculations, the Task Force approved an increase to the frequency of monitoring at the P4-SBC1 site from once per year to monthly in 2018-19 and as needed thereafter to develop a sufficient *E. coli* concentration dataset. Water quality sampling is planned to continue through 2020-21 program year and a preliminary calculation of a new antidegradation target will be included in the 2020-21 annual RMP report.

Retrospective

It has been nearly two decades since the SQSS Task Force was formed and its successor in 2016, the Regional Monitoring Program Task Force, is continuing to collaborate on common objectives to protect recreational use in the region's inland surface waters. We have accomplished so much including the advancement of scientific understanding of fecal bacteria sources in urban watersheds, taking action to address fecal bacteria impairments with source investigation and structural controls, and using the tools afforded in the Clean Water Act to prioritize use of resources to protect public health. Tim Moore of Risk Sciences (regulatory expert to the Task Force since inception of the SQSS in 2002) once said, "the single most important element to make our Task Force effective is not the scientific or regulatory expertise of its individuals, but rather faith in the collective benefits from working together and courage to stay together despite numerous outside pressures that want to divide us…" It is apparent that the approach is working; as evidenced by improving water quality conditions in most of the SAR basin's inland surface waters and significant investments in studies and implementation projects in the waters with the highest risk of exposure.

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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 through bacteria monitoring:

- 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

- Revision of 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 the BPA in collaboration with the Stormwater Quality Standards Task Force (SWQSTF), composed 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 Statewide Bacteria Provisions

On August 7, 2018, the State Water Resources Control Board adopted *Bacteria Provisions and a Water Quality Standards Policy for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (Statewide Bacteria Provisions)[7]. The Statewide Bacteria Provisions developed new statewide numeric water quality objectives for bacteria to protect primary contact recreation beneficial use, as follows:

- *E. coli*: For all waters where the salinity is equal to or less than 1 part per thousand (ppth) 95 percent or more of the time, a six-week rolling geometric mean not to exceed 100 cfu/100 mL, calculated weekly, and a statistical threshold value (STV) of 320 cfu/100 mL not to be exceeded by more than 10 percent of the samples collected in a calendar month, calculated in a static manner.
- *Enterococcus*: For all waters where the salinity is greater than 1 ppth 95 percent or more of the time, a six-week rolling geometric mean not to exceed 30 cfu/100mL, calculated weekly, and a STV of 110 cfu/100 mL not to be exceeded by more than 10 percent of the samples collected in a calendar month, calculated in a static manner.

The Statewide Bacteria Provisions supersede numeric WQOs for REC1 use contained in regional Basin Plans, except for cases involving a site-specific standard or if an existing TMDL was developed with targets based on prior regional Basin Plan REC1 WQOs (such as the MSAR Bacteria TMDL). The following section describes the MSAR Bacteria TMDL and associated numeric targets, which differ from those included in the Statewide Bacteria Provisions. This

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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

[7] State Water Board Resolution: 2018-0038, August 7, 2018

comprehensive monitoring program was developed to facilitate data collection needed to evaluate both TMDL numeric targets and Statewide Bacteria Provisions WQOs for the TMDL waters. Compliance metrics, however, are based solely on the TMDL numeric targets.

Lastly, the Statewide Bacteria Provisions do not supersede narrative WQOs in regional Basin Plans. The BPA to *Revise Recreation Standards for Inland Freshwaters in the Santa Ana Region* is composed of predominantly narrative criteria, which remain in effect for the Santa Ana region. The narrative criteria in the BPA are largely consistent with narrative criteria contained in the Statewide Bacteria Provisions.

1.1.3 MSAR Bacteria TMDL

Currently, there is one bacteria TMDL adopted for inland freshwater streams in the Santa Ana River Watershed, the MSAR Bacteria TMDL, which was adopted by Santa Ana Water Board in 2005[8] and became effective when approved by the EPA 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

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 become ineffective upon EPA approval of the BPA.[9]

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

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

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.[10] 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.[11] 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.[12]

1.1.4 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 percentile of the fitted lognormal distribution was selected as the antidegradation target when relying on a single sample result. Table 1-1 summarizes the antidegradation targets for the REC2 waterbodies included in the SAR RMP.

Table 1-1. Antidegradation 75th Percentile Targets for Waterbodies with only a REC2 Designation in the SAR RMP

Waterbody	*E. coli* (MPN/100 ML)	*Enterococcus* (MPN/100 ML)
Temescal Creek Reach 1a/1b	725 MPN/100 mL	
Santa Ana Delhi Channel Reach 1/2	1,067 MPN/100 mL	
Santa Ana Delhi Channel in Tidal Prism[1]		464 MPN/100 mL
Greenville-Banning Channel in Tidal Prism[1]		64 MPN/100 mL
Cucamonga Creek Reach 1	1,385 MPN/100 mL	

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

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

[12] SAR Monitoring Plan and QAPP Version 2.0 August 2019: http://www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/recreational_standards.shtml

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.

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.

1.2.1 Priority Designation

Basin Plan requirements for an 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 waterbodies 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 sample collection for 5 consecutive weeks on an annual basis. Data from Priority 3 sites are 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 are 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 updated on June 28th, 2019.

1.2.3 Annual Report

This Annual Report summarizes the results of the 2019-2020 monitoring efforts. Annual Reports summarizing monitoring efforts from 2016-2018 are available from SAWPA.[14] Previous seasonal water quality reports prepared only for the sites subject to the MSAR Bacteria TMDL (2007 – 2015) are also available.[15]

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[13] SAR RMP Monitoring Plan and QAPP, Version 2.0, August 2019: http://sawpa.org/task-forces/regional-water-quality-monitoring-task-force/#geographic-setting

[14] SAR RMP Annual Monitoring Reports 2016-2018: https://sawpa.org/task-forces/regional-water-quality-monitoring-task-force/#geographic-setting

[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 2019-2020 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 Harbor and Coyote Creek.

2.1.2 Middle Santa Ana River Watershed

The MSAR watershed exists within the region Santa Ana River above Prado Dam and Chino Basin Region and covers approximately 488 square miles. The MSAR watershed 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.

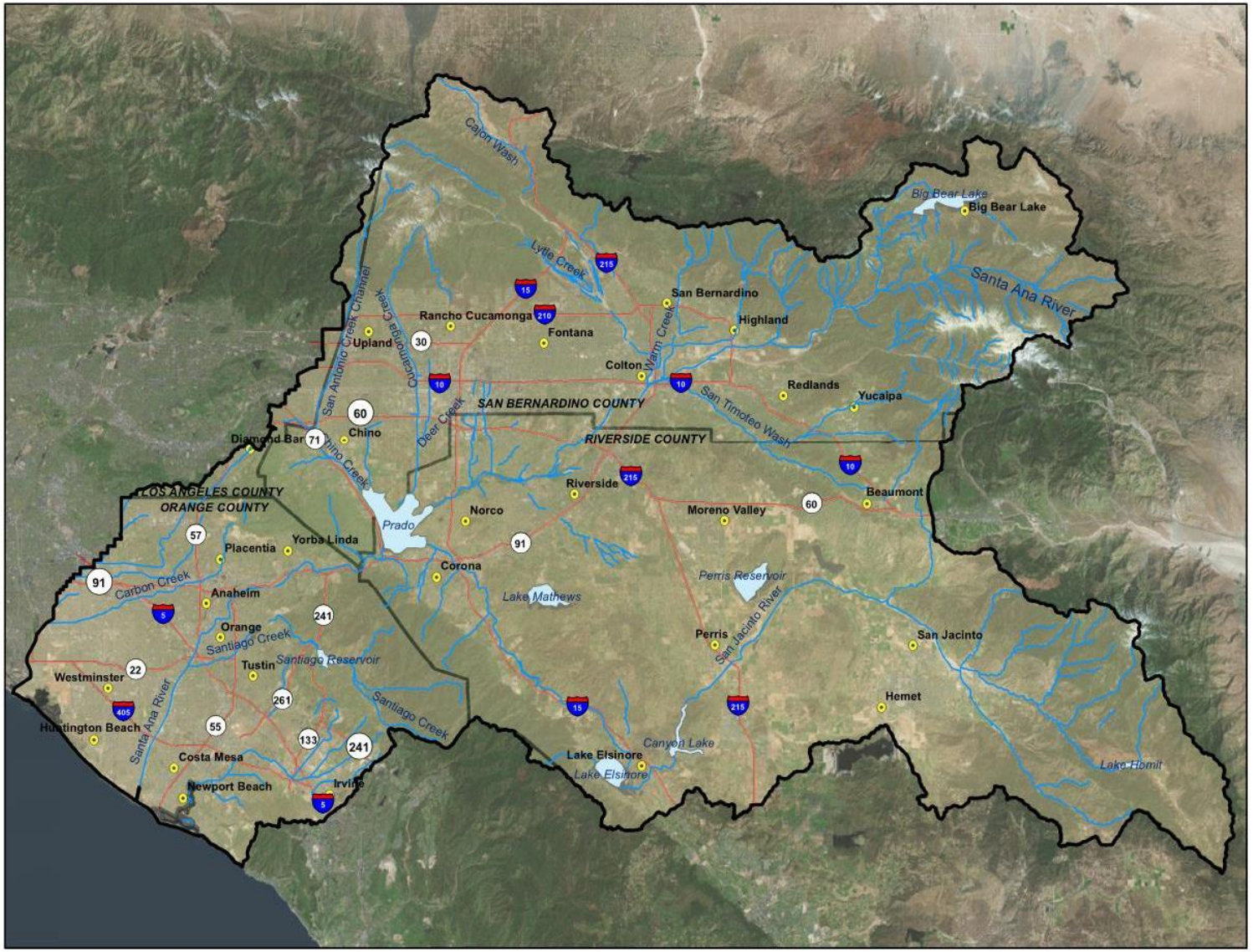

Figure 2-1. Santa Ana River Watershed and Location of Orange, Riverside and San Bernardino Counties (Source: SAWPA)

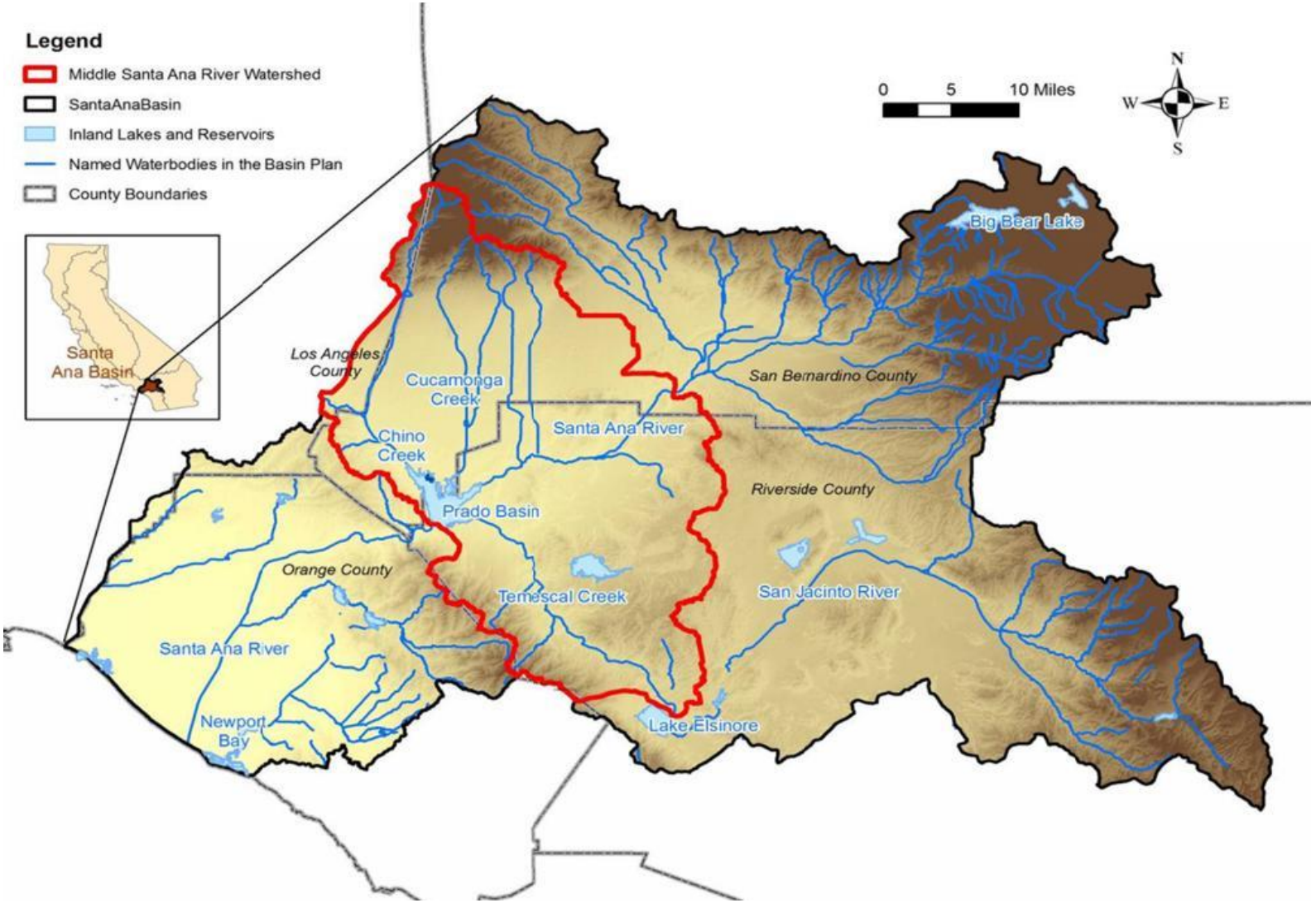

Figure 2-2. Middle Santa Ana River Watershed

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 2019-2020 monitoring 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 2019 at Key Rainfall Gages

Station No.	Rainfall Gage	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
178	Riverside North	2.67	5.78	1.80	0.09	0.95	0	0	0	0	0	1.87	2.79	15.95
179	Riverside South	2.20	5.11	1.60	0.00	0.91	0	0	0	0	0	1.83	2.97	14.62
35	Corona	3.8	8.1	3.35	0.04	1.27	0.01	0	0	0	0	2.34	3.96	22.91
131	Norco	3.0	5.4	2.3	0.05	0.76	0	0	0	0	0	2.01	3.53	16.98
67	Elsinore	2.5	6.0	1.59	0.00	0.68	0	0.11	0.02	0	0.02	2.26	3.79	16.99
90	Idyllwild	15.9	18.6	3.66	0.28	3.45	0	0.02	0	0.54	0	2.09	5.19	49.76
9022	Fawnskin	3.32	8.52	3.12	0.04	1.36	0.04	0.08	0.00	0.16	0	1.04	3.48	21.16
2965	Lytle Creek Canyon	8.44	10.36	3.80	0	1.00	0	0	0	0	0	3.44	4.88	31.92
2808	Highland Plunge Creek	4.52	7.84	2.16	0.32	2.52	0.00	0.00	0	0.16	0	2.80	2.88	23.20
61	Tustin-Irvine Ranch	4.67	7.69	2.00	0.15	1.04	0.18	0.04	0	0.07	0	2.31	4.48	22.63
169	Corona del Mar	5.39	5.78	1.32	0.13	0.68	0.02	0.04	0	0.06	0	2.74	4.65	20.81
219	Costa Mesa Water District	5.09	4.85	1.32	0.13	0.49	0.04	0.02	0	0	0	2.31	5.42	19.67
163	Yorba Reservoir	5.91	7.67	2.29	0.22	0.93	0	0	0	0	0	2.54	4.22	23.78
5	Buena Park	5.60	5.38	2.16	0.12	0.76	0.07	0.02	0	0	0	2.24	4.94	21.29

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 be collected only if there is no measurable rainfall in the preceding 72-hour period.

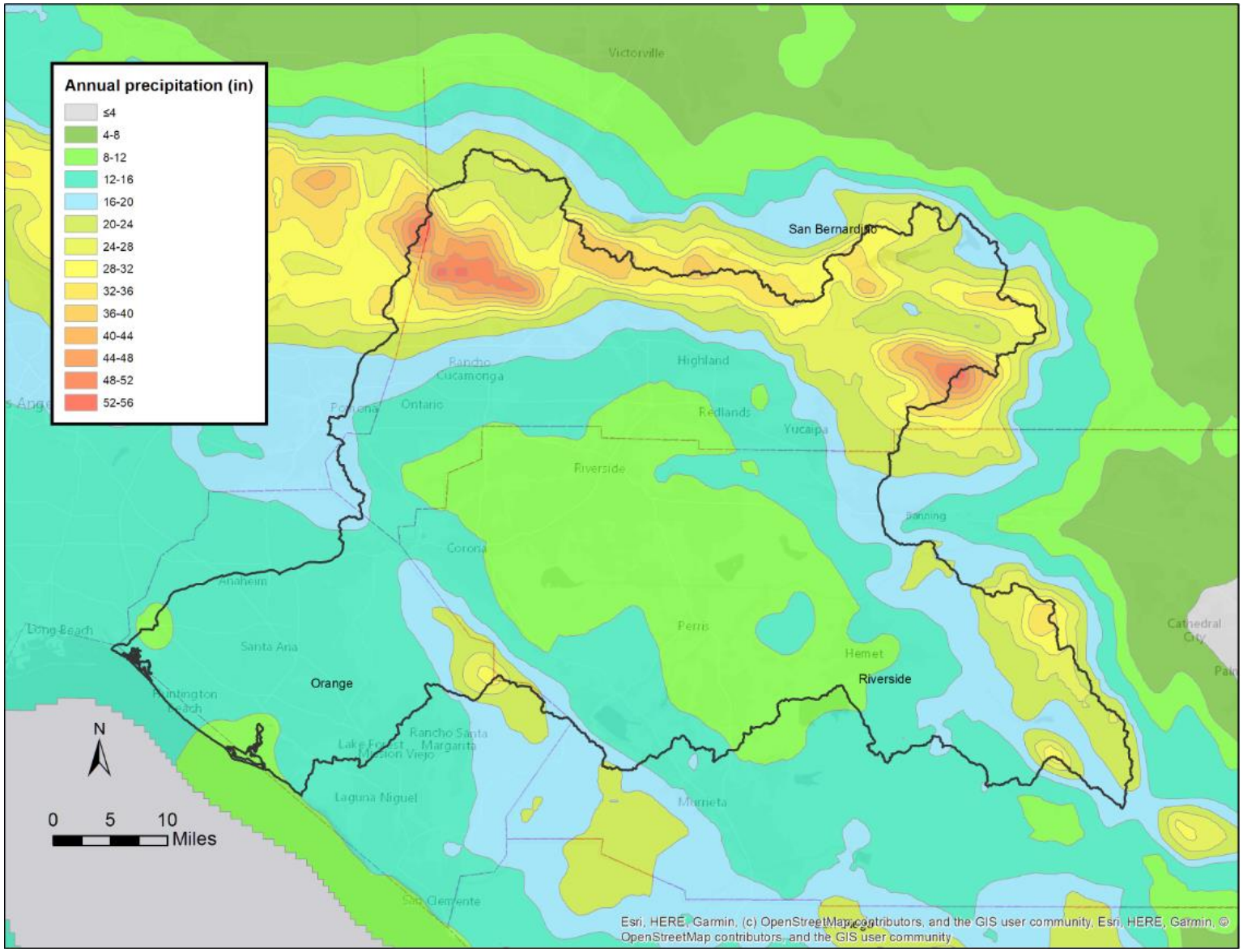

Figure 2-3. Historical Average Annual Rainfall in the Santa Ana River Watershed from 1980-2010

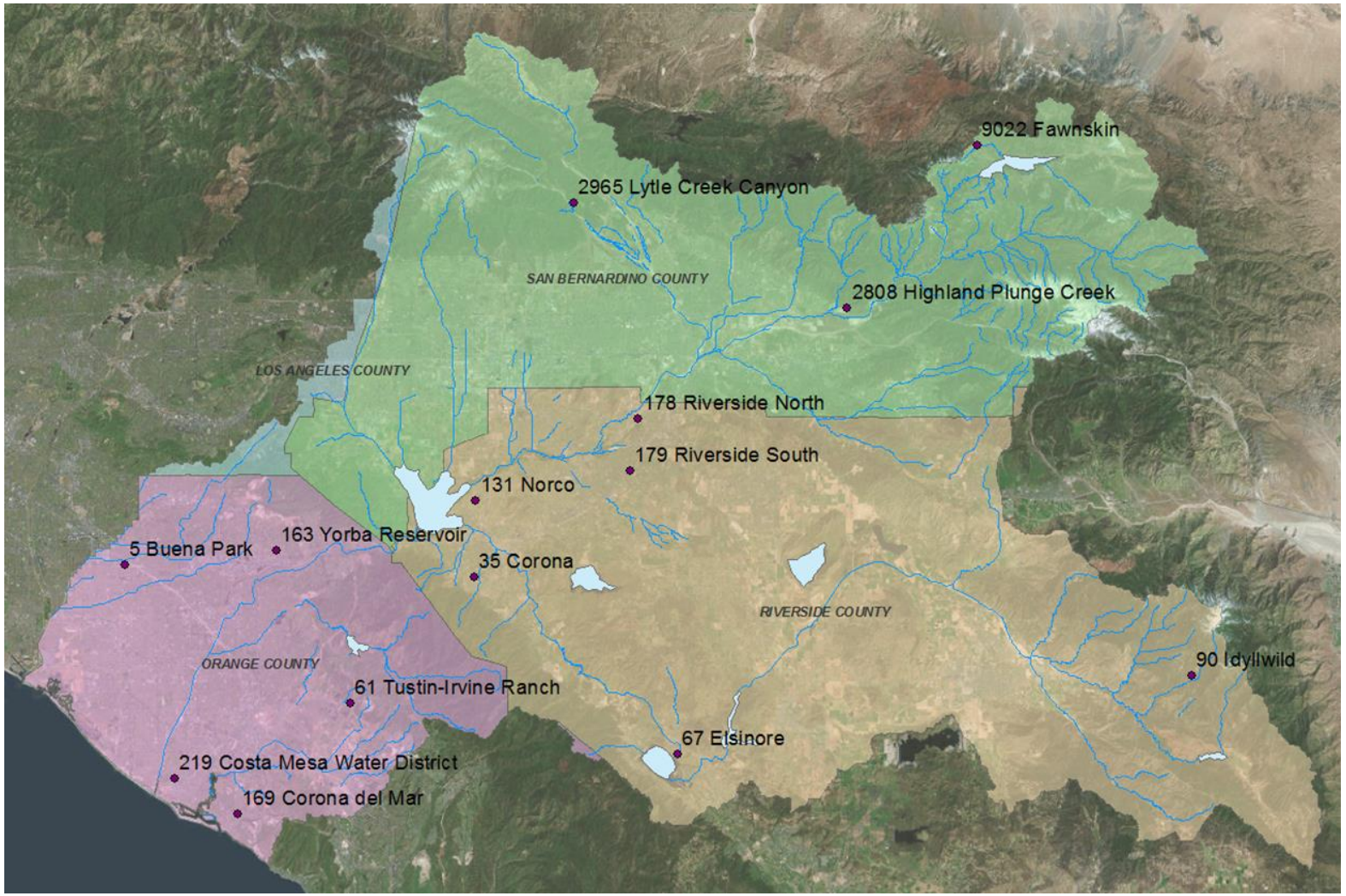

Figure 2-4. Key Rainfall Gages

2.2 Monitoring Locations

The following sections describe the monitoring sites based on priority designations described in Section 1.2.1.

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

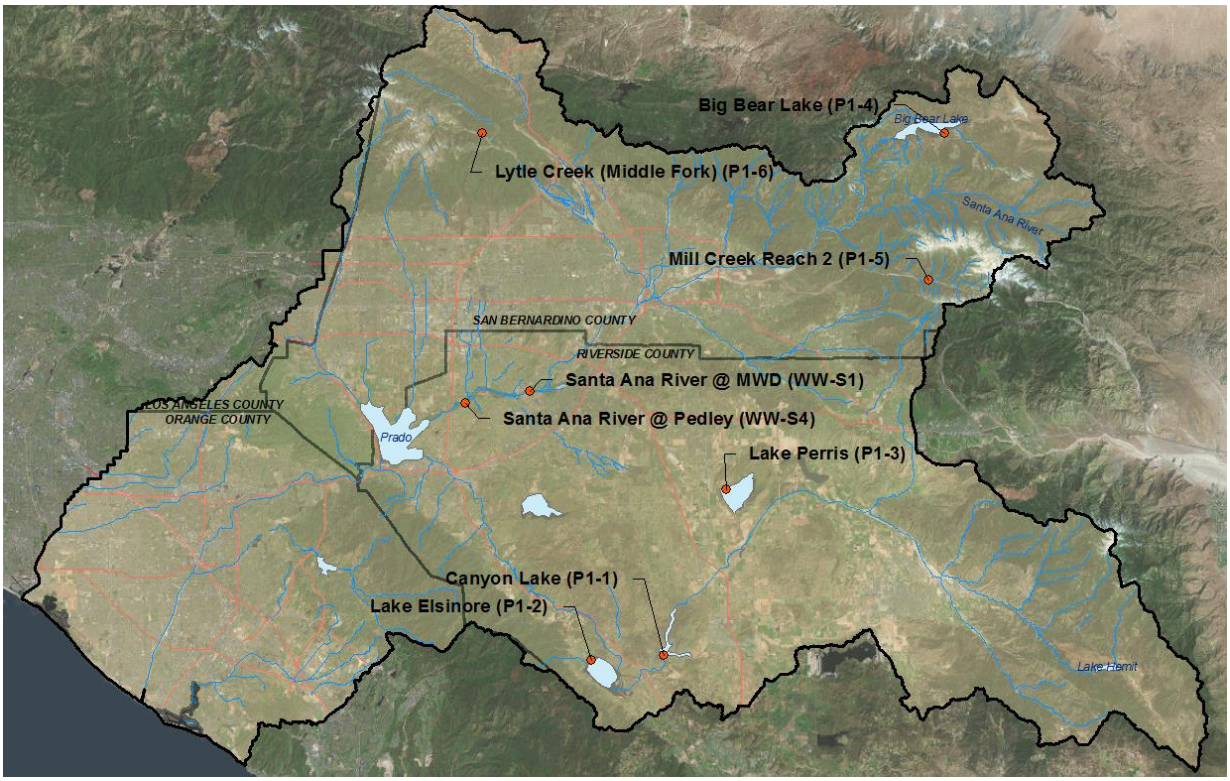

Figure 2-5. Priority 1 Monitoring Sites

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.

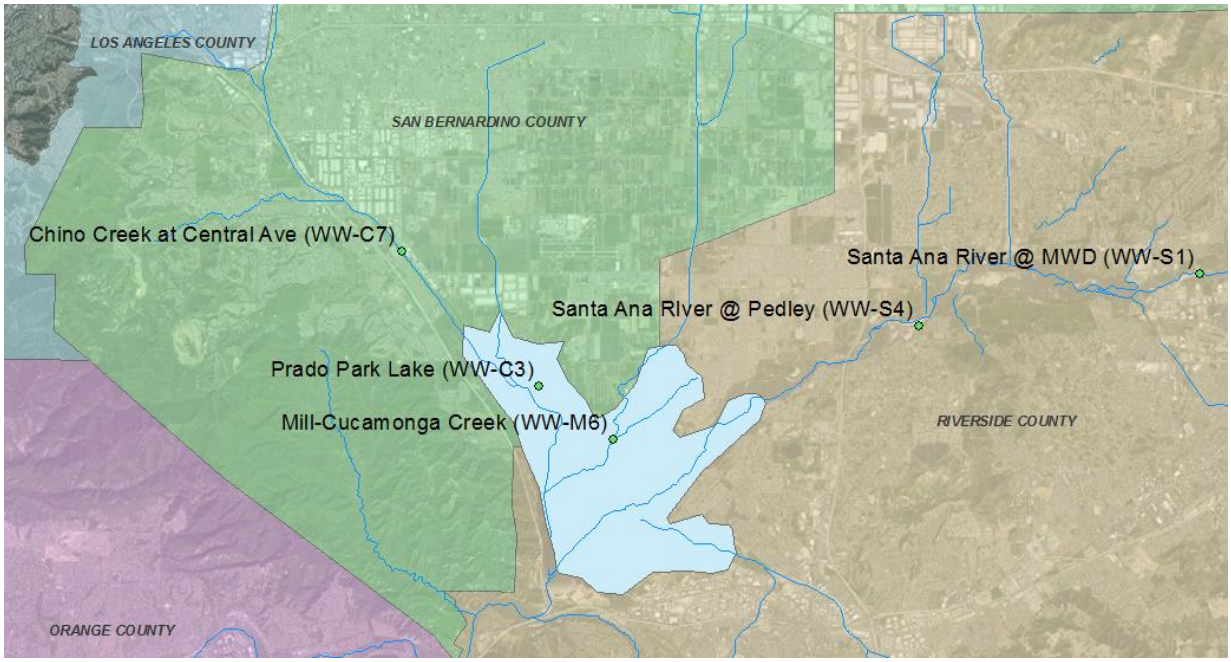

Figure 2-6. Priority 2 Monitoring Sites

2.2.3 Priority 3

In the Santa Ana River watershed, 23 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 original RMP for reasons described in the Monitoring Plan Section 3.3.3.2. Of the eleven waterbodies that are monitored in the RMP in 2019-2020, nine are located in Orange County, one 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
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-SBC1	Santa Ana River Reach 4 above S. Riverside Avenue Bridge	San Bernardino	34.0248	-117.3628

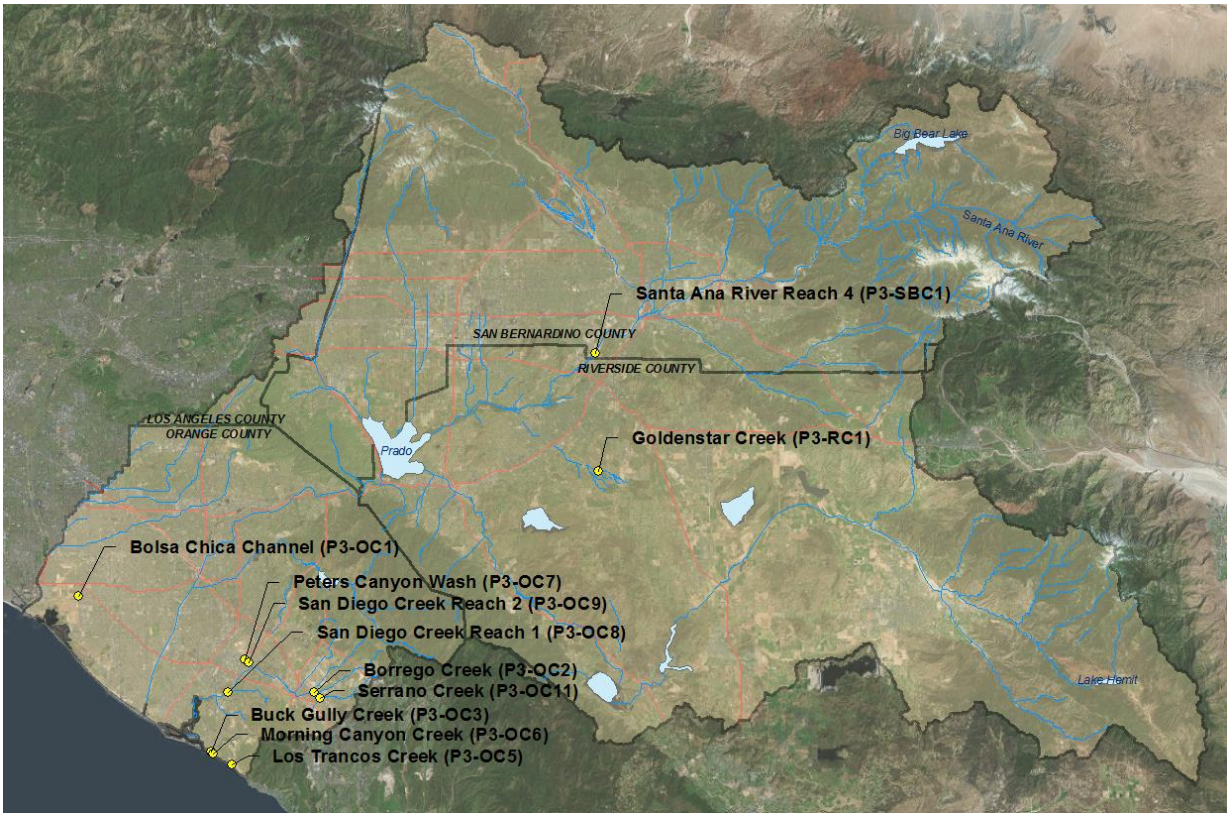

Figure 2-7. Priority 3 Monitoring Sites

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

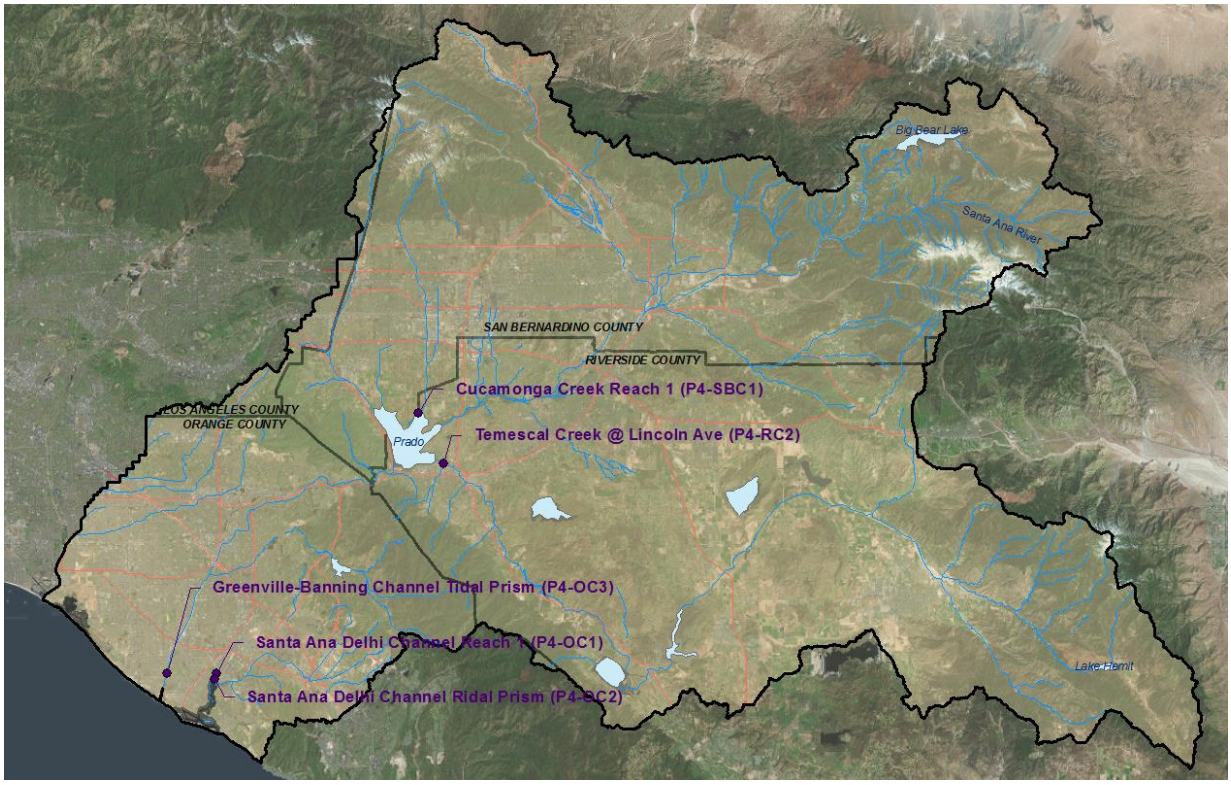

Figure 2-8. Priority 4 Monitoring Sites (top: Riverside County and San Bernardino County; bottom: Orange County)

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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 – September 30) and cool, dry (October 1 – November 30) season periods. Sample collection target schedule 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 5, 2019 through September 22, 2019. Dry weather, cool season monitoring occurred over a five-week period from October 20, 2019, through November 24, 2019. 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, dry season.
- Priority 3 sites were monitored weekly for five consecutive weeks during the warm or cool, dry 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. Santa Ana Delhi Channel in Tidal Prism (P4-OC2) did not meet the site-specific antidegradation target in 2019 and required three monthly follow-up samples. All other Priority 4 sites met their antidegradation targets in 2019 and did not require additional sampling.

3.1.2 Wet Weather

Wet weather sample collection occurs during the wet season (November 1 – March 31). 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 2019-2020 wet season, the March 10, 2020 storm was monitored with samples collected on March 10, 12, 13, and 16, 2020.

3.1.3 Summary of Sample Collection Effort

In general, the 2019-2020 monitoring program was successful in meeting the requirements with the exception of some events where site conditions could not accommodate sampling. Differences

between planned and executed sampling events are summarized in Table 3-1 and described as follows:

- Two sites (Borrego Creek and Los Trancos Creek) were dry during the monitoring period. Although field crews went to each site during each scheduled monitoring event, samples from those sites were not collected due to dry conditions.
- Although only five weeks of monitoring were required for Priority 3 sites, a sixth week of monitoring (and sample collection) was conducted at Goldenstar Creek. This aligns better with State provisions that request a 6-week sampling range with at least 5 samples collected. The 6th sample allows for a more robust geomean calculation and provides protection against sample loss.
- Additional samples were collected at Santa Ana River Reach 4 to begin developing an increased dataset for potential delisting from the 303(d) List of Impaired Water in the future.

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	125	20
Priority 3	Planned	80	0
	Collected	71[A]	0
Priority 4	Planned	16	0
	Collected	19[B]	0

[A] Five samples were not collected at Borrego Creek (P3-OC2) and five samples were not collected from Los Trancos Creek (P3-OC5) as conditions were dry during each monitoring event; one extra sample was collected at Goldenstar Creek (P3-RC1).
[B] Three additional samples were collected at Santa Ana Delhi Channel in Tidal Prism (P4-OC2) due to an exceedance of the antidegradation target.

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 three sites in this Regional Monitoring Program.
- *Enterococcus* is quantified at Lake Elsinore (P1-2) and two Orange County sites, Santa Ana Delhi Channel in Tidal Prism (P4-OC2) and Greenville-Banning Channel in Tidal Prism (P4-OC3) due to persistence of salinities greater than 1ppt.

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 and Enthalpy Analytical 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 2019-2020 dataset, which includes the 2019 dry season and the 2019-2020 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 are summarized and compliance is assessed using water quality standards or antidegradation targets established by the BPA 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 two Santa Ana River sites were within the allowable pH range of 6.5 to 8.5, established by the EPA water quality standards. Eight percent of samples at Lytle Creek and four percent of Mill Creek samples exceeded the upper allowable pH limit. At the four lake sites, pH observations are higher than in flowing waters, with 44 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°Celsius) at higher elevations and higher ambient air temperatures (median greater than 23°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. WQOs for minimum DO for waterbodies with the WARM and COLD habitat beneficial use designations are 5 mg/L and 6 mg/L, respectively.[19] These standards were met at all Priority 1 sites except for 10 percent of measurements taken at Canyon Lake and 20 percent of measurements taken at Lake Elsinore.

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

- 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 300 µS/cm at two sites and less than 500 µS/cm at Big Bear Lake) than sites located in the downstream portions of the watershed (500 to 1,100 µS/cm). Waterbodies in the upper watershed generally consist of rain and snow melt, while waterbodies in the lower watershed also include groundwater baseflow and runoff, which commonly have higher salt concentrations. Lake Elsinore exhibits particularly high conductivity (3,395 to 3,940 µS/cm), which is not unusual for a terminal lake.
- Turbidity for the eight sites remained generally low with the exception of outlier samples taken on the same day at SAR at MWD Crossing and SAR at Pedley Avenue (253 NU and 233 NTU). These samples were attributed to wet weather that occurred early in the monitoring season. Stations with the greatest variability throughout the year were Lake Perris and Big Bear Lake (0 NTU to 76 NTU).
- Similar to turbidity, TSS at the eight sites remained generally low with the exception of an outlier sample taken at Lake Perris (280 mg/L). This sample was taken at the beginning of the cool, dry season and while there were no quality assurance concerns, the sample was deemed atypical. TSS had the greatest range at SAR at MWD Crossing and SAR at Pedley Avenue (2 to 210 mg/L).
- Flow is lower at the upstream sites, Mill Creek Reach 2 (9 to 55 cubic feet per second [cfs]) and Lytle Creek (5 to 35 cfs). Flow is greatest at SAR at Pedley Avenue (53 to 338 cfs), which is fed 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

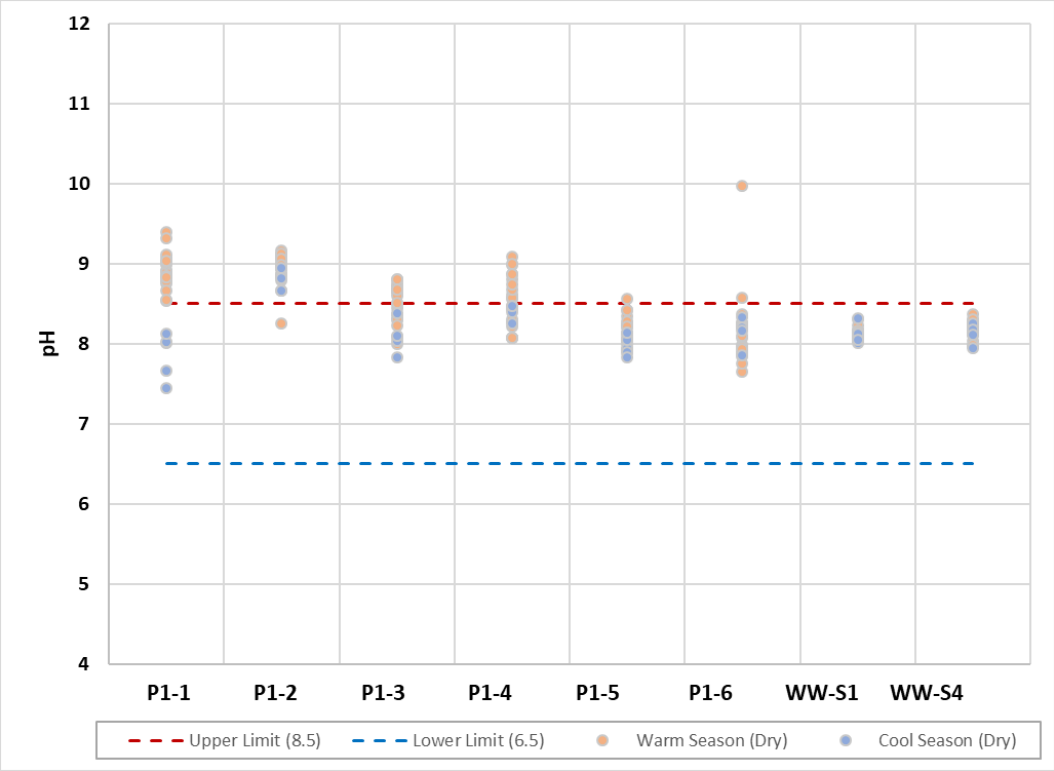

Figure 4-1. Distribution of pH Measurements at Priority 1 Sites

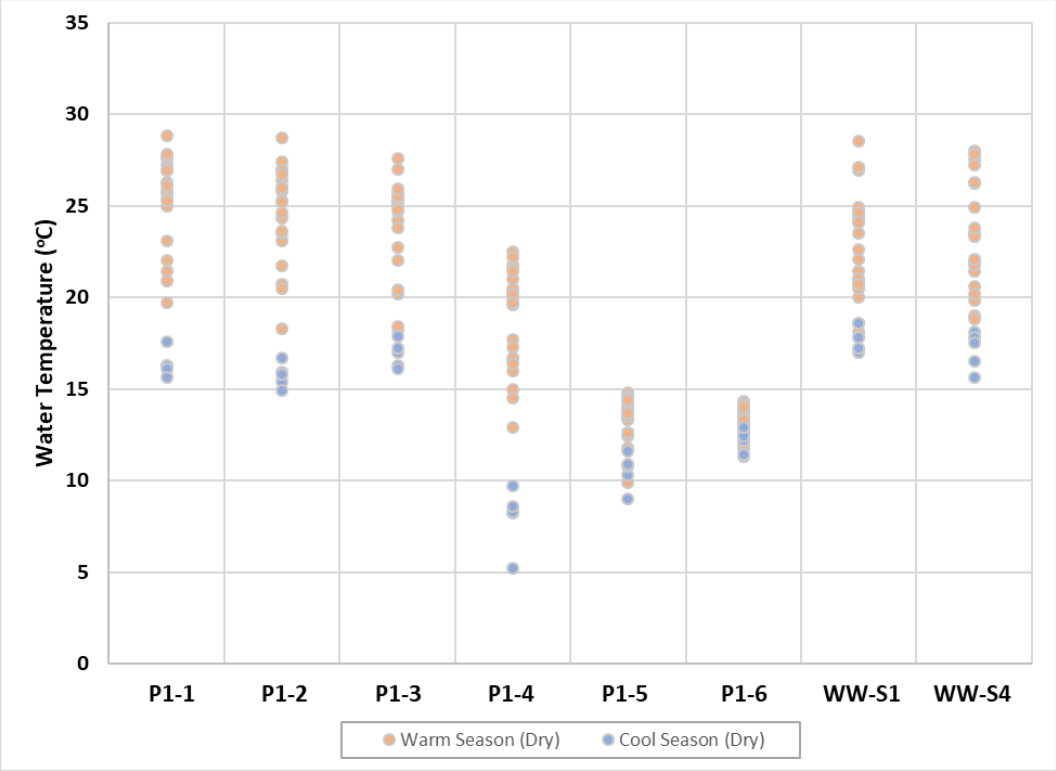

Figure 4-2. Distribution of Water Temperature Measurements at Priority 1 Sites

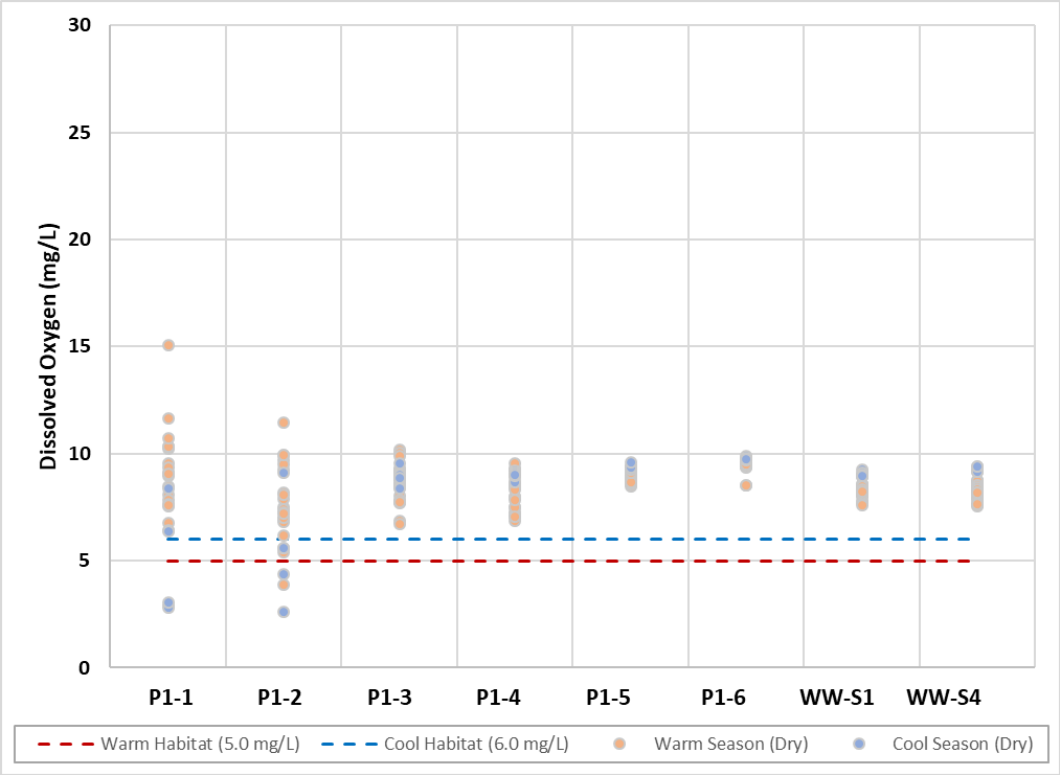

Figure 4-3. Distribution of Dissolved Oxygen Measurements at Priority 1 Sites

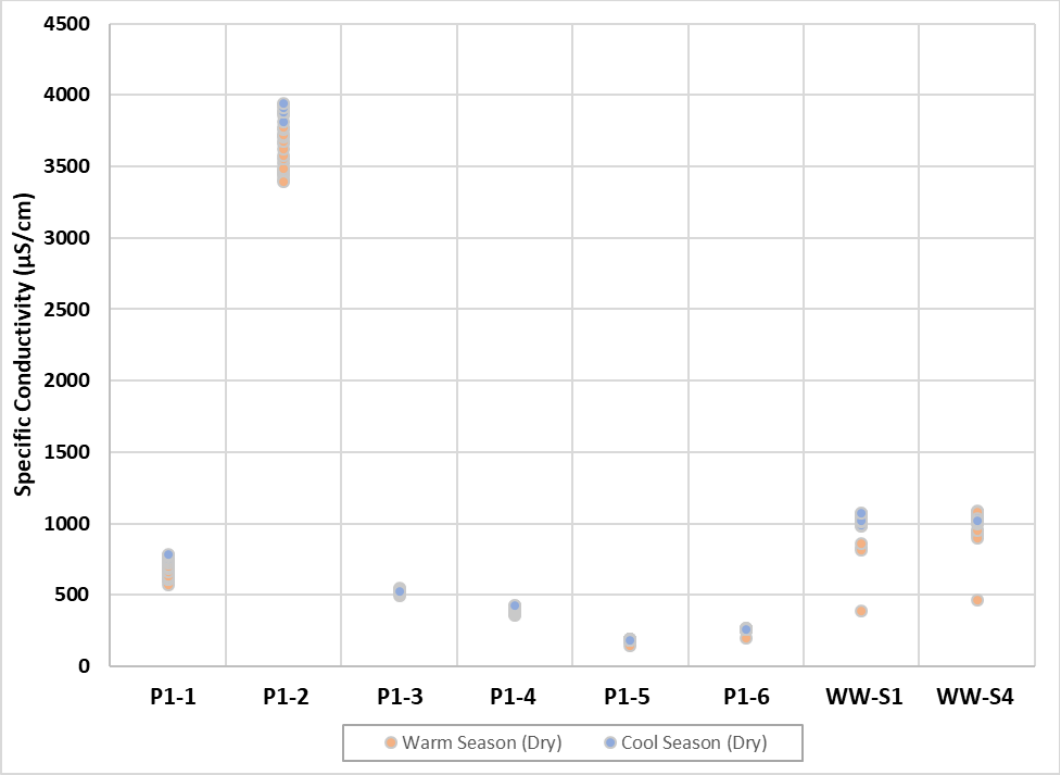

Figure 4-4. Distribution of Specific Conductivity Measurements at Priority 1 Sites

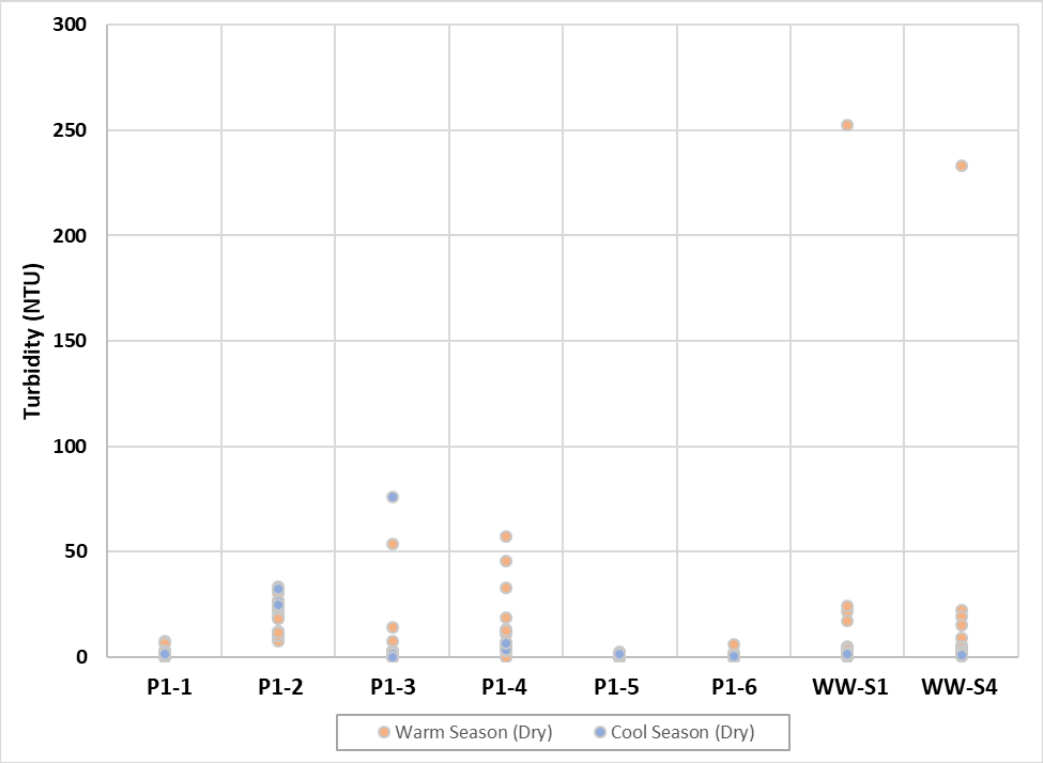

Figure 4-5. Distribution of Turbidity Measurements at Priority 1 Sites

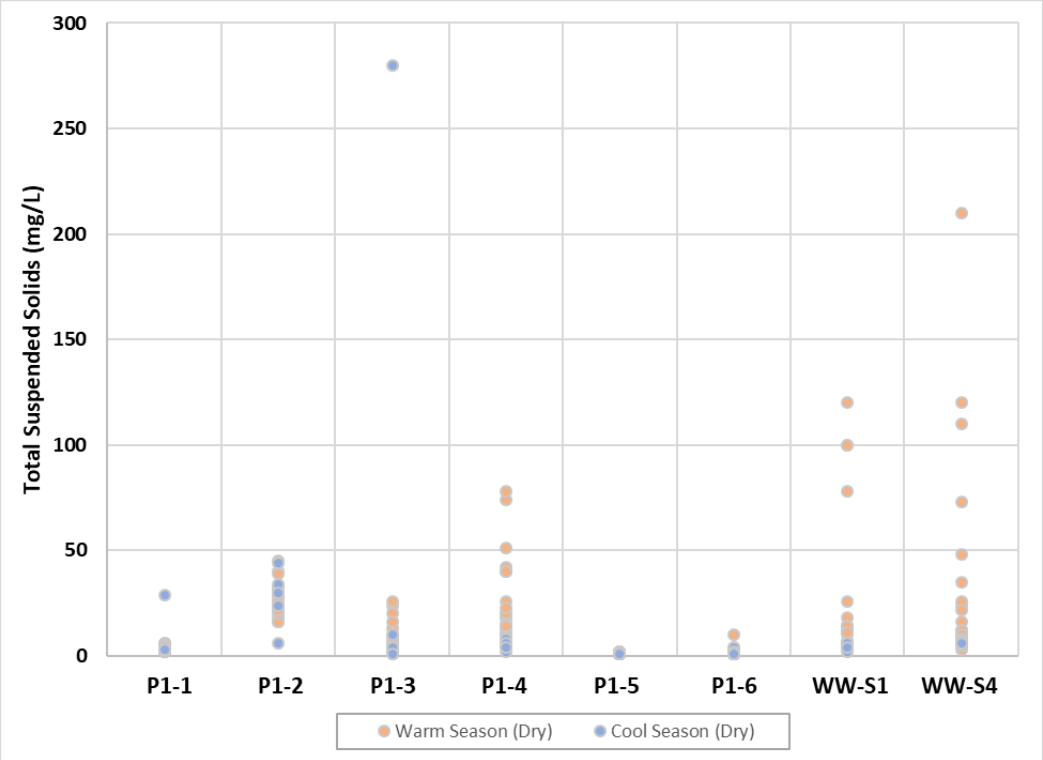

Figure 4-6. Distribution of TSS Measurements at Priority 1 Sites

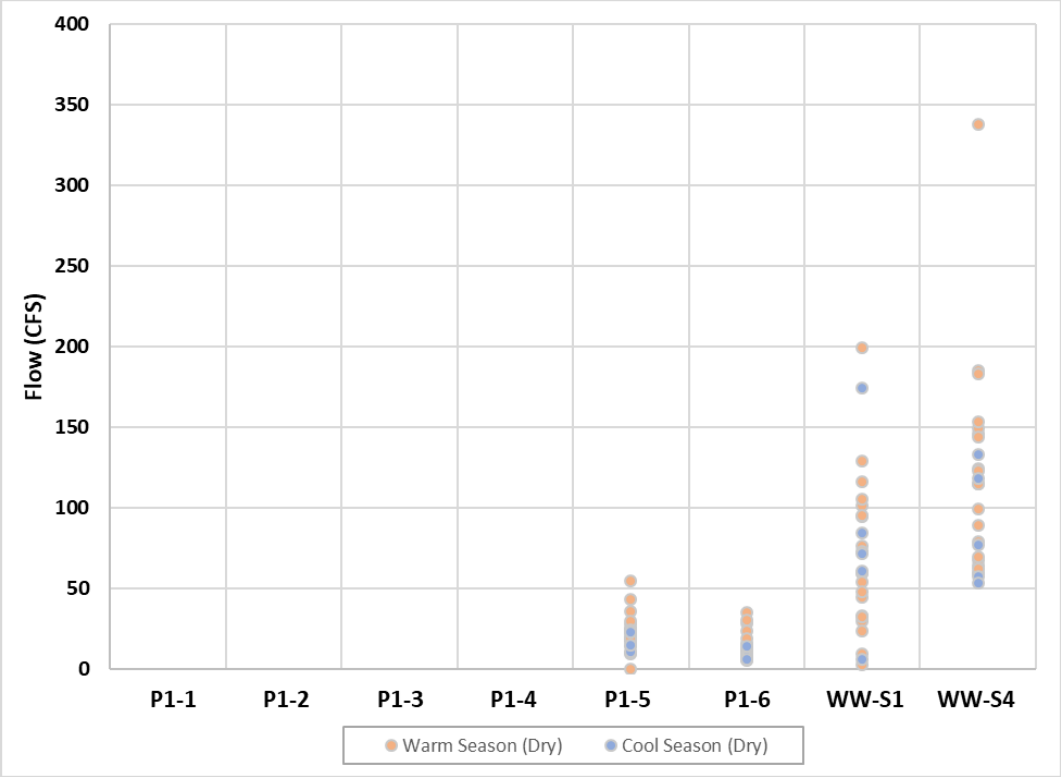

Figure 4-7. Distribution of Flow Measurements at Priority 1 Sites
**Note that lake sites are not monitored for flow*

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. All sites not located in SAR had generally low concentrations of *E. coli*. When sample concentrations were below the laboratory detection limit, one-half of that detection limit was used to calculate the geometric mean. All samples collected from Canyon Lake, Lake Elsinore, Big Bear Lake, Mill Creek Reach 2, and Lytle Creek were below the STV single sample limit of 320 MPN/100mL. 17 samples taken at Big Bear Lake were below the detection limit. Lake Perris had two samples above 320 MPN/100 mL with one being determined to be an outlier (2000 MPN/100 mL).

E. coli concentrations at the two SAR sites were consistently higher than concentrations at all other Priority 1 sites (Figure 4-8). Approximately 99 percent of the individual *E. coli* sample results from the six sites not located in SAR were less than 320 MPN/100 mL while only 40 percent of the individual sample results from the two SAR sites were less than 320 MPN/100 mL.

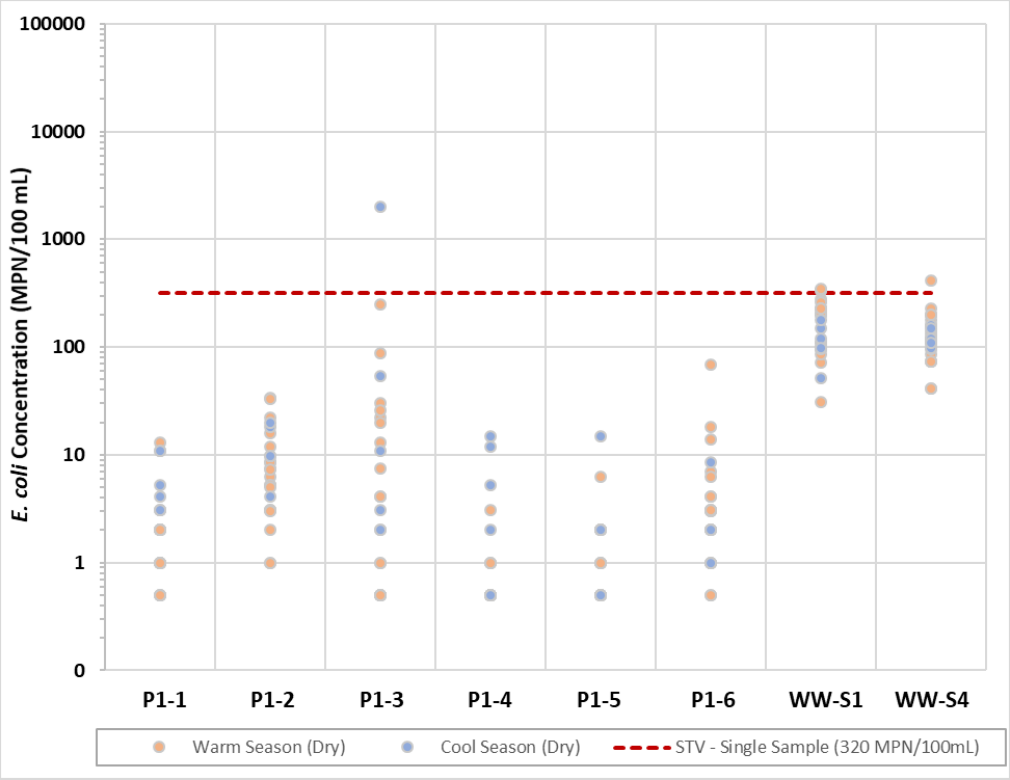

Figure 4-8. Distribution of *E. coli* Concentrations at Priority 1 Sites

Figures 4-9 through 4-16 show the individual and geomean *E. coli* concentrations for each Priority 1 site. Geomeans from the warm, dry season are 6-week rolling geomeans while the geomean from the cool, dry season is a 5-week geomean. The figures show that for at several sites, the cool, wet season samples had slightly higher *E. coli* concentrations than in the warm, dry season.

Key observations from the Priority 1 site data include:

- The highest *E. coli* concentration observed at a Priority 1 site was 2000 MPN/100 mL at Lake Perris during the week of October 27, 2019 (Figure 4-15).
- Aside from the SAR sites, Priority 1 *E. coli* concentrations continue to consistently meet Water Quality Objectives with few exceptions that have been noted as outliers.

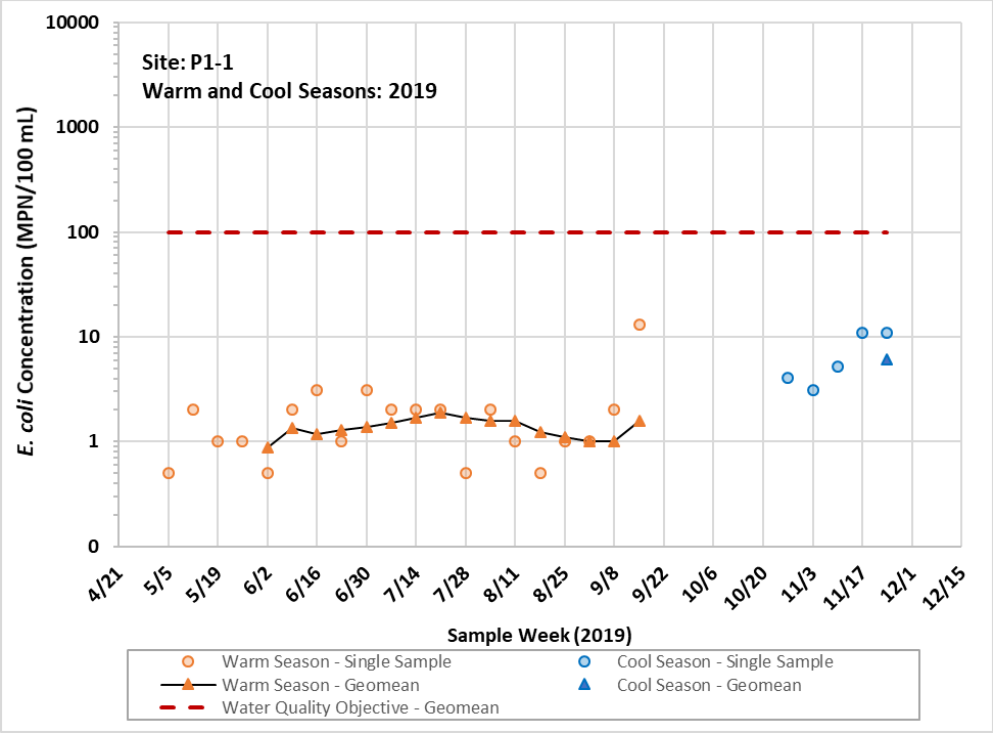

Figure 4-9. *E. coli* Concentrations and Geomeans at Canyon Lake (P1-1)

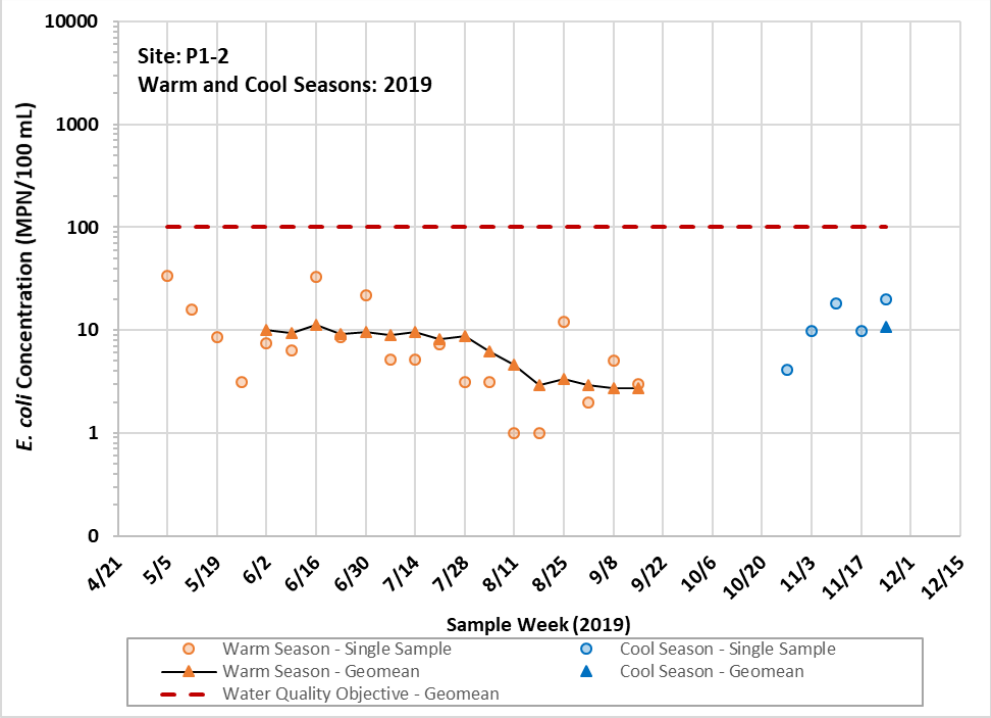

Figure 4-10. *E. coli* Concentrations and Geomeans at Lake Elsinore (P1-2)

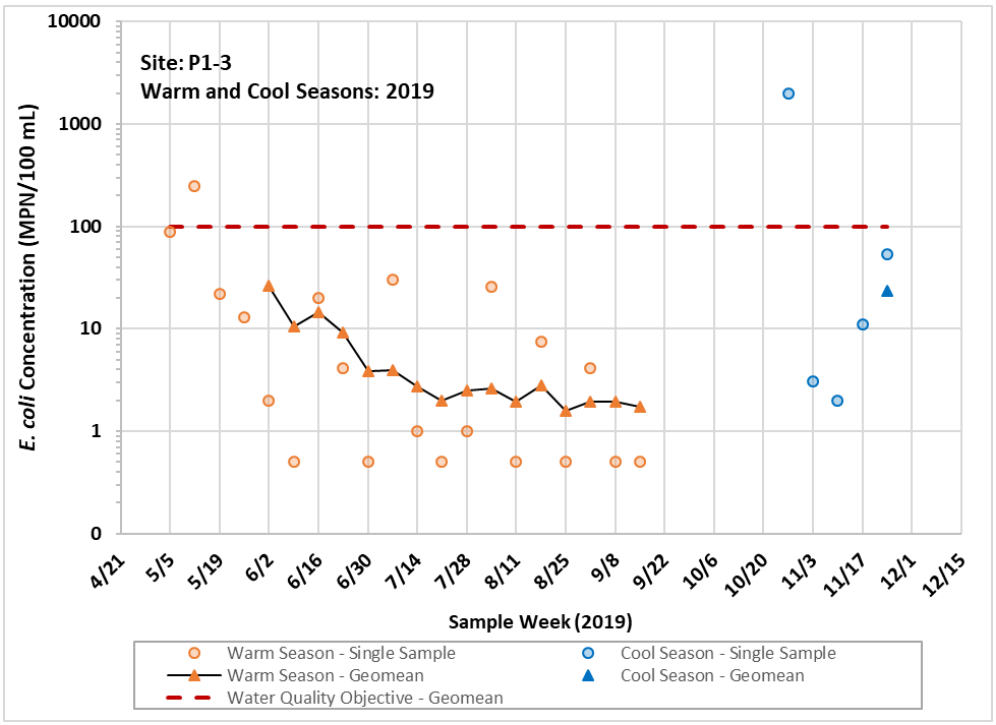

Figure 4-11. *E. coli* Concentrations and Geomeans at Lake Perris (P1-3)

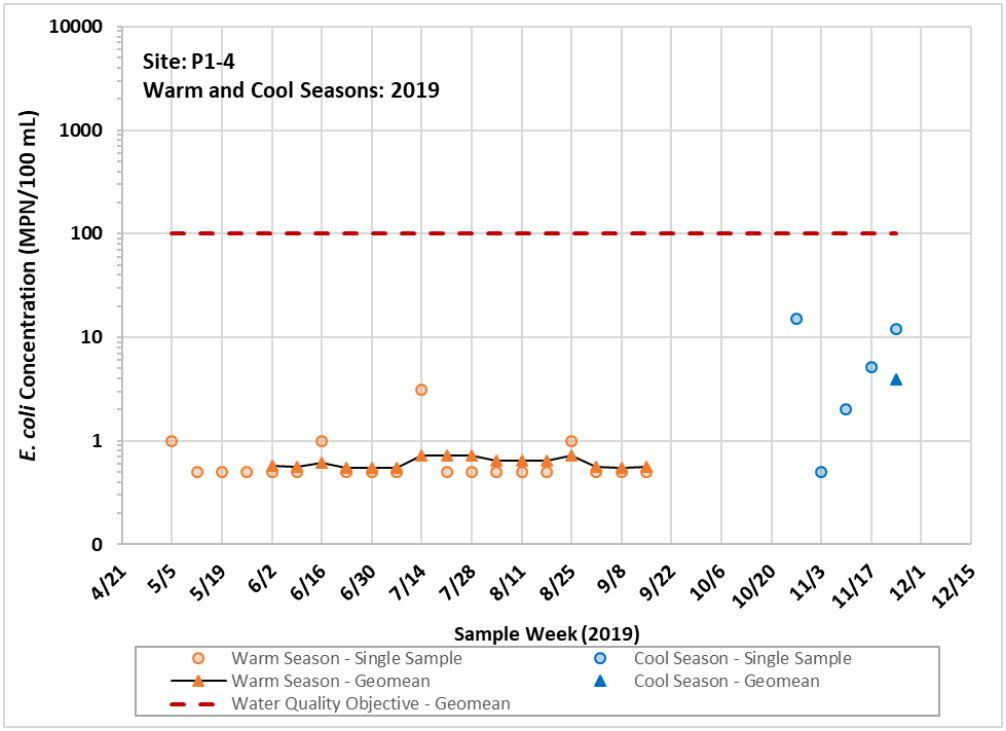

Figure 4-12. *E. coli* Concentrations and Geomeans at Big Bear Lake (P1-4)

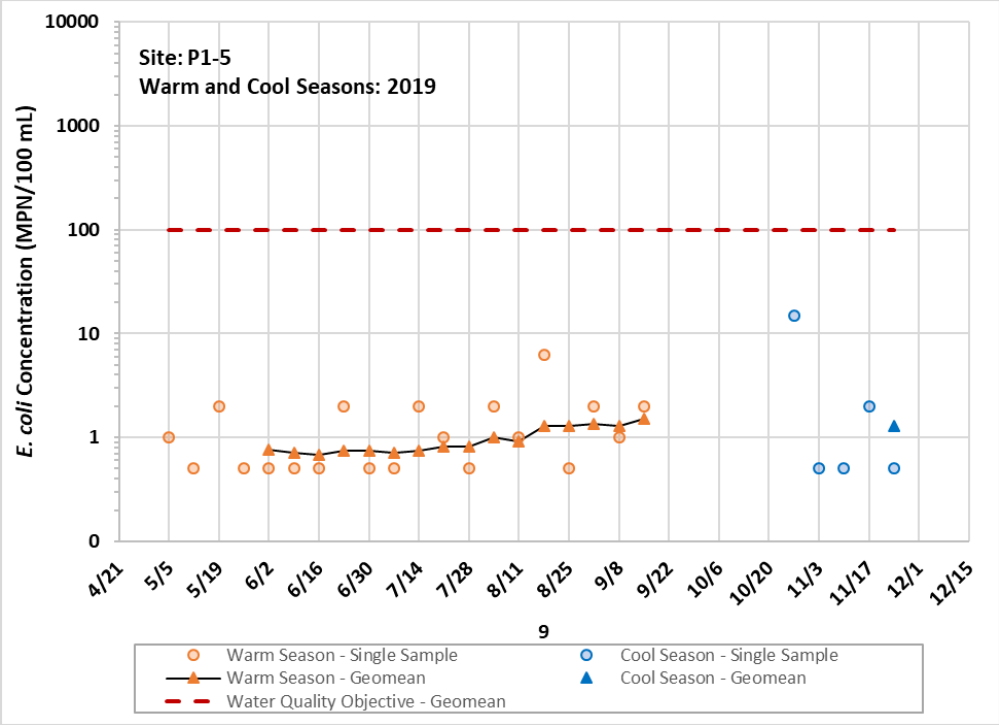

Figure 4-13. *E. coli* Concentrations and Geomeans at Mill Creek Reach 2 (P1-5)

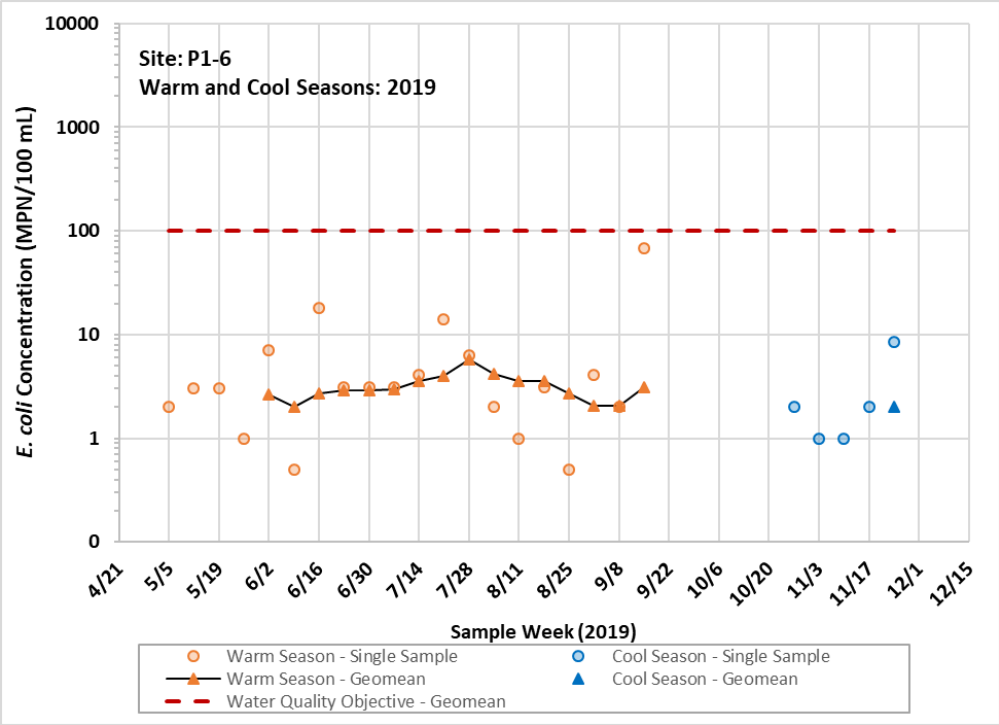

Figure 4-14. *E. coli* Concentrations and Geomeans at Lytle Creek (P1-6)

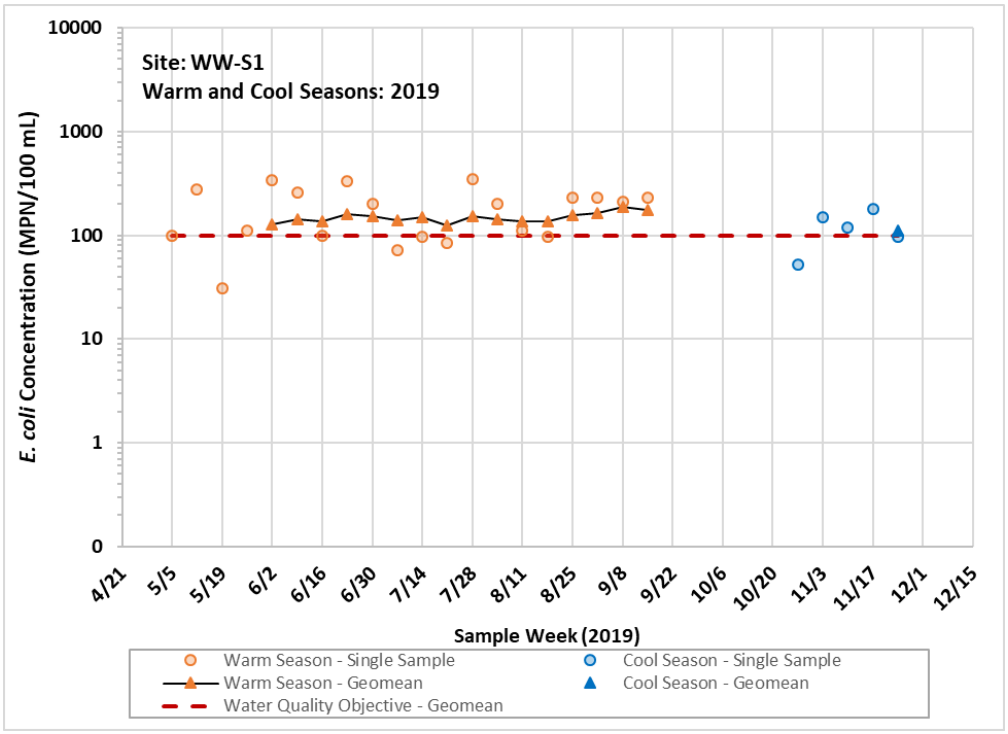

Figure 4-15. *E. coli* Concentrations and Geomeans at Santa Ana River at MWD Crossing (WW-S1)

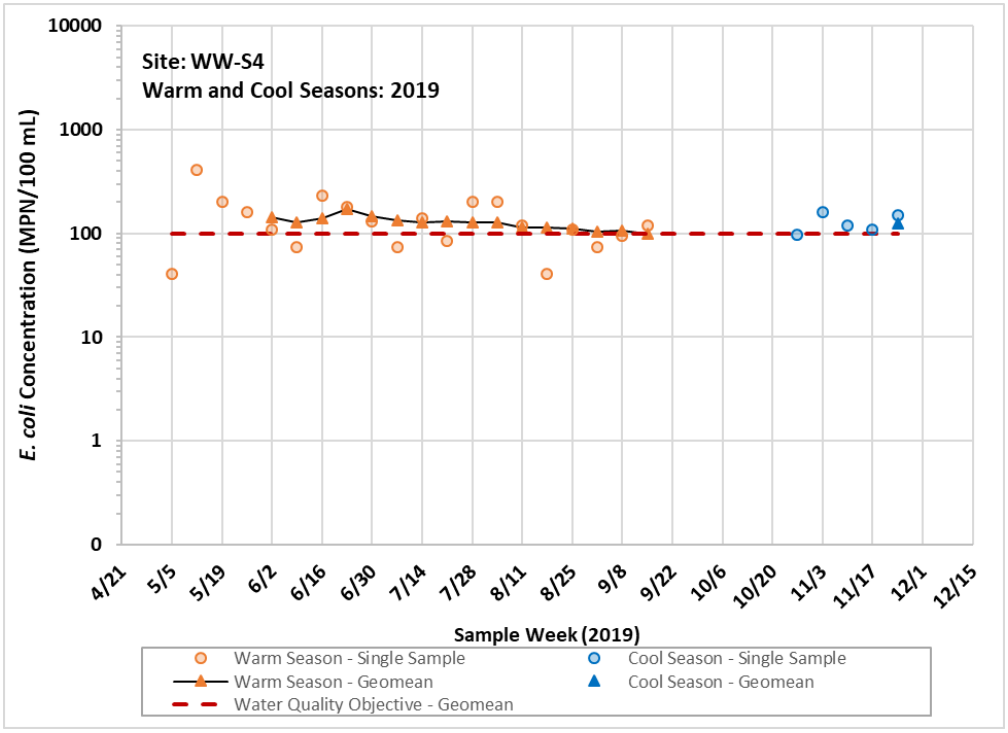

Figure 4-16. *E. coli* Concentrations and Geomeans at Santa Ana River at Pedley Avenue (WW-S4)

4.1.3 Bacteria Compliance Analysis

The compliance analysis compared the *E. coli* geomeans to the Statewide Bacteria Provisions geomean WQO of 100 MPN/100 mL. During the warm, dry season, rolling geometric means were calculated based on six weekly samples. During the cool, dry season, the geometric mean was calculated based on five weekly samples. The Statewide Bacteria Provisions also establish a single statistical threshold value (STV) of 320 MPN/100 mL for REC-1 waters that cannot be exceeded by more than 10 percent of samples in any calendar month.

Six out of eight Priority 1 sites had no geomean nor STV exceedances (Table 4-2). The two sites that exceeded the geomean WQO were SAR at MWD Crossing (WW-S1) and SAR at Pedley Avenue (WW-S4) with 100 percent and 94 percent exceedance frequencies, respectively. The same two sites also had samples that exceeded the STV.

One sample at SAR at Pedley Avenue (WW-S4) exceeded the STV which is enough to exceed the 90th percentile STV. Three samples from May through August at SAR at MWD Crossing (WW-S1) exceeded the STV (Table 4-3).

Table 4-2. 2019-2020 Monitoring Season Frequency of Exceedance with *E. coli* Geomean (100 MPN/ 100 mL) and STV (320 MPN/100 mL) Water Quality Objective During the 2019 Dry Weather Samples

Site ID	Site	Geometric Mean Criterion Exceedance Frequency (%)	STV Criterion Exceedance Frequency (%)
P1-1	Canyon Lake	0	0
P1-2	Lake Elsinore	0	0
P1-3	Lake Perris	0	8
P1-4	Big Bear Lake	0	0
P1-5	Mill Creek Reach 2	0	0
P1-6	Lytle Creek (Middle Fork)	0	0
WW-S1	Santa Ana River Reach 3 at MWD Crossing	100	16
WW-S4	Santa Ana River Reach 3 at Pedley Avenue	94	4

Table 4-3. Monthly Frequency of Exceedance of STV (320 MPN/100 mL) Water Quality Objective During the 2019 Dry Weather Samples

Month	Number of Samples Collected	STV Criterion Exceedance Frequency (%)	
		SAR @ MWD Crossing	SAR @ Pedley Avenue
May	4	0	25
June	5	40	0
July	4	25	0
August	4	0	0
September	3	0	0
October	1	0	0
November	4	0	0

4.2 Priority 2

4.2.1 Water Quality Observations

Water quality parameters measured in the field at Priority 2 sites (Table 4-4) are summarized in Figures 4-17 through 4-23. 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, several measurements exceeded the upper allowable limit of 8.5. The exceedances were observed at Prado Park Lake (88 percent of measurements).
- 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 one dry weather sample from Chino Creek were below 5 mg/L. Algal growth documented on the bottom of Chino Creek during dry sample events may have caused low DO levels.
- Specific conductivity (Figure 4-20) is similar at the two SAR sites ranging from 813 µS/cm to 1085 µS/cm in all but one sample date when wet weather runoff provided dilution of the typically effluent dominated flow. The range of measurements observed at the other three sites was from 586 to 1856 µS/cm.
- Turbidity (Figure 4-21) and TSS (Figure 4-22) show similar trends with lower levels in a narrow range (turbidity: 0.0 to 16.8 NTU; TSS: below detectable limit to 22 mg/L) at Chino Creek and Cucamonga Creek. Prado Park Lake had a slightly higher range (turbidity: 3.3 to 33.2 NTU; TSS: below detectable limit to 38 mg/L). The two SAR sampling sites had the largest range (turbidity: 0.1 to 252.7 NTU; TSS: 2 to 210 mg/L) with turbidity and TSS values decreasing throughout the dry season. The largest turbidity measurements were collected during dry weather conditions, but there was runoff from upper watershed due to rainfall in San Bernardino Mountains that caused elevated flow in all of the SAR sites on May 15, 2019 above typical conditions on the day of sampling.
- Flow is lower at Prado Park Lake (spill from the lake) with rates ranging from 0.5 to 6.5 cfs. Chino and Cucamonga Creeks had similar ranges of flow (2 to 30.8 cfs and 1 to 72 cfs, respectively). Flow is higher in SAR and greatest at the most downstream site SAR at Pedley Avenue (Figure 4-23). Maximum flow at SAR at Pedley Avenue (338 cfs) is approximately 70 percent higher than the maximum flow at SAR at MWD Crossing (199 cfs) due to effluent from Van Buren treatment plant.

Table 4-4. Priority 2 Monitoring Sites

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

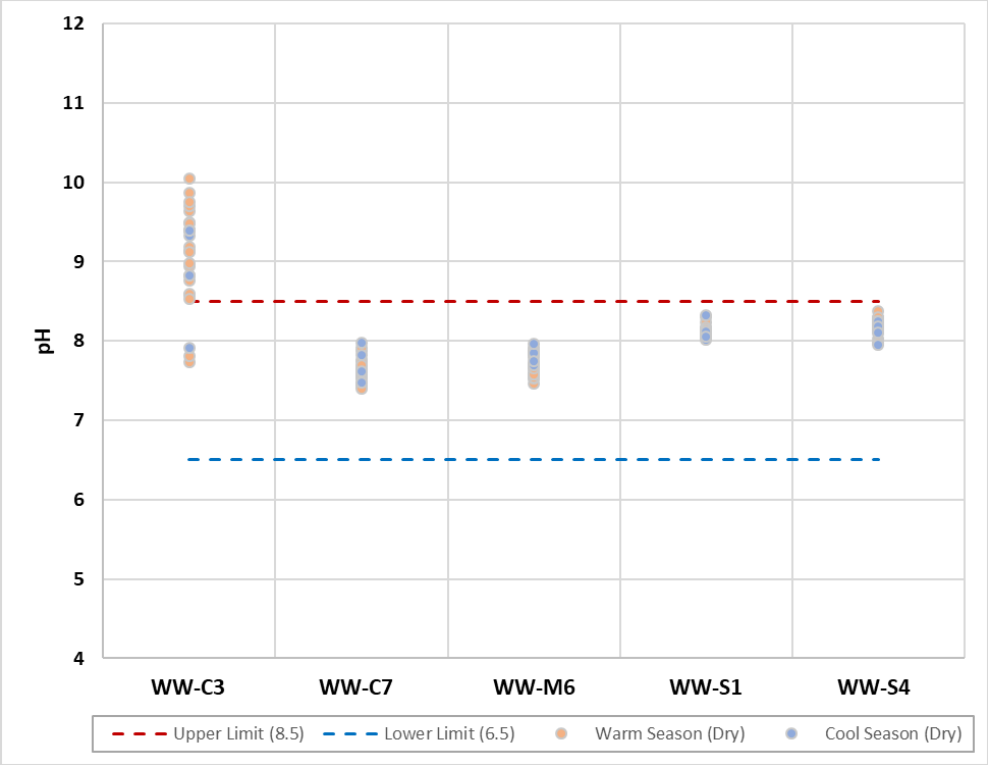

Figure 4-17. Distribution of pH Measurements at Priority 2 Sites

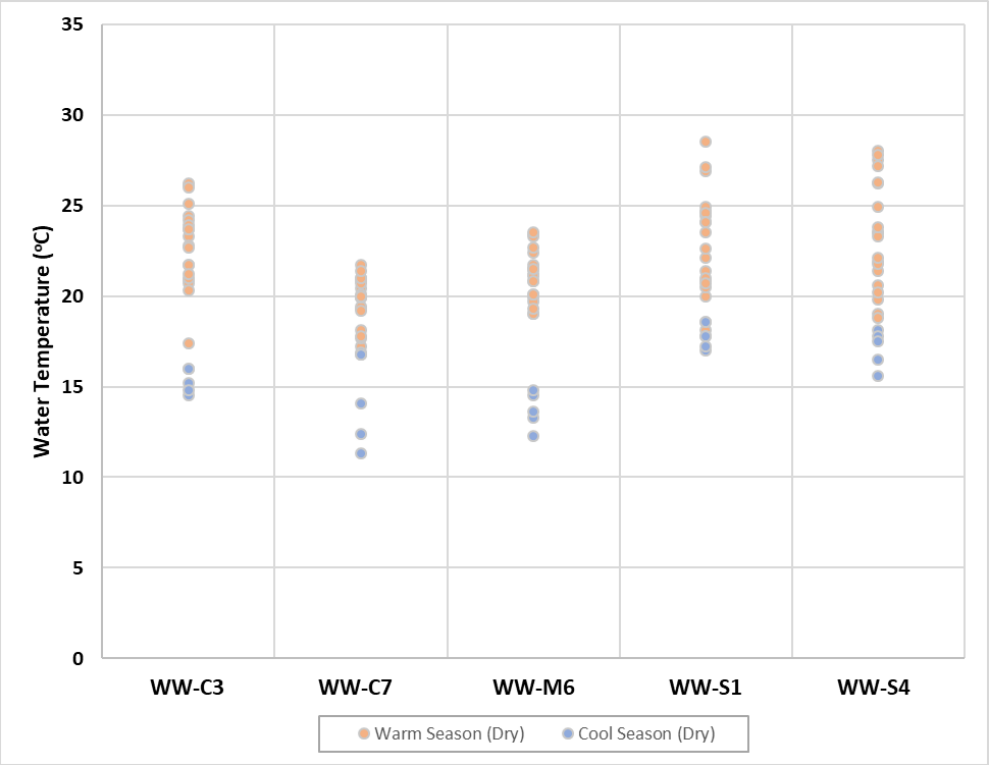

Figure 4-18. Distribution of Water Temperature Measurements at Priority 2 Sites

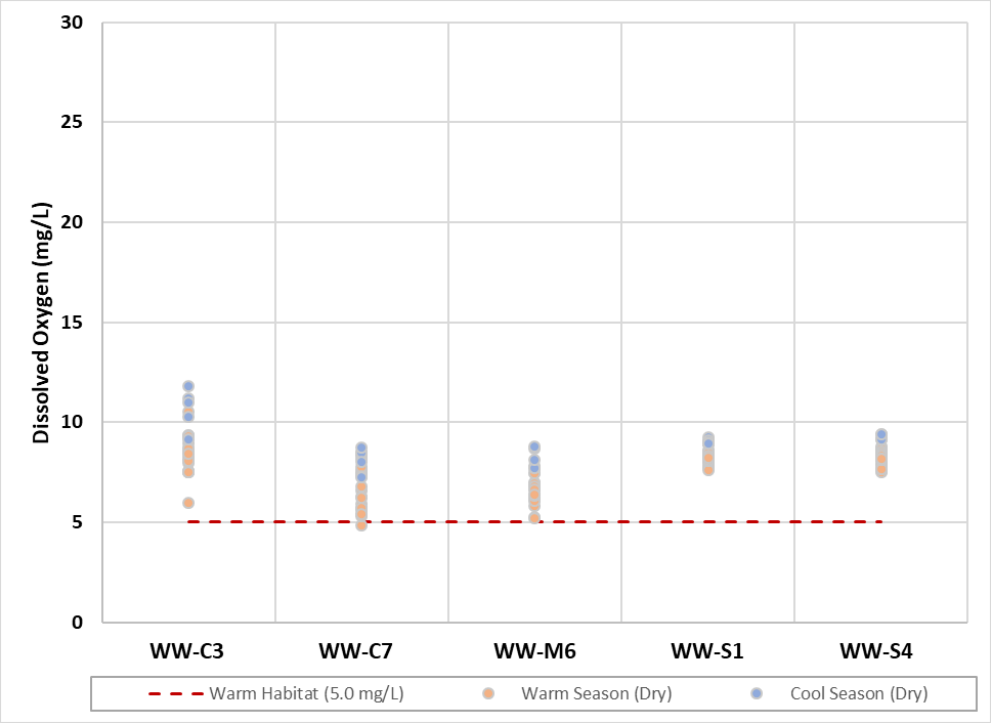

Figure 4-19. Distribution of Dissolved Oxygen Measurements at Priority 2 Sites

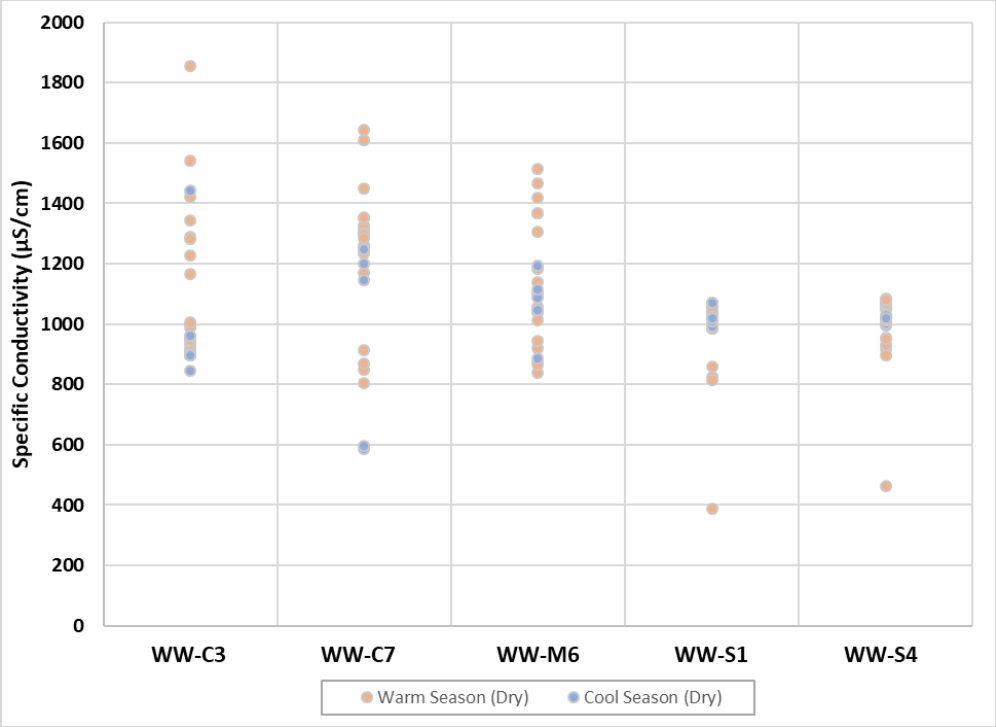

Figure 4-20. Distribution of Specific Conductivity Measurements at Priority 2 Sites

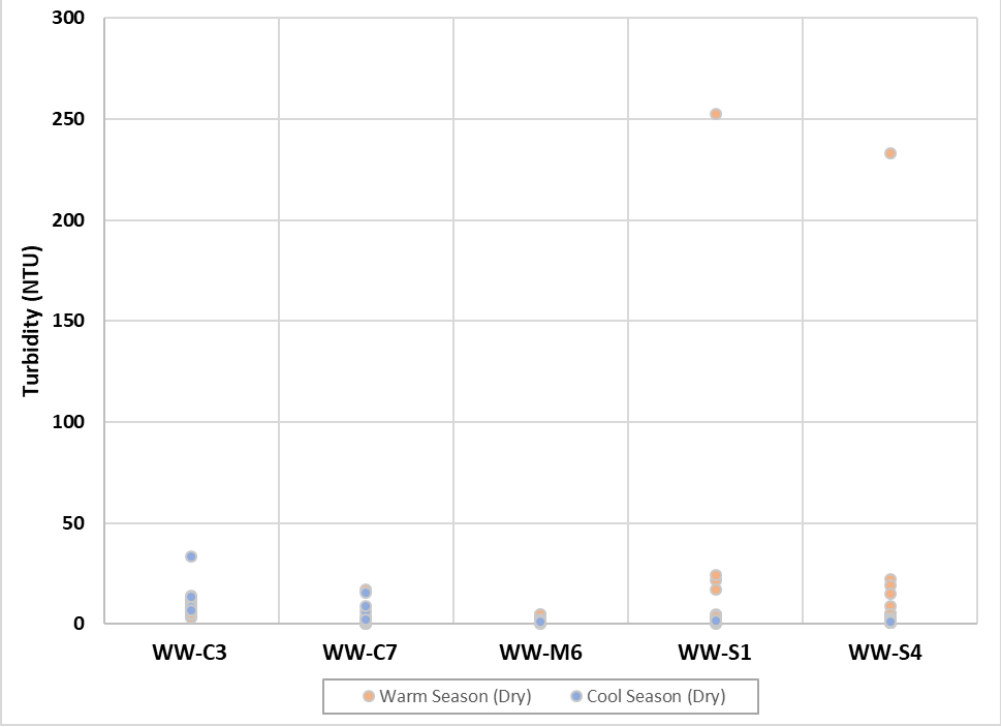

Figure 4-21. Distribution of Turbidity Measurements at Priority 2 Sites

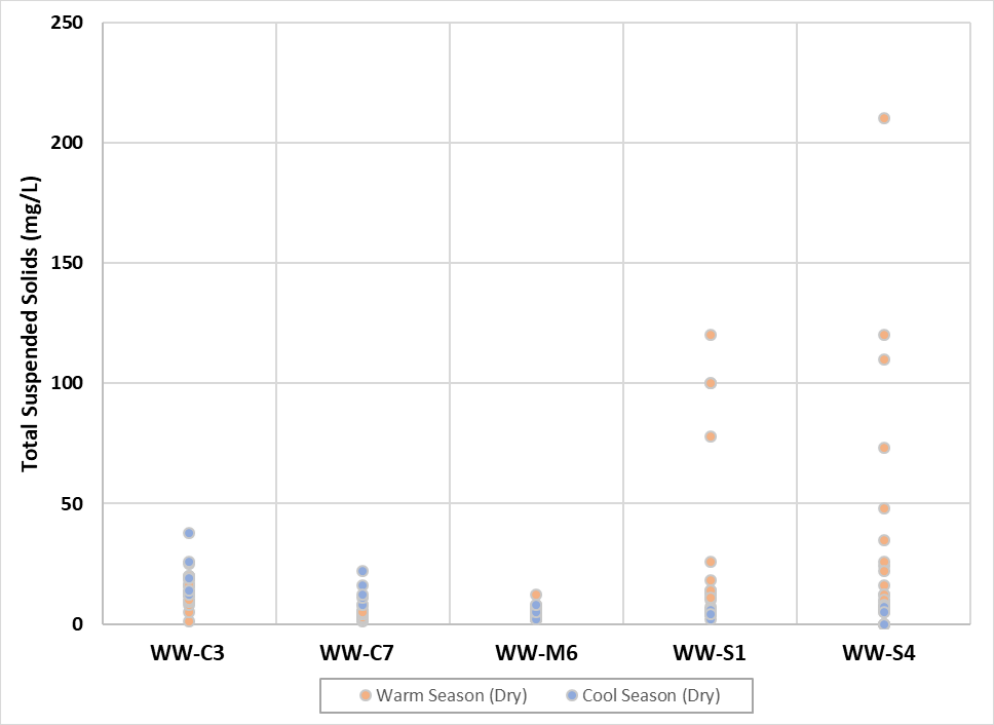

Figure 4-22. Distribution of TSS Measurements at Priority 2 Sites

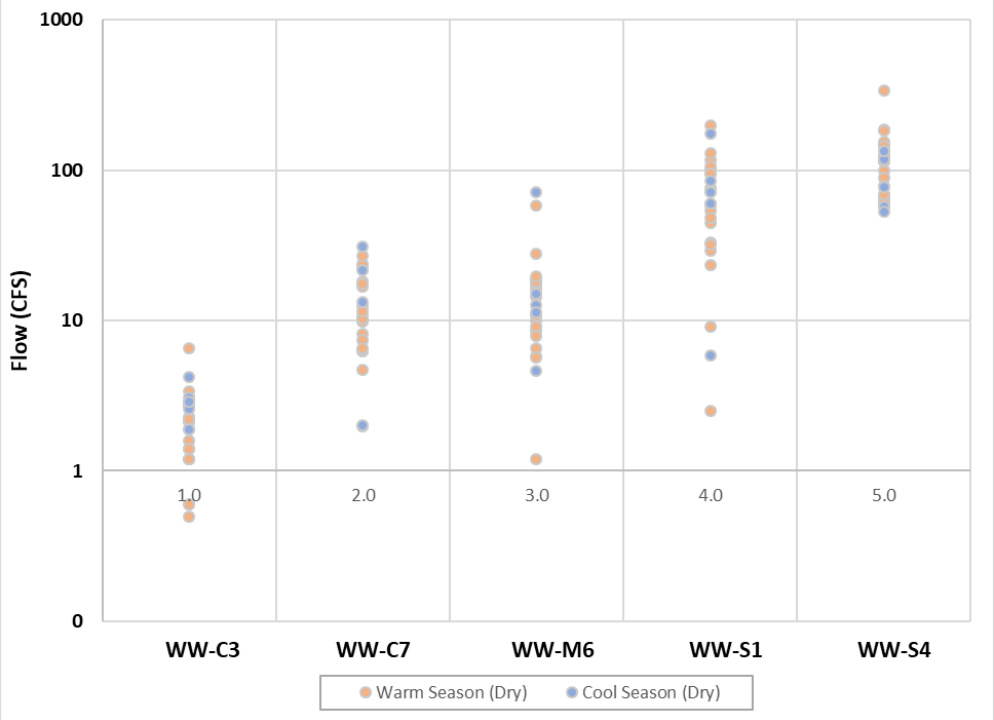

Figure 4-23. Distribution of Flow Measurements at Priority 2 Sites

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 had the highest single sample observed *E. coli* concentration of >24,000 MPN/100 mL, which was observed in two of the 25 dry weather samples in the 2019-2020 monitoring period. These two samples fell outside of the six-week synoptic study of bacteria sources in the MSAR watershed in 2019 dry season, thus no upstream data are available to better understand if they contributed to these extreme values. Other samples from Chino Creek ranged from 10 to 1100 MPN/100 mL. One important consideration when analyzing *E. coli* in Chino Creek from the 2019-2020 period is that there was no effluent flow from IEUA's Carbon Canyon WRP during most of the dry season. A loading analysis comparing MS4 inflows with downstream loads (WW-C7 site) revealed a net decay in *E. coli* between sources and the TMDL compliance site. Detections of human HF183 Bacteroides markers were inconsistent and of a low concentration. The reader is referred to the Middle Santa Ana River Synoptic Study and TMDL Triennial Report for more detail on this source analysis.

Mill-Cucamonga Creek had *E. coli* concentrations ranging from 20 to 3,700 MPN/100 mL during dry weather conditions. This variability is partially attributed to the highly variable daily volume of tertiary treated effluent discharged from IEUA's RP1, which ranged from 0.2 to 18.1 million gallons per day (mgd) in May – September 2019. Other important factors include instream growth or decay of colonized *E. coli*, the effectiveness of Mill Creek Wetlands, and the loading of *E. coli* from a few MS4 outfalls. These factors were evaluated in detail in the Middle Santa Ana River Synoptic Study and TMDL Triennial Report.

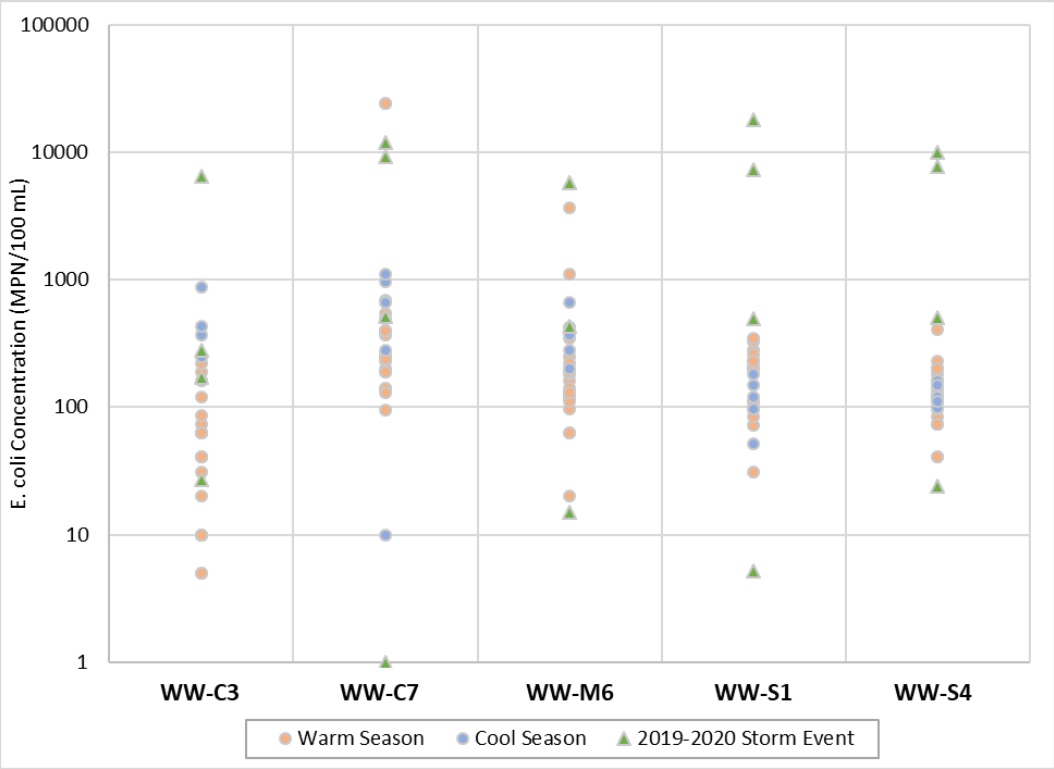

Figure 4-24. Distribution of *E. coli* Concentrations at Priority 2 Sites

E. coli concentrations at Prado Park Lake ranged from 5 to 880 MPN/100 mL. Following the 2018-2019 monitoring period, an apparent trend of declining *E. coli* concentration at this site was attributed to repairs to pipeline underneath the lake. Elevated concentrations in the 2019 – 2020 cool season suggests that a source of fecal bacteria persists, and ongoing monitoring will be important.

For the Santa Ana River monitoring sites, *E. coli* concentrations continue to exceed the geometric mean criteria by a relatively small margin (30-day rolling geomeans ranged from 82.6 to 224.6 MPN/100 mL). The 2019 dry season Synoptic Study found that uncontrollable sources that are not conveyed through the MS4 account for the majority (77%) of the total bacteria load in the Reach 3 of the Santa Ana River. Furthermore, the 2019 study showed no relationship between *E. coli* concentration and presence of human HF 183 marker within the receiving waters. This finding strongly suggests that the *E. coli* observed in the Santa Ana River is coming from natural or uncontrollable sources (e.g. sediment releases, wildlife) than controllable sources (e.g. MS4 discharges). The reader is referred to the Middle Santa Ana River Synoptic Study and TMDL Triennial Report for more detail on this source analysis.

Figures 4-25 through 4-29 show the individual and rolling geomean *E. coli* concentrations as well as concentrations from four storm samples during the 2019-2020 monitoring period. The figures include geomeans that were calculated using two different methods, one is based on a six-week rolling calculation and the other is a 30-day rolling calculation. The six-week rolling geomean serves as the basis for evaluating inland freshwaters per the statewide bacteria provisions that became effective in March 2019. The use of a six-week rolling geomean superseded numeric criteria in the Basin Plan, but do not supersede any TMDL numeric targets or allocations. Thus, plots also include five-sample, 30-day geomeans per the 2005 MSAR bacteria TMDL. For all Priority 2 sites, compliance with TMDL is assessed based on 16 geomeans due to only 4 samples being collected within the previous 30 days for the week of July 21, 2019. This is apparent in the break in the 30-day geomeans on each plot.

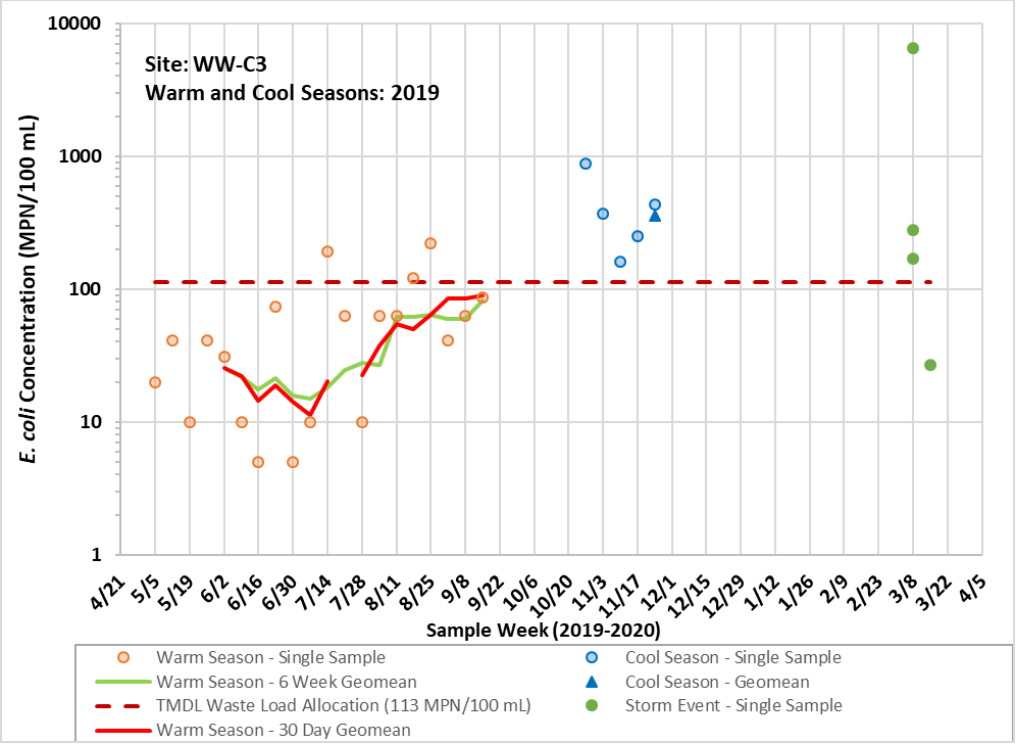

Figure 4-25. *E. coli* Concentrations and Geomeans at Prado Park Lake (WW-C3)

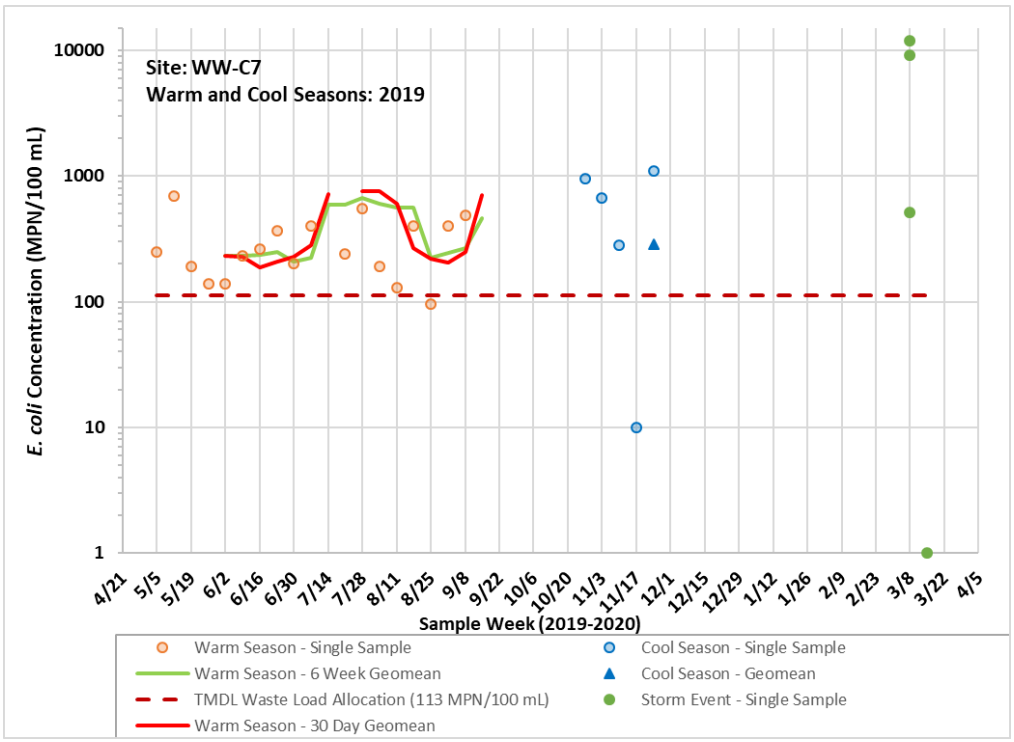

Figure 4-26. *E. coli* Concentrations and Geomeans at Chino Creek at Central Avenue (WW-C7)

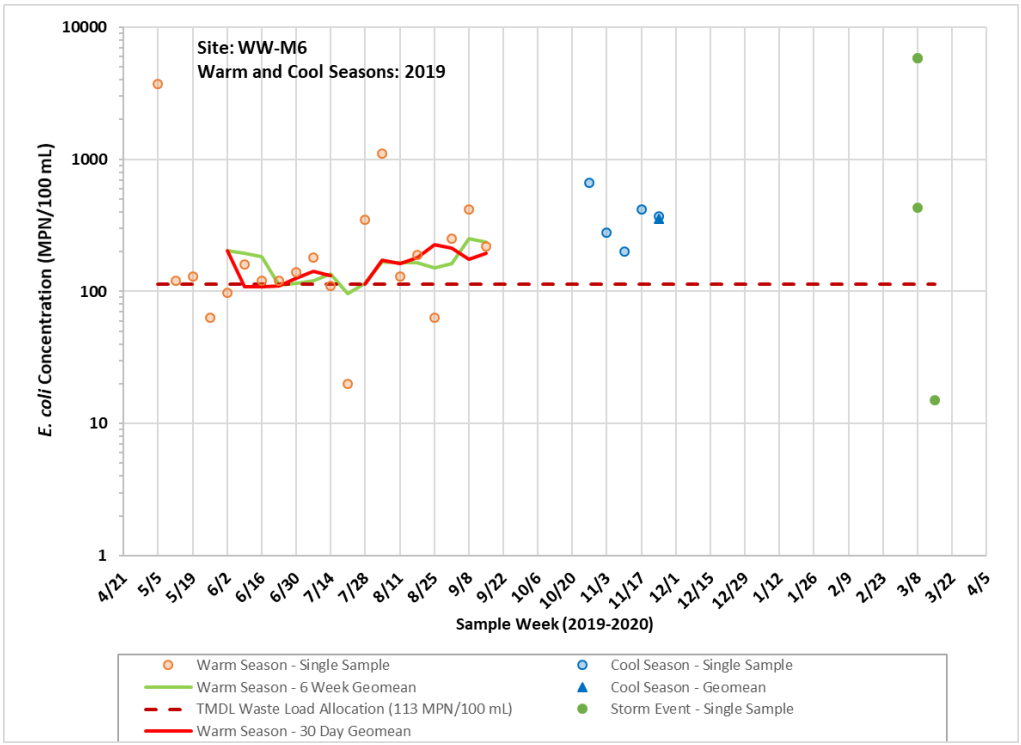

Figure 4-27. *E. coli* Concentrations and Geomeans at Mill-Cucamonga Creek Below Wetlands (WW-M6)

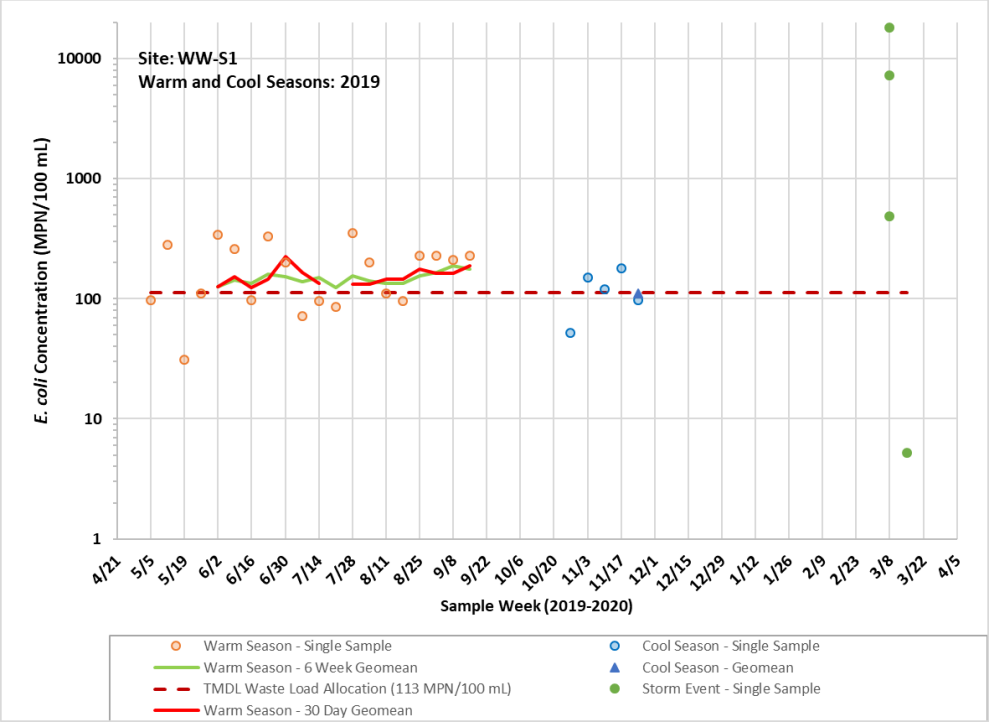

Figure 4-28. *E. coli* Concentrations and Geomeans at Santa Ana River at MWD Crossing (WW-S1)

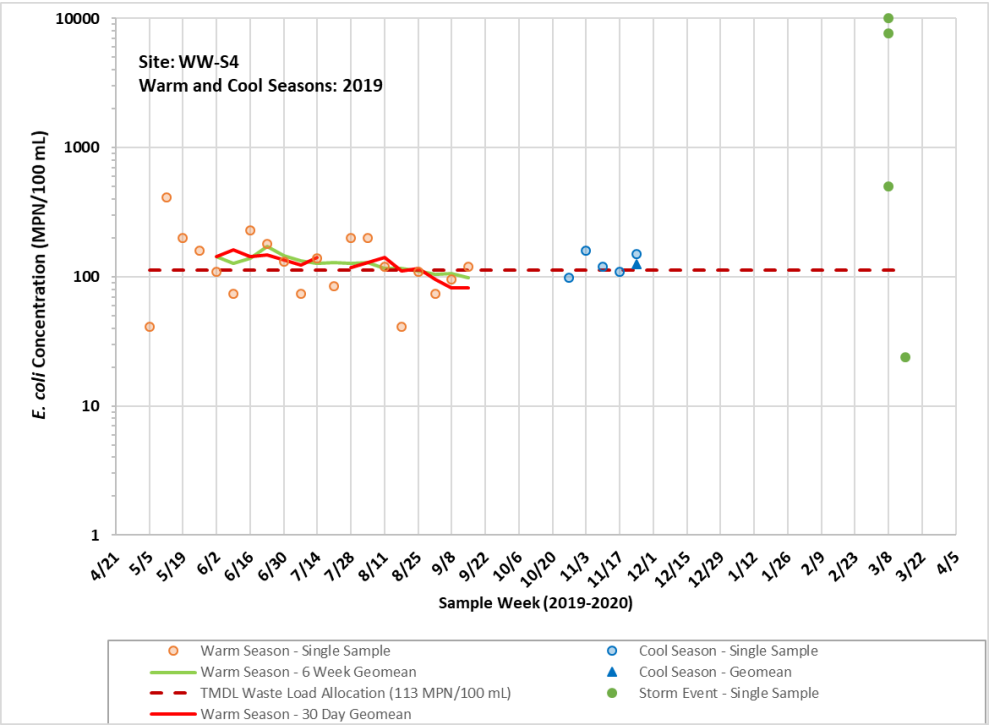

Figure 4-29. *E. coli* Concentrations and Geomeans at Santa Ana River at Pedley Avenue (WW-S4)

4.2.2.2 Wet Weather 2019-2020 Event

During wet weather, *E. coli* concentrations are more than one order of magnitude greater than dry weather concentrations at SAR at MWD Crossing (Figure 4-28) and SAR at Pedley Avenue (Figure 4-29). At Prado Park Lake (Figure 4-25), Chino Creek (Figure 4-26), and SAR at MWD Crossing (Figure 4-28), peak storm concentrations are greater than most of the dry weather concentrations but similar in magnitude as peak dry weather concentrations.

Storm samples collected for the March 10, 2020 storm event are summarized in Table 4-5. Figures 4-30 and 4-31 display changing *E. coli* concentrations at two stations over the sampling period. The storm event continued over multiple days and included several flow peaks that resulted in peak *E. coli* concentrations later in event (Figure 4-30 and Figure 4-31). For example, the highest wet weather *E. coli* concentration measured at SAR at Pedley Avenue (10,000 MPN/100 mL) was measured on March 16, 2020 – 6 days after the first sample. The highest amount of rainfall occurred on the night of March 12, 2020 that resulted in highest *E. coli* concentrations being observed on March 13, 2020 (72 hours after the event began but only several hours after that night's rain) for Prado Park Lake, Cucamonga Creek, and SAR at Pedley Avenue. Samples were collected on March 16, 2020 to avoid the continued rain event and allow for a post-event sample, and *E. coli* concentrations were among the lowest observed at the MSAR TMDL waters over the period of record since TMDL adoption. This could indicate that the wet weather event served to flush naturalized colonies of bacteria and new dry weather flow entering conveyance system is generally free of fecal bacteria. A special study in 2020-2021 is planned to further the current understanding of the relative role of naturalized colonies of *E. coli* in the MSAR watershed.

Table 4-5 *E. coli* Concentrations (MPN/100 mL) Observed During the 2019-2020 Storm Event

Site	3/10/2020	3/12/2020	3/13/2020	3/16/2020
Prado Park Lake (WW-C3)	280	170	6,500	27
Chino Creek at Central Avenue (WW-C7)	12,000	510	9,200	1
Mill-Cucamonga Creek below Wetlands (WW-M6)	5,800	430	5,800	15
SAR Reach 3 at MWD Crossing (WW-S1)	18,000	490	7,300	5.2
SAR Reach 3 at Pedley Avenue (WW-S4)	7,700	500	10,000	24

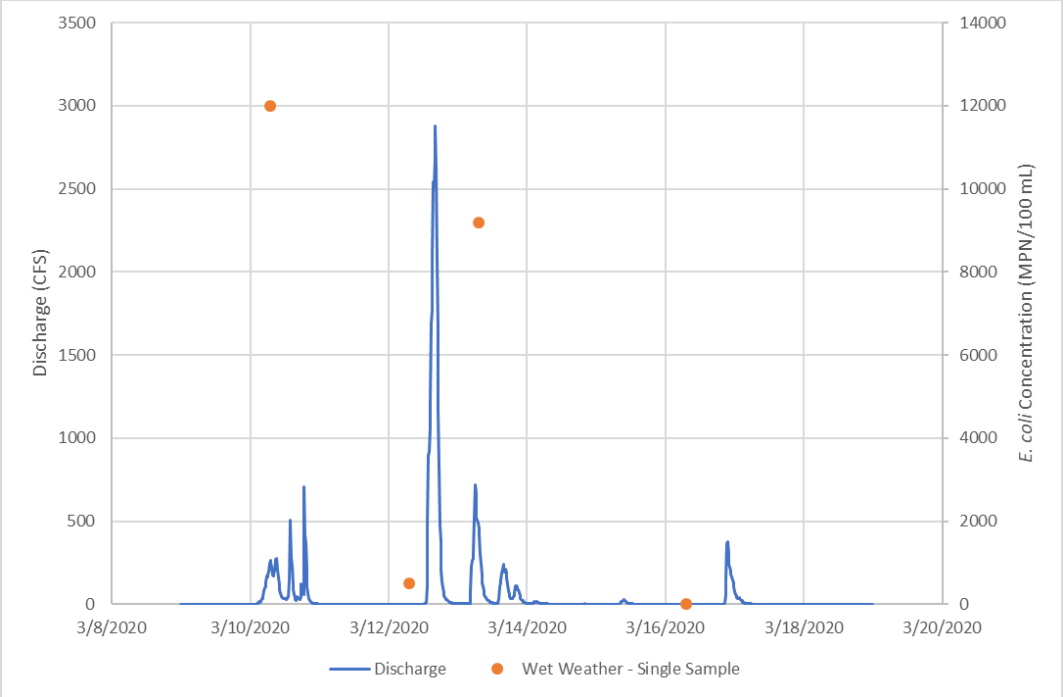

Figure 4-30. *E. coli* Concentrations Observed at Chino Creek During and After the March 10, 2020 Storm Event

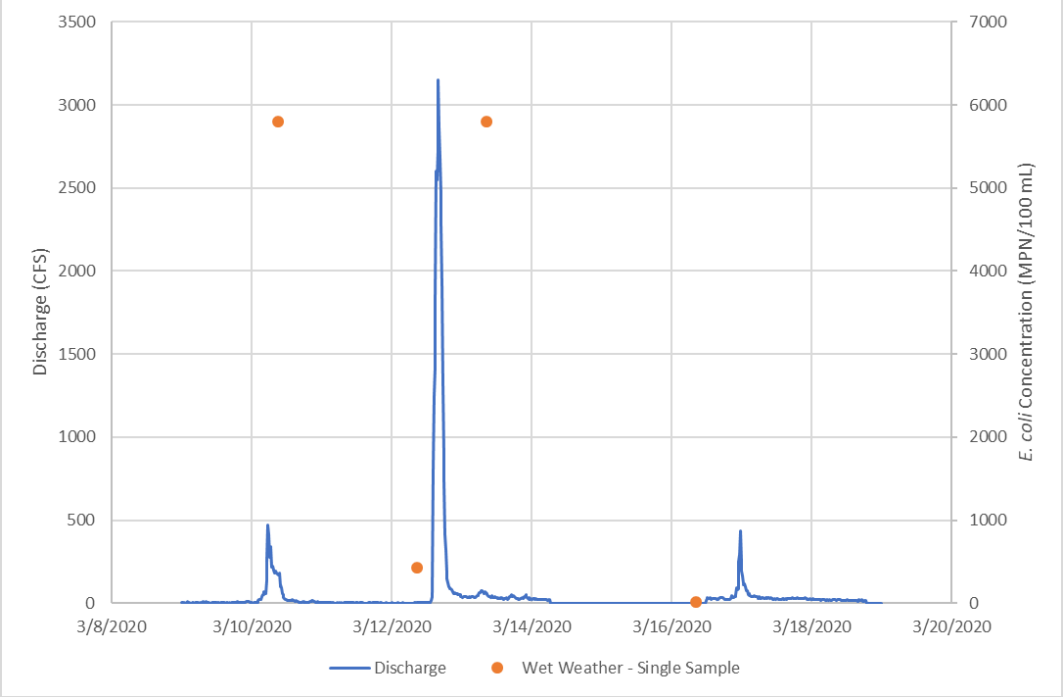

Figure 4-31. *E. coli* Concentrations Observed at Mill-Cucamonga Creek During and After the March 10, 2020 Storm Event

4.2.2.3 Analysis of Historical Wet Weather Data

One wet weather monitoring event has been completed in each wet season since the inception of the MSAR bacteria monitoring program in 2007-08. Data collected over 12 storm events at each of the MSAR TMDL compliance monitoring sites spanning the period from 2007-08 to 2019-2020 is presented and analyzed below. The once per year wet weather sampling event was included in the 2008 MSAR Water Quality Monitoring Plan to obtain data from the falling limb of the hydrograph (SAWPA, 2008). This focus differs from core wet weather monitoring by MS4 programs that aim to collect runoff from the rising limb of runoff hydrographs. Given that storm events greater than ½ inch trigger a high flow suspension of REC1 use, it is important to understand the levels of fecal bacteria impairment that may remain in the days following a storm when recreational use protection must be achieved in the MSAR TMDL waters. Ackerman and Weisberg (2003) showed that fecal bacteria concentrations in City of Los Angeles beaches remain above typical pre-event levels for as long as 3-5 days following a storm event.

The monitoring program for wet weather in MSAR TMDL waters was designed, and has been conducted accordingly through the present year, to collect samples on day 1 of a wet weather event, followed by sampling at intervals of 48, 72, and 96 hours. In many cases wet weather conditions extended over multiple days, therefore the three follow-up samples may have been collected during wet weather or may represent a shorter period of time following the presence of wet weather conditions. A detailed assessment of 15-minute interval flow records over the course of each of the sampled events in past 12 years was completed to determine whether each of the four samples are representative of wet weather conditions or to approximate the period of time elapsed since flow returned to pre-event levels.

The detailed review of hydrographs was used to stratify the data into wet weather and post-storm groups. Geometric means of E. coli concentration were compared between wet weather and post-storm groups for each site (Figure 4-32). A significant difference in wet weather and post-storm *E. coli* concentration was found at all sites. When accounting for the increased flow rate in wet weather samples, the relative rise in *E. coli* loading during wet weather reaches 2-3 orders of magnitude. Put another way, the *E. coli* load during a typical wet weather sampling event is comparable to the total load during dry weather over the entire year.

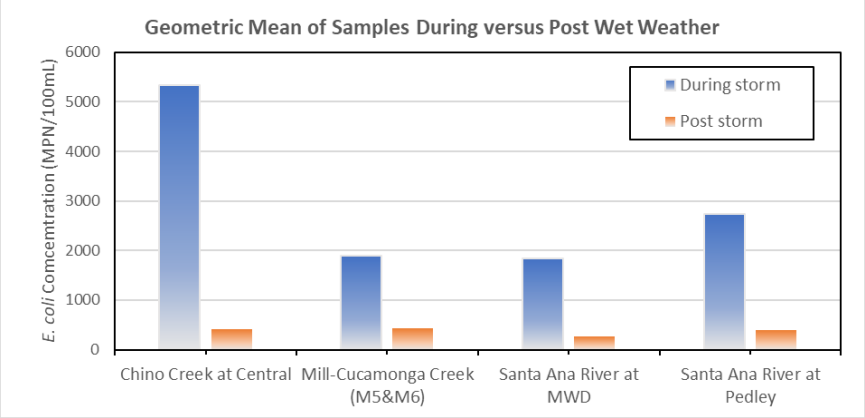

Figure 4-32. Comparison of Geometric Means of *E. coli* Concentration for Samples Collected during Wet Weather and Post-storm for TMDL Compliance Monitoring Sites on Chino Creek, Mill-Cucamonga Creek, and the Santa Ana River Reach 3

Post-storm events samples were evaluated to assess how long following a wet weather event are elevated bacteria concentrations apparent in the MSAR bacteria TMDL waterbodies; Chino Creek, Mill-Cucamonga Creek, and Santa Ana River Reach 3. Results for MSAR TMDL waters show a return to pre-event *E. coli* concentrations within 24 hours of the return to pre-event flow conditions (Figure 4-33).

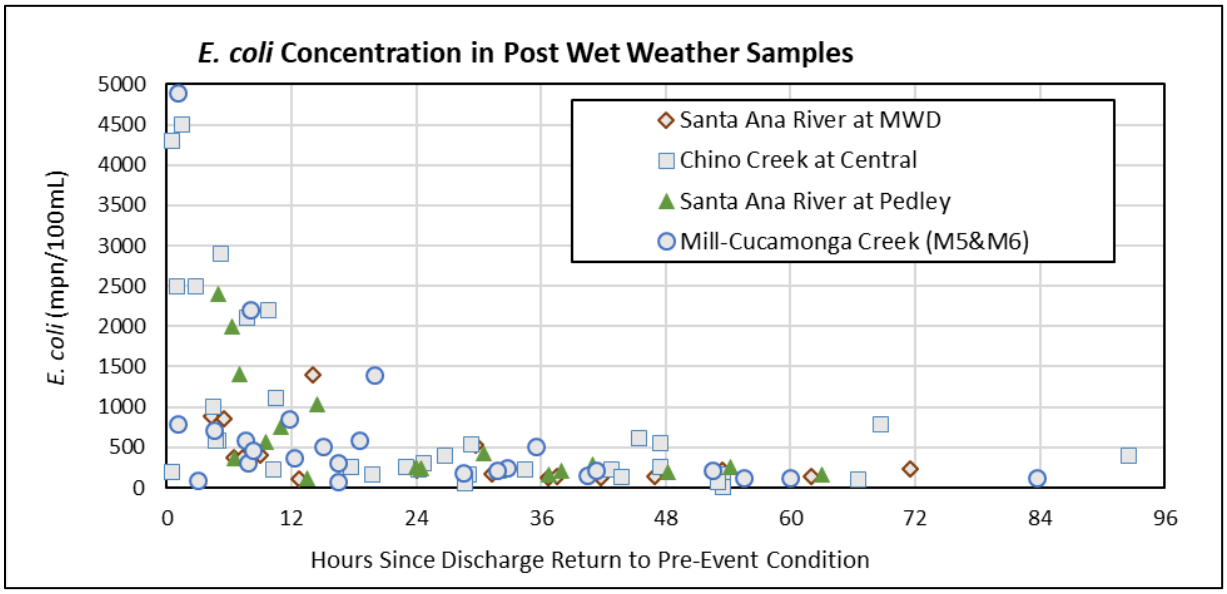

Figure 4-33. Post-storm Event Samples from MSAR TMDL Waters Plotted against the Time to Return to Pre-event Flow Conditions

4.2.3 Historical Trends

Figures 4-34 through 4-38 illustrate the distribution and variability of dry-weather, rolling geometric mean values for *E. coli* since 2007.[20] *E. coli* concentrations from 2007 through 2015 are presented in CFU/100 mL while 2016 and 2017 concentrations are presented in MPN/100 mL.

Figure 4-34 suggests that *E. coli* levels are improving at Prado Park Lake (WW-C3). Throughout the 2018 and 2019 warm seasons, *E.* coli geomeans for Prado Park Lake (15 to 81 MPN/100mL) are below the MSAR Bacteria TMDL WLAs/LAs of 113 MPN/100mL. This improvement was believed to be linked to the draining and repair of concrete piping underneath the lake. However, the *E. coli* concentrations gradually increased throughout the warm, dry season and that trend continued with the geomean for the cool, dry season (355 MPN/100mL) exceeding the WLA/LA.

[20] 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/

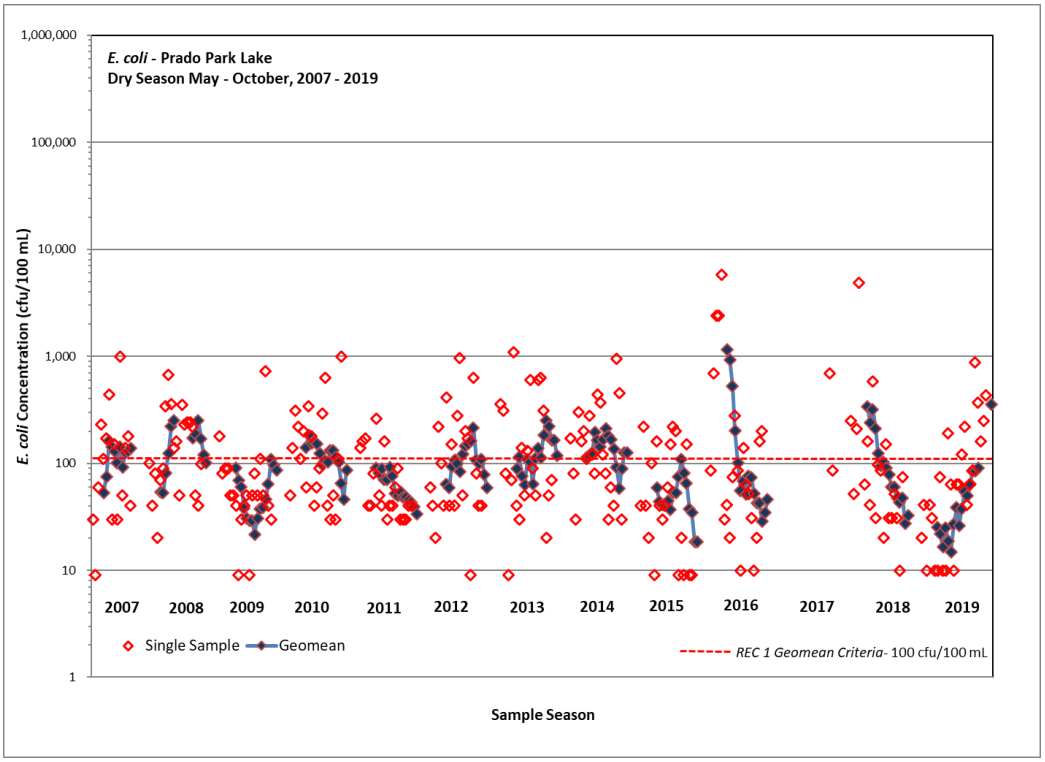

Figure 4-34. Time Series Distribution of *E. coli* Geomean Concentrations at Prado Park Lake from 2007 through 2019

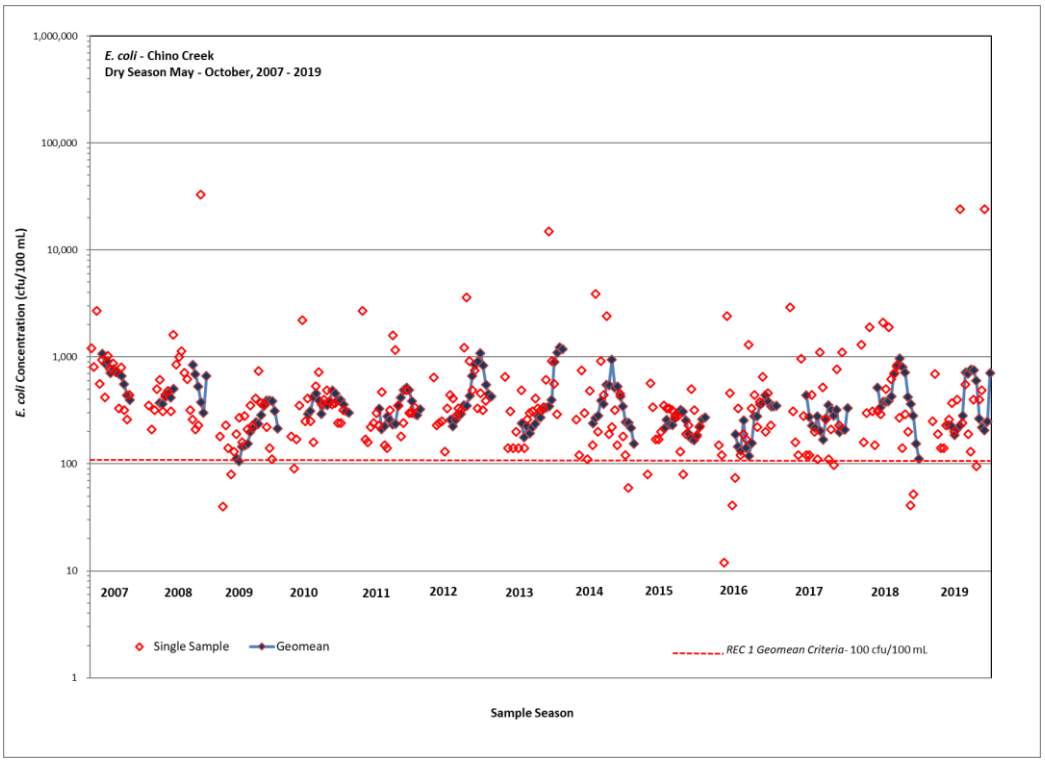

Figure 4-35. Time Series Distribution of E. coli Geomean Concentrations at Chino Creek from 2007 through 2019

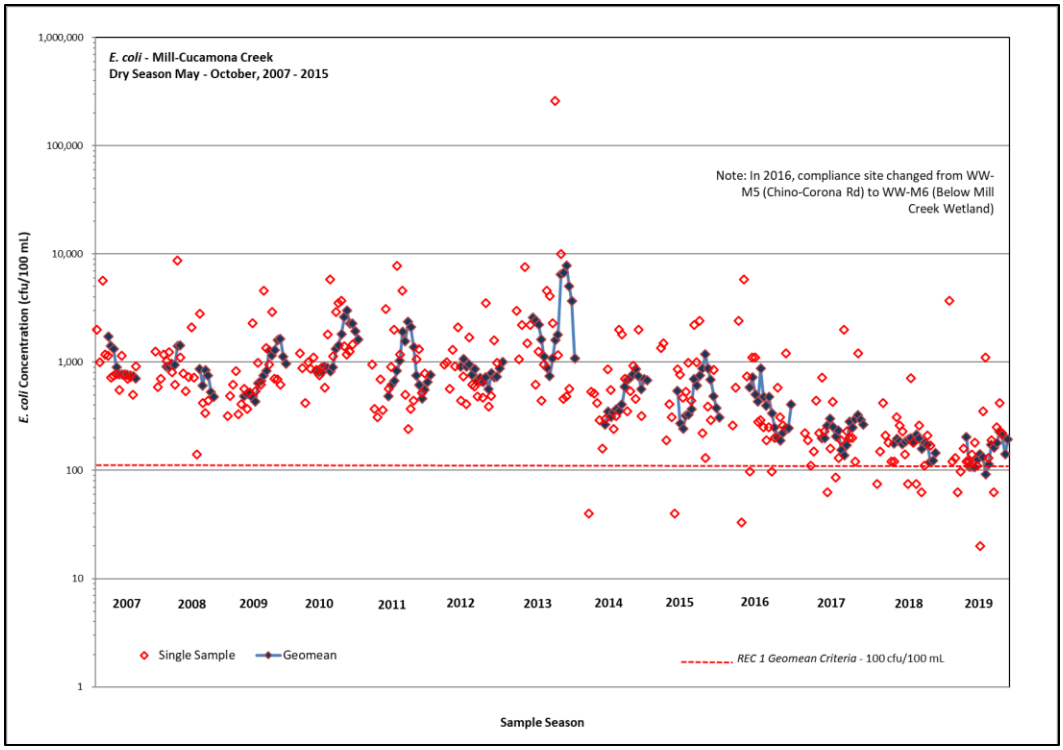

Figure 4-36. Time Series Distribution of *E. coli* Geomean Concentrations at Mill-Cucamonga Creek from 2007 through 2019

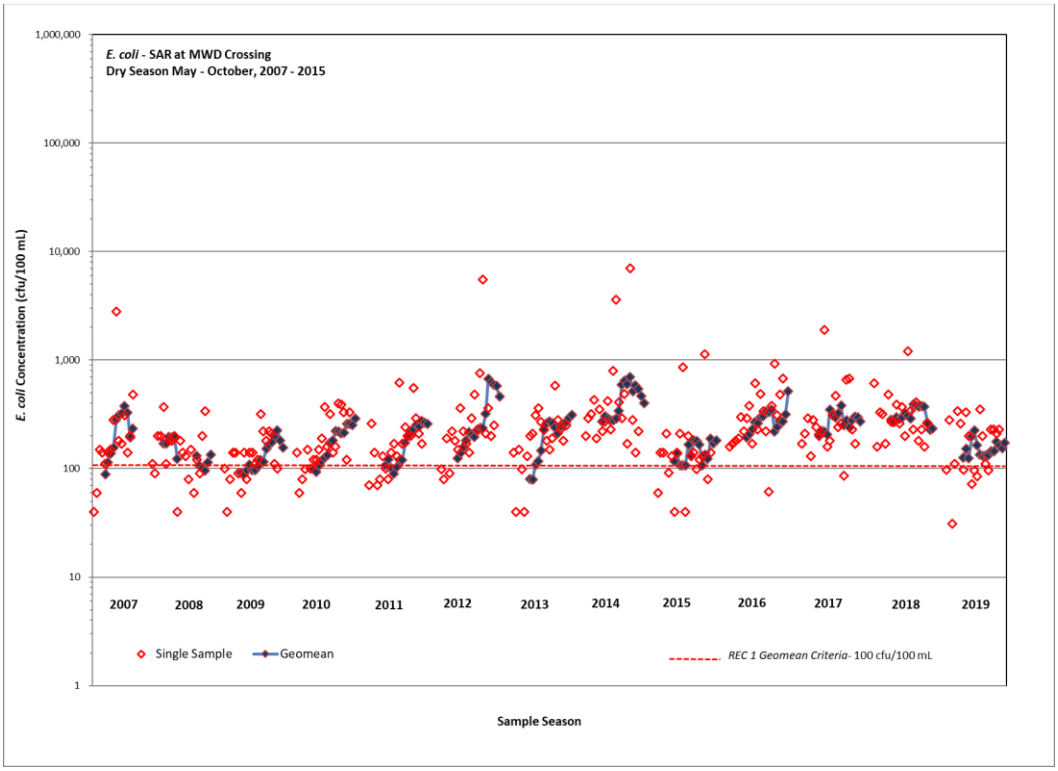

Figure 4-37. Time Series Distribution of *E. coli* Geomean Concentrations at Santa Ana River at MWD Crossing from 2007 through 2019

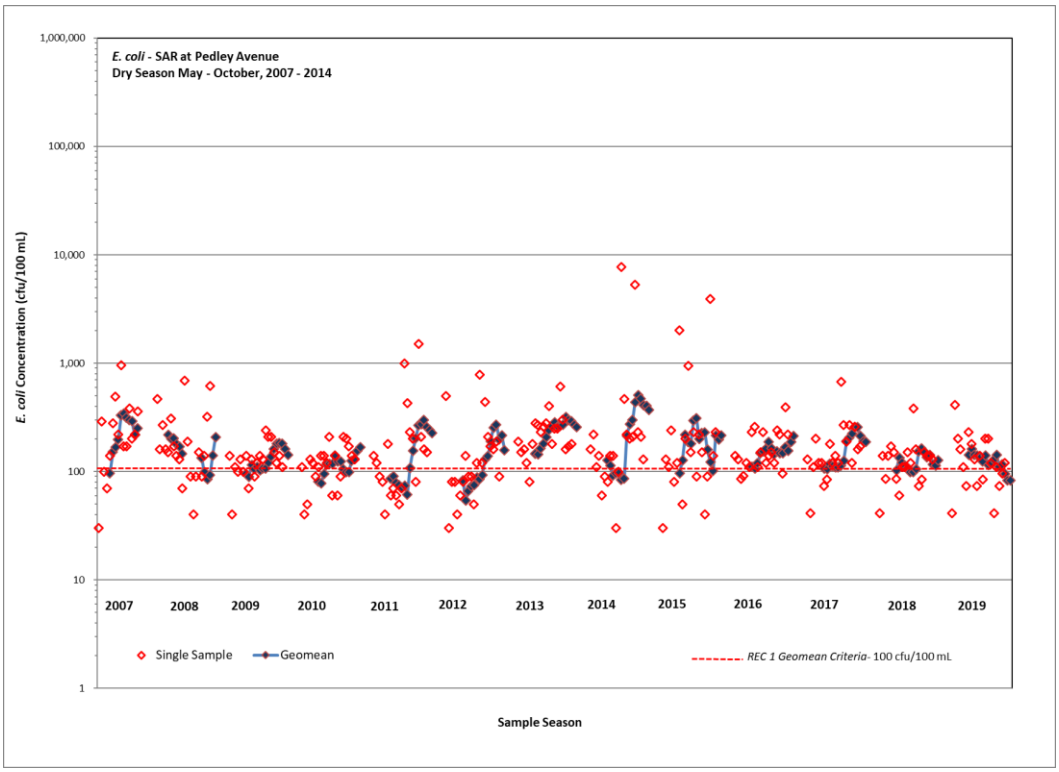

Figure 4-38. Time Series Distribution of *E. coli* Geomean Concentrations at Santa Ana River at Pedley Avenue from 2007 through 2019

4.2.4 Compliance Analysis

The compliance analysis compared the *E. coli* geomeans to the MSAR Bacteria TMDL geomean WLAs/LAs 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. For all Priority 2 sites, compliance is assessed based on 16 geomeans due to only 4 samples being collected within the previous 30 days for the week of July 21, 2019.

Most of the Priority 2 geomeans exceeded the MSAR TMDL WLAs/LAs, with all samples collected at Chino Creek exceeding the goal. At Prado Park Lake, only the cool, dry season sample exceeded the goal. All geomeans calculated during the cool, dry season except for SAR at MWD Crossing exceeded the TMDL WLAs/LAs.

Table 4-6. Frequency of Exceedance with MSAR TMDL WLAs/LAs for *E. coli* During the 2019 Dry Weather Samples (113 MPN/100 mL)

Site ID	Site	Warm, Dry Season Geomean WLA/LA Exceedance Frequency (%) (n=16)	Cool, Dry Season Geomean WLA/LA Exceedance Frequency (%) (n=1)
WW-C3	Prado Park Lake	0%	100%
WW-C7	Chino Creek at Central Avenue	100%	100%
WW-M6	Mill-Cucamonga Creek	88%	100%
WW-S1	Santa Ana River at MWD Crossing	100%	0
WW-S4	Santa Ana River at Pedley Avenue	75%	100%

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 4-7). Key observations are summarized as follows:

- Samples and measurements were not collected from Borrego Creek (P3-OC2) and Los Trancos Creek (P3-OC5) due to dry conditions. As such, Borrego Creek and Los Trancos Creek are not included in Figures 4-39 through 4-45.
- Figure 4-39 presents pH measurements. During the dry, warm pH observations were generally within the allowable range (6.5 to 8.5) except at three sites. Forty percent of the measurements exceeded 8.5 at Bolsa Chica Channel (P3-OC1), twenty percent exceeded at San Diego Creek Reach 1 (P3-OC8), and all of the measurements exceeded 8.5 at Serrano Creek (P3-OC11).
- Water temperatures generally range from 15°C to 30°C with the highest temperatures (26 to 32°C) observed at Peters Canyon Wash (P3-OC7), San Diego Creek Reach 1 (P3-OC8), San Diego Creek Reach 2 (P3-OC9), and Serrano Creek (P3-OC11). These samples were all collected later in the warm, dry season which likely led to elevated temperatures.
- Figure 4-41 shows that DO levels at all sites met the WQO for a minimum of 5 mg/L for WARM use except for at Bolsa Chica Channel (P3-OC1), where the observations ranged from 3.0 to 5.2 mg/L.
- Typically, conductivity ranged from 700 to 3,000 µS/cm at Priority 3 sites (Figure 4-42). The lowest conductivity levels was observed at SAR Reach 4 (P3-SBC1). Conductivity levels at the sites near the coast (Buck Gully Creek [P3-OC3] and Morning Canyon Creek [P3-OC6]) are generally higher than 5,000 µS/cm (between 8,000 and 22,000 respectively). At inland sites, conductivity ranges from 717 to 2,967 µS/cm.
- Figure 4-43 shows that turbidity levels are generally low with 85 percent of measurements less than 10 NTU. The highest turbidity measurement observed was 173 NTU taken at SAR Reach 4 (P3-SBC1). While this occurred during dry weather conditions, there was runoff from upper watershed due to rainfall in San Bernardino Mountains that caused elevated flow in all of the SAR sites on May 15, 2019 above typical conditions on the day of sampling.
- Similar to turbidity, Figure 4-42 shows that TSS is generally low at all sites, with the exception of 1200 mg/L taken at SAR Reach 4 (P3-SBC1). This sample was taken the same day as the elevated turbidity and is attributed to runoff from upper watershed causing elevated flow in all SAR sites. TSS at Peters Canyon Wash (P3-OC7), San Diego Creek Reach 1 (P3-OC8), and Serrano Creek (P3-OC11) is generally higher than TSS at the other Priority 3 sites.

- Figure 4-43 shows that flow was low at all of the Priority 3 sites (less than 10 cfs) except for SAR Reach 4 (P3-SBC1). Borrego Creek (P3-OC2) and Los Trancos Creek (P3-OC5) were both dry every time field teams arrived onsite. Flow at SAR Reach 4 (2.6 to 53.8 cfs) was substantially higher than the other sites as a result of being downstream of Rialto/RIX effluent discharge.

Table 4-7. 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 2)	Orange
P3-OC11	Serrano Creek upstream of Barranca/Alton Parkway	Orange
P3-RC1	Goldenstar Creek at Ridge Canyon Drive	Riverside
P3-SBC1	Santa Ana River Reach 4 above S. Riverside Avenue Bridge	San Bernardino

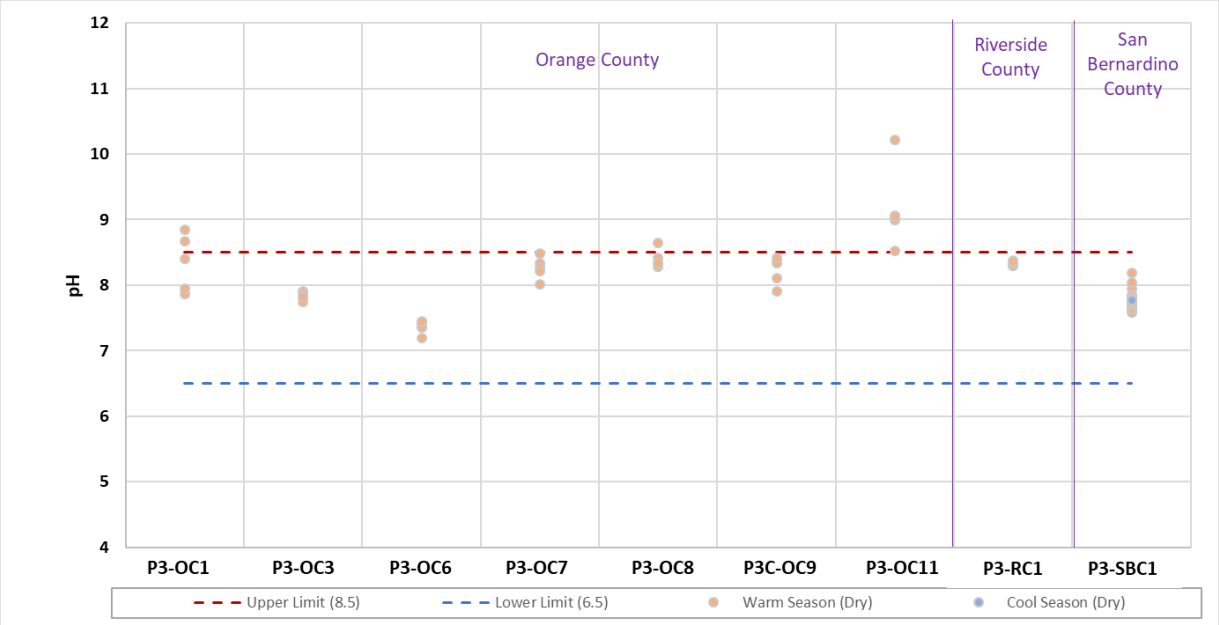

Figure 4-39. Distribution of pH Measurements at Priority 3 Sites

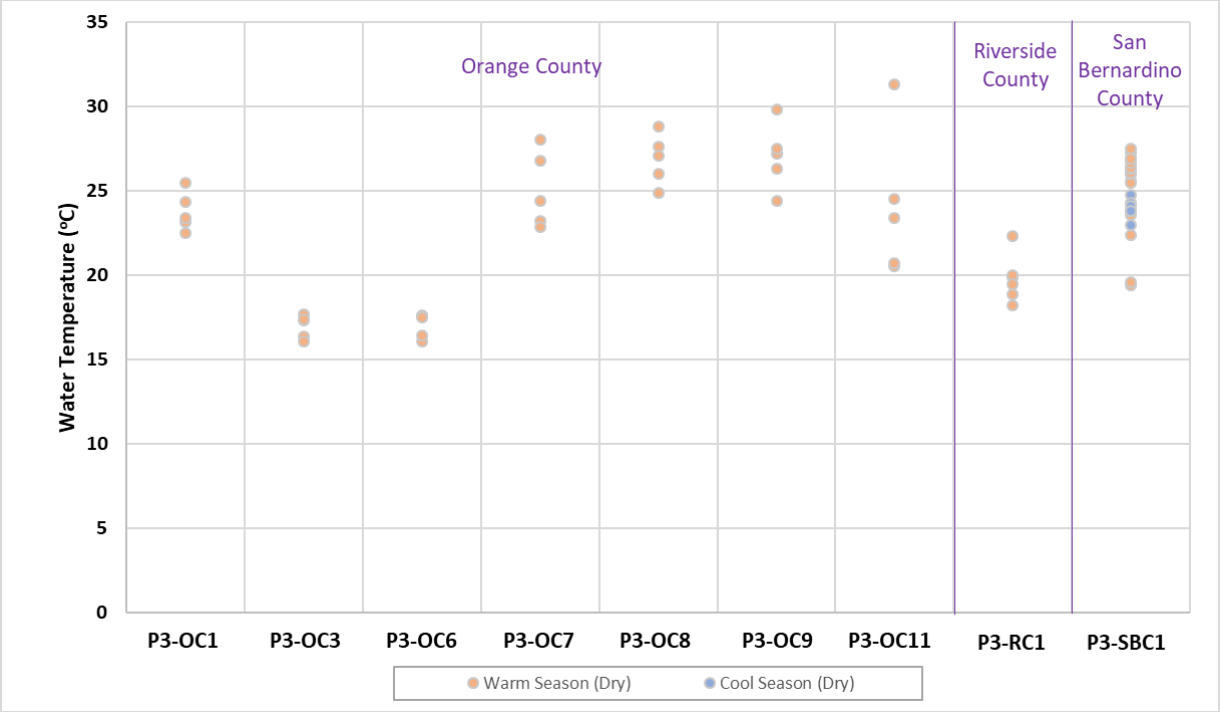

Figure 4-40. Distribution of Water Temperature Measurements at Priority 3 Sites

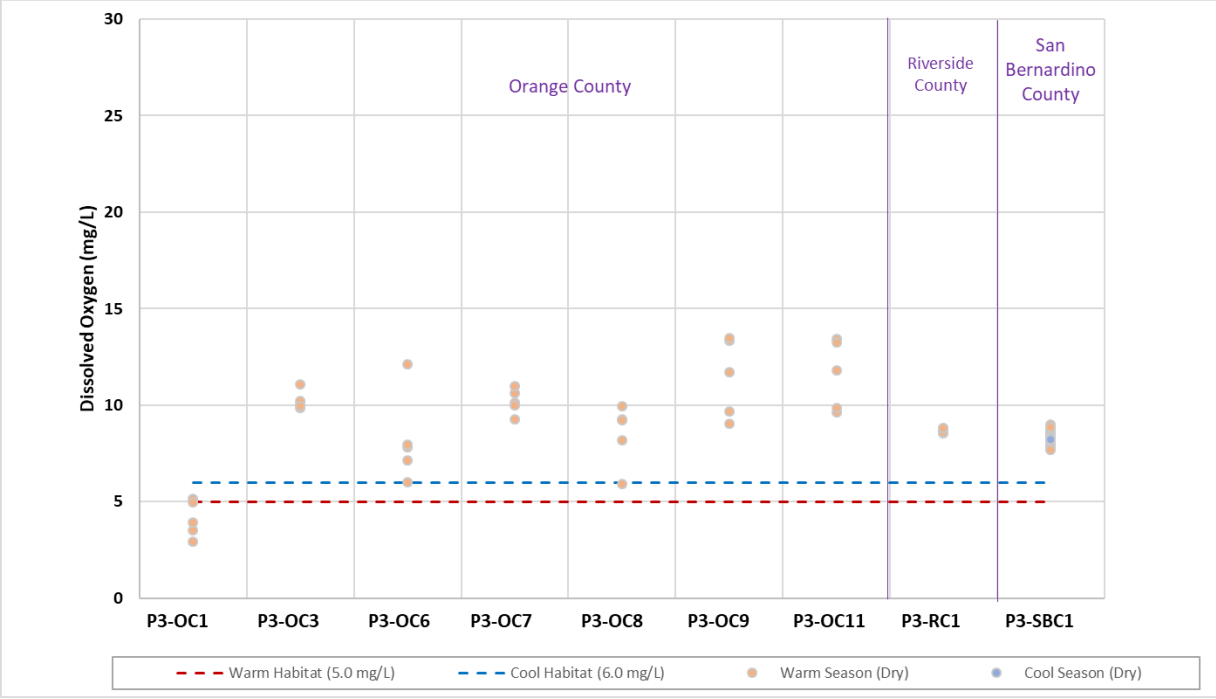

Figure 4-41. Distribution of Dissolved Oxygen Measurements at Priority 3 Sites

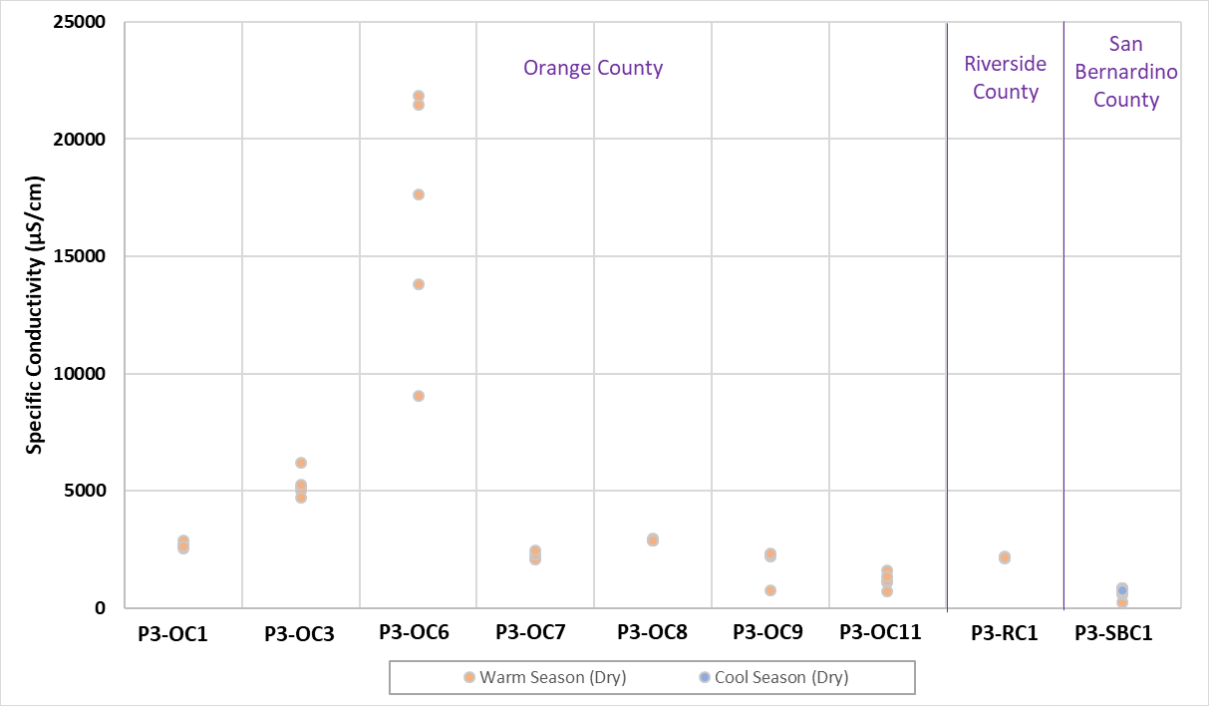

Figure 4-42. Distribution of Specific Conductivity Measurements at Priority 3 Sites

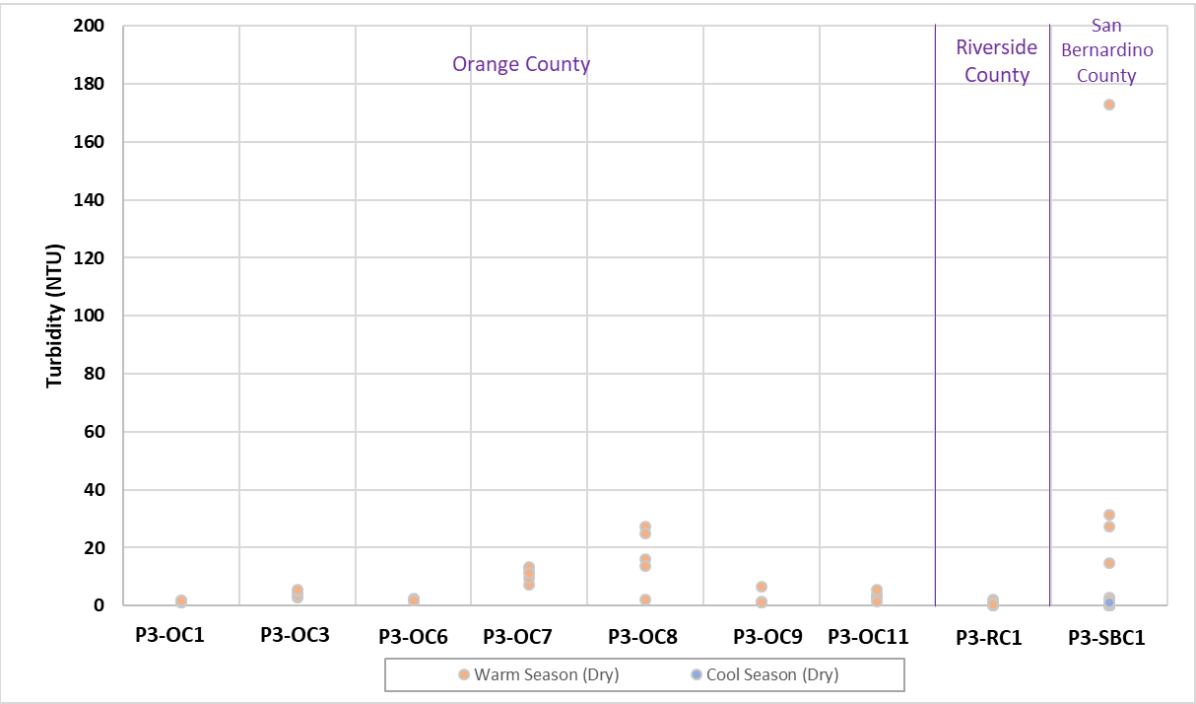

Figure 4-43. Distribution of Turbidity Measurements at Priority 3 Sites

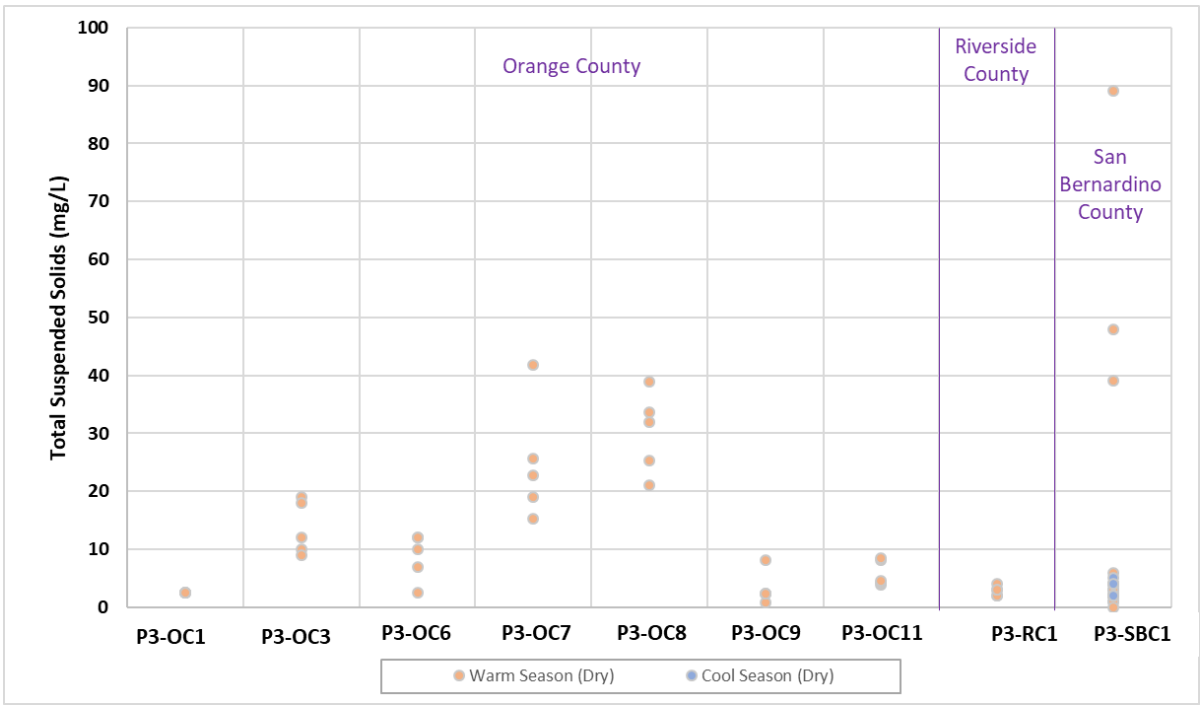

Figure 4-44. Distribution of TSS Measurements at Priority 3 Sites

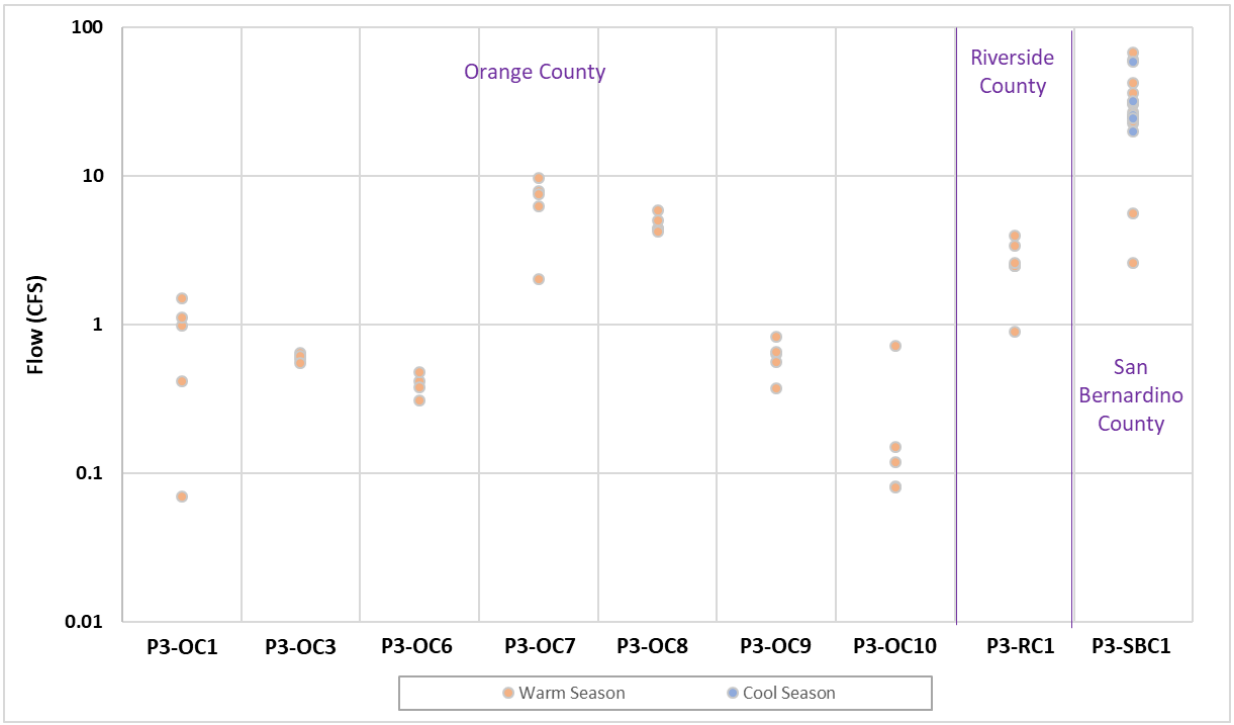

Figure 4-45. Distribution of Flow Measurements at Priority 3 Sites

4.3.2 Bacteria Characterization

Figure 4-46 summarizes the distribution of *E. coli* concentrations observed at Priority 3 sites during dry weather. Figure 4-47 further illustrates the distribution of concentrations.

Three comparisons to previous data are provided. Table 4-8 compares the 25th and 75th percentile concentrations of the mid-2000 era sampling, which was used to place these locations on the impaired waters list, with data from the last four sampling periods (2016-18). Table 4-9 provides the single 5-sample geomean calculated for each site in 2017, 2018 and 2019.

Table 4-9 provides the 5-sample geomean calculated for each site. Key observations are summarized as follows:

- Table 4-9 shows that the 2019 geomeans of *E. coli* concentrations from six Priority 3 sites were greater than the Statewide Bacteria Provision geomean WQO of 100 organisms/100 mL. The geomean at Bolsa Chica Channel (P3-OC1) and SAR Reach 4 (P3-SBC1) did not exceed the geomean WQO. Borrego Creek (P3-OC2) and Las Trancos Creek were dry during sampling events.
- Santa Ana River Reach 4 (P3-SBC1) was sampled weekly starting the first week of the warm, dry season and concluding during the final week of cool, dry season monitoring. The increased sampling resulted in 28 geomeans that will be used to support future delisting. Of the 28 geomeans, 27 of them meet the delisting criteria of 100 MPN/100mL (Figure 4-47) qualifying Santa Ana River Reach 4 for delisting.
- *E. coli* concentrations at Peters Canyon Wash (P3-OC7) and Serrano Creek (P3-OC11), ranged from 350 to 836 MPN/100 mL and 30 to 24,196 MPN/100 mL, respectively. These sites are within the San Diego Creek watershed and will be further evaluated through a planned human source investigation being led by the Newport Bay Fecal Coliform TMDL Workgroup.
- San Diego Creek (P3-OC8 and P3-OC9) sites had lower *E. coli* concentrations than Peters Canyon Wash and Serrano Creek. Concentrations in San Diego Creek are also impacted by widespread deployment of natural treatment systems, diversions to the San Joaquin treatment wetlands, dilution effects from groundwater inflows, and in-stream decay. The Newport Bay fecal coliform TMDL workgroup has developed a bacteria source investigation study design to identify and eliminate source of human fecal bacteria in this watershed. Data collection is planned to begin in the 2020 dry season and will continue over long term via an iterative/adaptive framework.
- Bolsa Chica Channel (P3-OC1) and Buck Gully Creek (P3-OC3) have lower *E. coli* concentrations (5 to 275 MPN/100 mL and 78to 2100 MPN/100 mL, respectively) than other sites. However, historical *Enterococcus* data have been higher concentrations at both sites.
- The same Priority 3 sites that exceeded the geomean WQO also exceeded the Statewide Bacteria Provisions STV exceedance allowance. Each of the seven sites had at least one sample greater than 320 organisms/100 mL, all five samples from Peters Canyon Wash exceeded the STV.

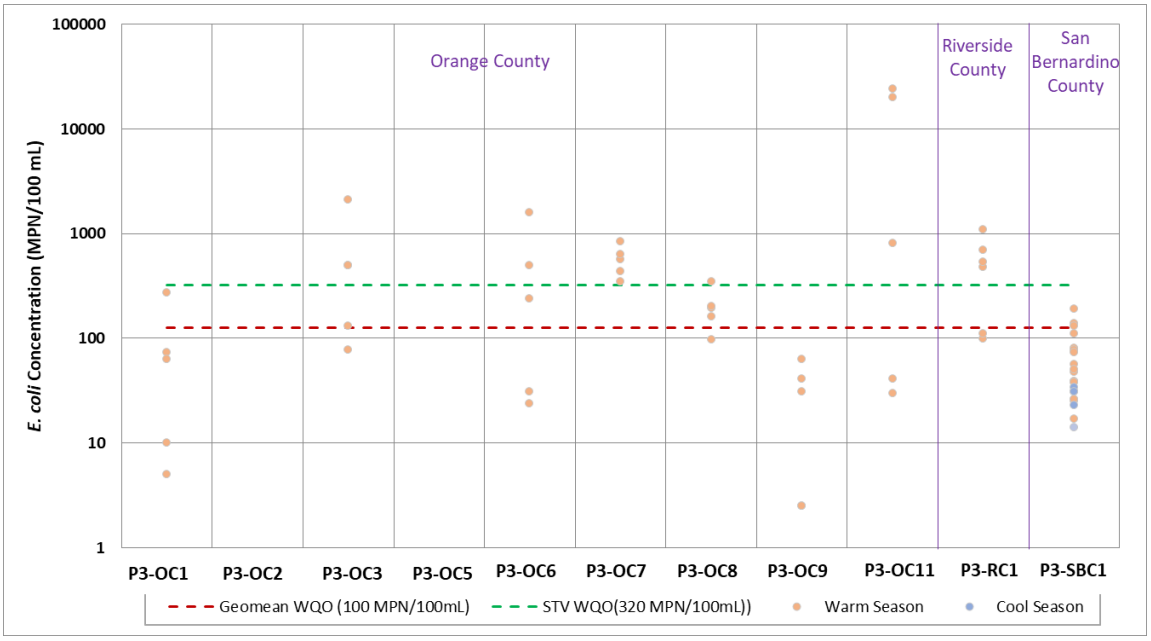

Figure 4-46. Distribution of *E. coli* Concentrations at Priority 3 Sites

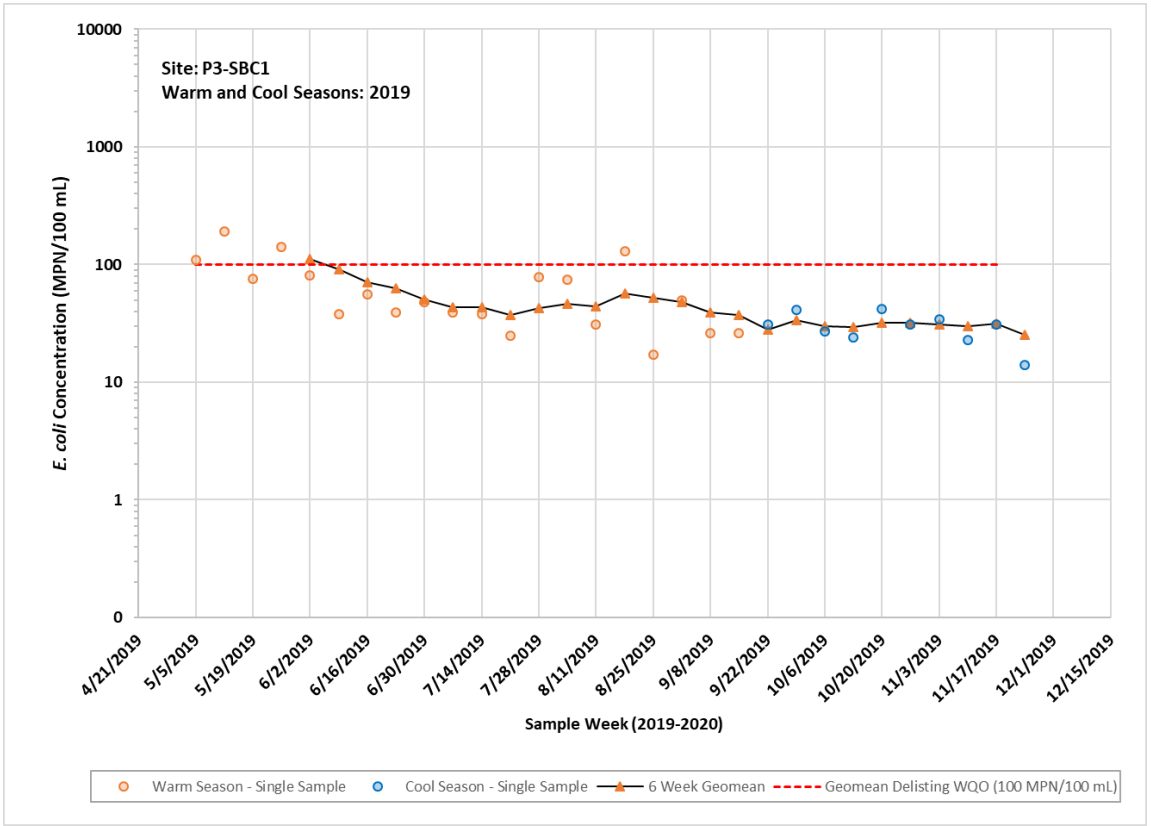

Figure 4-47. Time Series Distribution of *E. coli* Geomean Concentrations at SAR Reach 4 during the 2019-2020 monitoring period

Figure 4-48 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.[21] Note that the historical data from the same waters are not always collected from the same site locations within the waterbody segments as Priority 3 sites in this RMP.

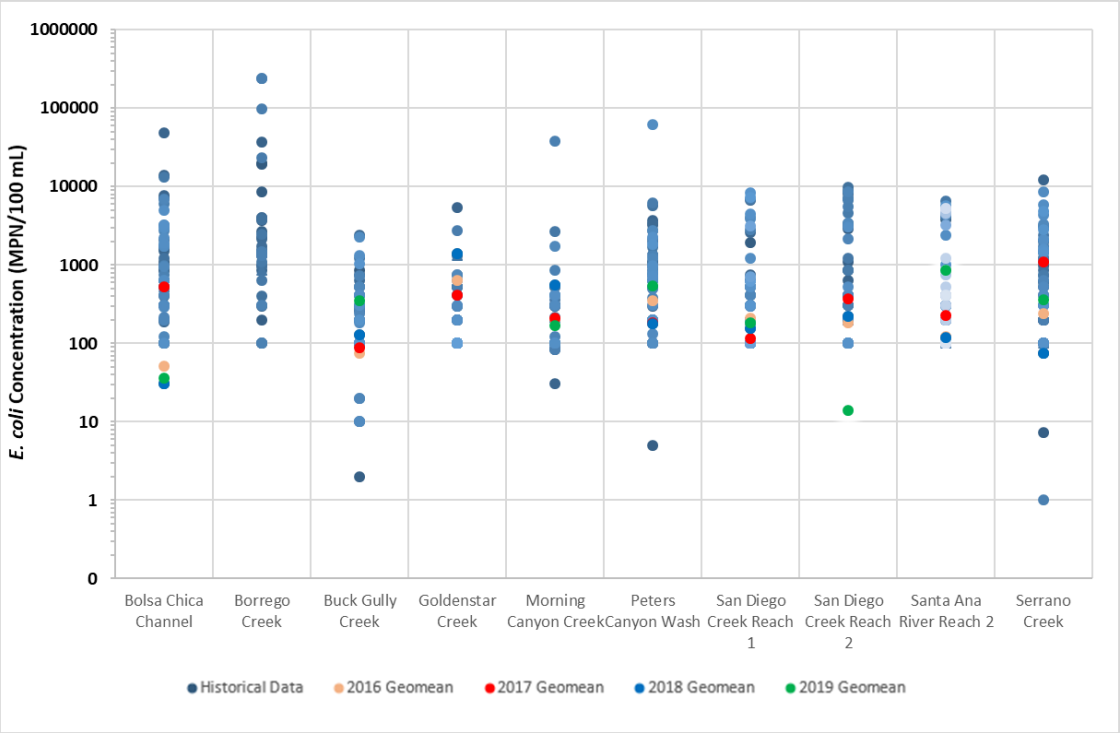

Figure 4-48. Distribution of Historical *E. coli* Concentrations at Priority 3 Waterbodies

Table 4-8. Summary of Historical *E. coli* Concentrations (MPN/100 mL) at Priority 3 Waterbodies

Waterbody	Basis of Impairment Listing			RMP Sampling (2016 - 2019)	
	Collection Period[2]	Sample Size	25th – 75th Quartiles *E. coli*[1] (MPN/100 mL)[3]	Sample Size	25th – 75th Quartiles *E. coli* (MPN/100 mL)
Bolsa Chica Channel	Mar 2004 – Mar 2006	65	310 – 1750	20	20 – 168
Borrego Creek	Mar 2004 – Mar 2006	43	518 – 3755	20	Dry
Buck Gully Creek	Mar 2004 – Apr 2006	68	100 – 335	21	30 – 134
Morning Canyon Creek	Mar 2004 – Apr 2006	61	100 – 300	21	240 – 1461
Peters Canyon Wash	Mar 2004 – Mar 2006	66	100 – 1100	21	179 – 428
San Diego Creek Reach 1	Oct 2002 – June 2004	84	100 – 520	21	135 – 350
San Diego Creek Reach 2	Oct 2002 – June 2004	64	100 – 1455	21	75 – 270

[21] https://www.waterboards.ca.gov/water_issues/programs/tmdl/2014_16state_ir_reports/category5_report.shtml

Waterbody	Basis of Impairment Listing			RMP Sampling (2016 - 2019)	
	Collection Period[2]	Sample Size	25th – 75th Quartiles *E. coli*[1] (MPN/100 mL)[3]	Sample Size	25th – 75th Quartiles *E. coli* (MPN/100 mL)
Serrano Creek	Mar 2004 – Mar 2006	69	100 – 1460	21	161 – 1582
Goldenstar Creek	Oct 2002 – June 2004	79	100 – 200	21	110 – 515

[1] Historical refers to pre-2016 data collected before the RMP

[2] 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 geomeans are calculated from the historical data set for comparison with RMP data since the frequency and locations of data are not the same.

[3] Historical data was analyzed with a reporting limit of 100 MPN/100mL.

Table 4-9. *E. coli* Geometric Means for Priority 3 Sites

Site ID	Site	2017 Geometric Mean (MPN/100 mL)[1]	2018 Geometric Mean (MPN/100 mL)[1]	2019 Geometric Mean (MPN/100 mL)[1]	2019 Compliance with WQO?
P3-OC1	Bolsa Chica Channel	534	31	36	Yes
P3-OC2	Borrego Creek	NA (Dry)	NA (Dry)	NA (Dry)	NA
P3-OC3	Buck Gully Creek	89	130	351	No
P3-OC5	Los Trancos Creek	NA (Dry)	NA(Dry)	NA (Dry)	NA
P3-OC6	Morning Canyon Creek	212	NA	170	No
P3-OC7	Peters Canyon Wash	183	562	540	No
P3-OC8	San Diego Creek Rch 1	116	176	184	No
P3-OC9	San Diego Creek Rch 2	373	155	14	Yes
P3-OC11	Serrano Creek	1080	221	864	No
P3-RC1	Goldenstar Creek	417	118	360	No

[1] Samples used to calculate the geomean are from 5 consecutive weeks during the dry season and are different 5-week periods each year

4.4 Priority 4

4.4.1 Water Quality Observations

Each Priority 4 site (Table 4-10) is sampled once each year to evaluate compliance with the antidegradation target established for each waterbody. Table 4-11 summarizes the water quality field parameters from each site in 2019.

Table 4-10. 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 4-11. 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)
Sample Date	9/23/2019	9/26/2019	9/23/2019	6/19/2019
pH	7.8	7.5	7.9	8.8
Water Temperature (°C)	22.3	24.1	22.9	23.5
Dissolved Oxygen (mg/L)	5.9	4.8	4.4	9.3
Conductivity (µS/cm)	2602	27,327	26,399	1404
Turbidity (NTU)	5.1	2.7	2.2	0
TSS (mg/L)	16	5	5	6
Flow (cfs)	NA	NA	NA	4

4.4.2 Bacteria Characterization

Priority 4 water quality sample results were compared to site-specific single sample antidegradation targets (Figure 4-50, Table 4-12). Santa Ana Delhi Channel in Tidal Prism (P4-OC2) exceeded the antidegradation target of 464 MPN/100mL. As shown in Table 4-13, three monthly follow-up samples were required, and all were below the antidegradation target. The other three Priority 4 sites met their antidegradation targets. All other priority 4 sites indicator bacteria results did not exceed the antidegradation target and monitoring at these sites was considered complete for the monitoring year.

Table 4-12. Antidegradation Targets for Priority 4 Sites

Site ID	Site Description	Single Sample Antidegradation Target (MPN/100 mL)	*E.coli* Sample Result	*Enterococcus* Sample Result	Sample Date
P4-OC1	Santa Ana Delhi Channel Upstream of Irvine Avenue	1067	884		9/23/2019
P4-OC2	Santa Ana Delhi Channel in Tidal Prism	464		988[1]	9/26/2019
P4-OC3	Greenville-Banning Channel in Tidal Prism	64		10	9/23/2019
P4-RC2	Temescal Creek at Lincoln Avenue	725	23		6/19/2019
P4-SBC1[2]	Cucamonga Creek at Hellman Avenue	1385			

[1] This sample exceeded the anti-degradation target for Santa Ana Delhi Channel Upstream of Irvine Channel in Tidal Prism of 464 MPN/100mL and resulted in three monthly follow-up samples. Results are shown in Table 4-13.
[2] Cucamonga Creek at Hellman Avenue was sampled monthly to provide data to support updating the anti-degradation target. The background and results are further explained in Section 4.4.3.

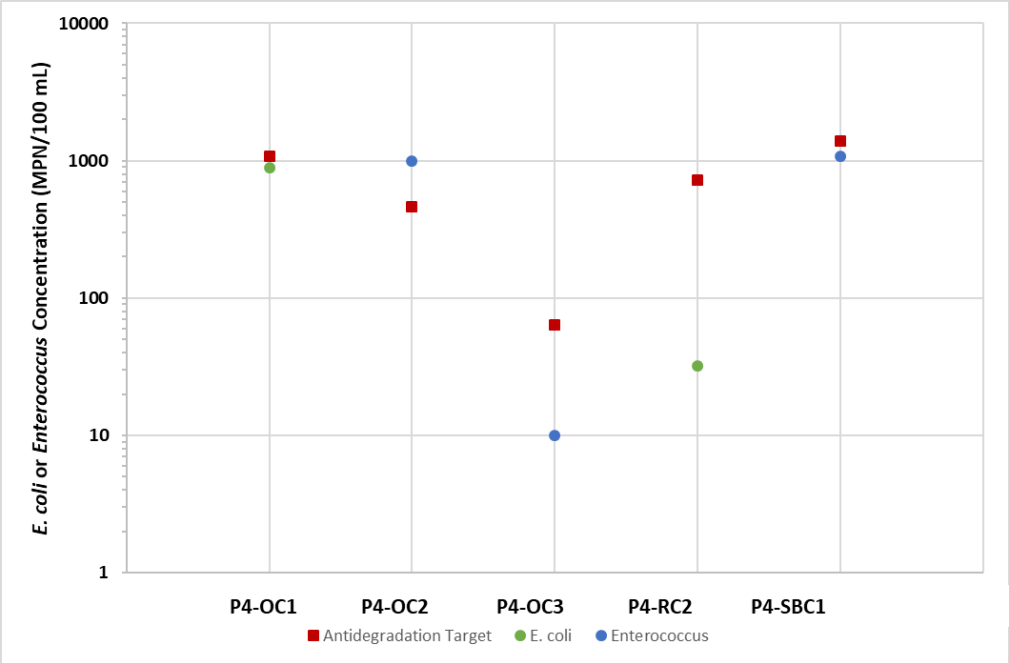

Figure 4-50. Monitoring Results and Antidegradation Targets for Priority 4 Sites

Table 4-13. Monthly Follow-Up Sampling at Santa Ana Delhi Channel in Tidal Prism (P4-OC2)

Sample Requirement	Sample Date	*Enterococcus* Concentration (MPN/100 mL)
Original Annual Sample	9/23/2019	988[1]
Required Monthly Follow-up Samples	10/21/2019	31
	11/18/2019	10
	12/15/2019	185

[1] This sample exceeded the anti-degradation target for Santa Ana Delhi Channel Upstream of Irvine Channel in Tidal Prism of 464 MPN/100mL

4.4.3 Cucamonga Creek Reach 1 Anti-Degradation Update

In 2013, a use attainability analysis (UAA) was completed for Cucamonga Creek Reach 1 and served as the basis for EPA approval of changes to the beneficial use from REC1 and REC2 to REC2 only (CDM Smith, 2013a). Numeric water quality objectives were not included in the Basin Plan for REC2 only waters, but the BPA does require "…appropriate measures are taken to assure that water quality conditions in these waters are not degraded as the result of controllable water quality factors, consistent with antidegradation policy requirements." Upon completion of the UAA documents, CDM Smith computed anti-degradation targets for the waterbodies recommended to be designated as REC2 only (CDM Smith, 2013). These targets were included in the BPA approved by EPA in 2015. The basis for the anti-degradation target in Cucamonga Creek included samples collected from the concrete lined segment by the Regional Board on a somewhat routine basis during dry weather between 2002 and 2004.

Historical review of data from USGS gauge 11073495, Cucamonga Creek at Merrill Avenue, shows that typical dry weather flow rates in Cucamonga Creek Reach 1 in the early 2000s ranged from 25-50 cfs. Currently, dry weather flow rates have declined by an order of magnitude in this segment of Cucamonga Creek (Figure 4-51). Thus, changes to fecal bacteria concentrations may have resulted from a change to hydrologic condition, which is largely attributable to IEUA's expansion of recycled water use over this same time period. In February 2019, the Task Force proposed that the change in hydrologic condition warranted a change to the anti-degradation target for Cucamonga Creek Reach 1. To that end, the Task Force approved an increase to the frequency of monitoring at the P4-SBC1 site from once per year to monthly in 2018-19 and as needed thereafter to develop a sufficient *E. coli* concentration dataset for updating the antidegradation target using the same statistical method employed in the 2013 calculations. In recent years, other monitoring programs have collected data from this site as well, including 10 weekly samples in the 2016-18 dry seasons by the SBCFCD and six weekly samples during the 2019 dry season Synoptic Study led by the MSAR Bacteria TMDL Task Force. Integrating data from each of these sources, a total of 54 samples have been collected from Cucamonga Creek at Hellman Avenue in 2016-2019 (Figure 4-52). Water quality sampling is planned to continue through 2020-21 program year and a preliminary calculation of a new antidegradation target will be included in the 2020-21 annual RMP report.

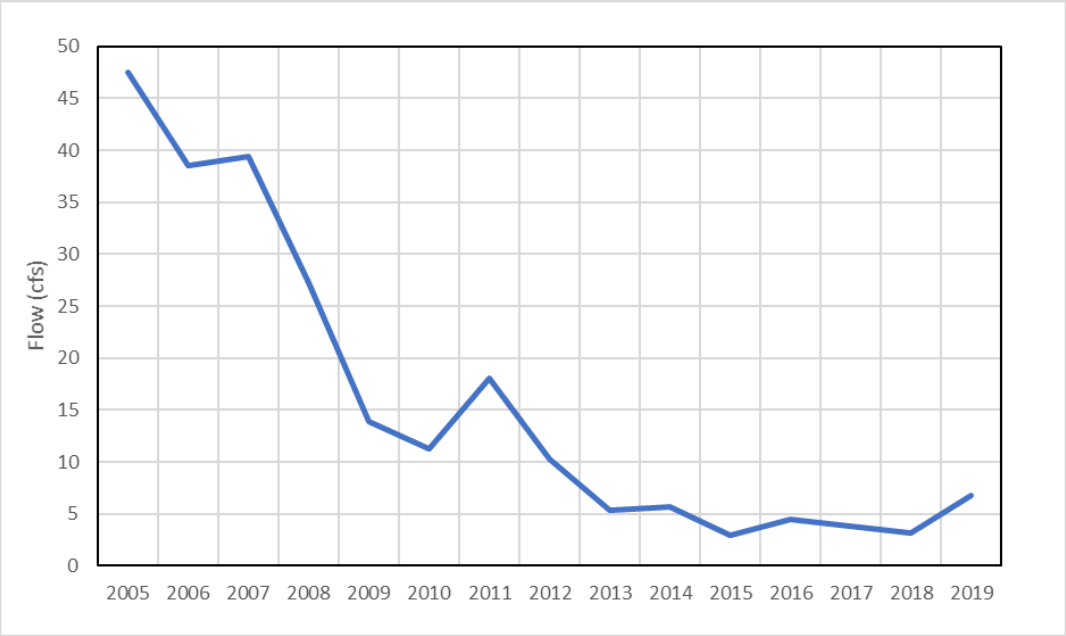

Figure 4-51. Median daily flow in Cucamonga creek from July to September (USGS gage 11073495 Cucamonga Creek near Mira Loma)

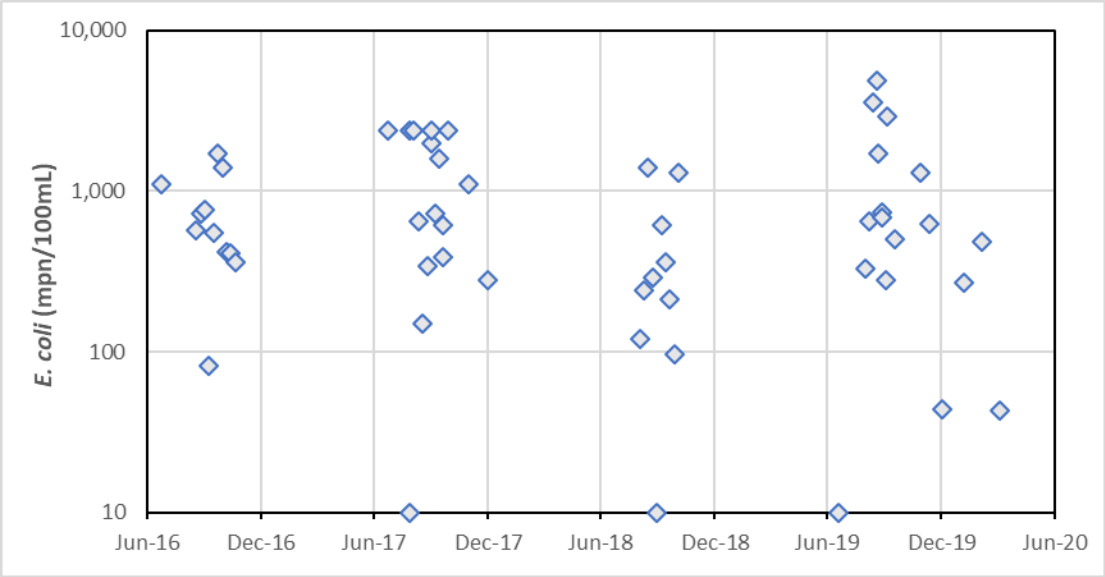

Figure 4-52. Recent *E. coli* Concentrations in Samples from Cucamonga Creek at Hellman Avenue
(These Data and Results from 2020-21 Monitoring Efforts will be used to Update the Anti-Degradation Target for Cucamonga Creek Reach 1.)

Section 5
Recommendations for 2020-2021

This section describes recommended updates to the Monitoring Plan for the 2020-2021monitoring year.

- Inclusion of new sampling point Santa Ana River Reach 3 at Mission Avenue (WW-MISSION) as a Priority 2 site location to be included in the 2020-2021 monitoring year. This site was included as part of the 2019 Synoptic Study and showed significant *E. coli* load to the Santa Ana River can be attributed to non-human sources upstream of MS4 inflows. Data from this site will capture a coinciding record of non-MS4 upstream boundary during dry weather. Monitoring will begin during the 2020-2021 monitoring period.
- Sites newly listed in the 2014/16 303(d) List of Impaired Waters should be added to the RMP. This includes Warm Creek and San Timoteo Creek Reaches 1A and 2. Sites will be included as Priority 3 sites in San Bernardino County. Monitoring will begin during the 2020-2021 monitoring period.
- Conduct a special study to analyze bacteria present Santa Ana channel bed. This study will evaluate the extent to which naturalized *E. coli* in bottom sediments or biofilms of the Santa Ana River. The study will leverage work already conducted in the 2015 Uncontrollable Bacteria Sources Study conducted by RCFC&WCD.

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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 2019 dry weather sampling activities and 2019-2020 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 2019 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; BDL: below detection limit)

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
5/5/2019	BDL	--	34	--	88	--	1	--
5/12/2019	2.0	--	16	--	250	--	BDL	--
5/19/2019	1.0	--	8.5	--	22	--	BDL	--
5/26/2019	1.0	--	3.1	--	13	--	BDL	--
6/2/2019	BDL	0.9	7.4	10	2	26.3	BDL	0.6
6/9/2019	2.0	1.4	6.3	9	BDL	10.6	BDL	0.6
6/16/2019	3.1	1.2	33	11	20	14.4	1	0.6
6/23/2019	1.0	1.3	8.6	9	4.1	9.3	BDL	0.6
6/30/2019	3.1	1.4	22	10	0.5	3.8	BDL	0.6
7/7/2019	2.0	1.5	5.2	9	30	4.0	BDL	0.5
7/14/2019	2.0	1.7	5.2	10	1	2.8	3.1	0.7
7/21/2019	2.0	1.9	7.3	8	BDL	2.0	BDL	0.7
7/28/2019	BDL	1.7	3.1	9	1	2.5	BDL	0.7
8/4/2019	2.0	1.6	3.1	6	26	2.6	BDL	0.6
8/11/2019	1.0	1.6	1	5	0.5	1.9	BDL	0.6
8/18/2019	BDL	1.2	1	3	7.4	2.8	BDL	0.6
8/25/2019	1.0	1.1	12	3	BDL	1.6	1	0.7
9/1/2019	1.0	1.0	2	3	4.1	1.9	BDL	0.6
9/8/2019	2.0	1.0	5	3	BDL	1.9	BDL	0.6
9/15/2019	13.0	1.6	3	3	BDL	1.7	BDL	0.6
10/27/2019	4.1	--	4.1	--	2000	--	15	--
11/3/2019	3.1	--	9.8	--	3.1	--	BDL	--
11/10/2019	5.2	--	18	--	2	--	2	--
11/17/2019	11.0	--	9.7	--	11	--	5.2	--
11/24/2019	11.0	6.0	20	11	54	24	12	4

Table A-2. *E. coli* (MPN/100 mL) Concentrations Observed at Priority 1 Stream Sites during the 2019 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; BDL = below detection limit)

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
5/5/2019	1	--	2	--	98	--	41	--
5/12/2019	BDL	--	3	--	280	--	410	--
5/19/2019	2	--	3	--	31	--	200	--
5/26/2019	BDL	--	1	--	110	--	160	--
6/2/2019	BDL	0.8	7	2.6	340	126.0	110	142.7
6/9/2019	BDL	0.7	BDL	2.0	260	142.2	74	127.9
6/16/2019	BDL	0.7	18	2.7	98	134.8	230	139.1
6/23/2019	2	0.7	3.1	2.9	330	160.4	180	171.8
6/30/2019	BDL	0.7	3.1	2.9	200	152.9	130	145.8
7/7/2019	BDL	0.7	3.1	3	72	139.1	74	134.0
7/14/2019	2	0.7	4.1	4	96	150.5	140	126.6
7/21/2019	1	0.8	14	4	85	124.9	85	129.6
7/28/2019	BDL	0.8	6.3	6	350	154.4	200	126.6
8/4/2019	2	1.0	2	4.2	200	142.1	200	128.9
8/11/2019	1	0.9	1	3.5	110	134.9	120	115.2
8/18/2019	6.3	1.3	3.1	3.5	96	134.9	41	115.2
8/25/2019	BDL	1.3	BDL	2.7	230	156.1	110	110.7
9/1/2019	2	1.4	4.1	2.1	230	165.0	74	104.5
9/8/2019	1	1.3	2	2.1	210	187.7	96	106.3
9/15/2019	2	1.5	68	3.1	230	176.8	120	98.9
10/27/2019	15	--	2	--	52	--	98	--
11/3/2019	BDL	--	1	--	150	--	160	--
11/10/2019	BDL	--	1	--	120	--	120	--
11/17/2019	2	--	2	--	180	--	110	--
11/24/2019	BDL	1	8.5	2	97	110	150	125

Table A-3. *E. coli* (MPN/100 mL) Concentrations Observed at Priority 2 Sites during the 2019 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
5/5/2019	20	--	250	--	3700	--	98	--	41	--
5/12/2019	41	--	690	--	120	--	280	--	410	--
5/19/2019	10	--	190	--	130	--	31	--	200	--
5/26/2019	41	--	140	--	63	--	110	--	160	--
6/2/2019	31	25.3	140	229.9	97	203.9	340	126	110	143
6/9/2019	10	22.0	230	226.1	160	108.8	260	153	74	161
6/16/2019	5	14.5	260	186.0	120	108.8	98	124	230	143
6/23/2019	74	19.0	370	208.6	120	110.6	330	146	180	149
6/30/2019	5	14.2	200	228.3	140	125.6	200	225	130	134
7/7/2019	10	11.3	400	281.6	180	142.2	72	165	74	124
7/14/2019	190	20.4	24000	713.3	110	131.9	96	135	140	141
7/21/2019[1]	63		240		20		85		85	
7/28/2019	10	22.7	550	759.9	350	114.2	350	133	200	118
8/4/2019	63	37.6	190	752.2	1100	172.4	200	133	200	129
8/11/2019	63	54.4	130	600.8	130	161.6	110	144	120	142
8/18/2019	120	49.6	400	264.9	190	180.2	96	144	41	111
8/25/2019	220	63.7	95	220.1	63	226.7	230	176	110	117
9/1/2019	41	84.5	400	206.5	250	212.0	230	162	74	96
9/8/2019	63	84.5	490	249.6	420	174.8	210	164	96	83
9/15/2019	86	89.9	24000	708.7	220	194.2	230	190	120	83
10/27/2019	880	--	960	--	660	--	52	--	98	--
11/3/2019	370	--	670	--	280	--	150	--	160	--
11/10/2019	160	--	280	--	200	--	120	--	120	--
11/17/2019	250	--	10	--	420	--	180	--	110	--
11/24/2019	430	354.5	1100	288.0	370	356.3	97	110	150	125

[1] The minimum of 5 samples in 30 days for a geomean calculation was not met this week

Table A-4. *E. coli* (MPN/100 mL) Concentrations Observed at Priority 3 Orange County Sites during the 2019 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 and Los Trancos were dry during all sample events)

Week Beginning Date	Bolsa Chica Channel		Buck Gully Creek		Morning Canyon Creek		Peters Canyon Wash		San Diego Creek Reach 1		San Diego Creek Reach 2		Serrano Creek	
	(P3-OC1)		(P3-OC3)		(P3-OC6)		(P3-OC7)		(P3-OC8)		(P3-OC9)		(P3-OC11)	
	SSV	GM	SSV	GM	SSV	GM	SSV	GM	SSV	GM	SSV	GM	SSV	GM
5/5/2019	--	--	500	--	24	--	--	--	--	--	--	--	--	--
5/12/2019	--	--	500	--	240	--	--	--	--	--	--	--	--	--
5/19/2019	--	--	2100	--	500	--	--	--	--	--	--	--	--	--
5/26/2019	--	--	130	--	1600	--	--	--	--	--	--	--	--	--
6/2/2019	--	--	78	350.9	31	170.2	--	--	--	--	--	--	--	--
6/9/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--
6/16/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--
6/23/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--
6/30/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7/7/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7/14/2019	74	--	--	--	--	--	--	--	--	--	--	--	--	--
7/21/2019	5	--	--	--	--	--	--	--	--	--	--	--	--	--
7/28/2019	63	--	--	--	--	--	--	--	--	--	--	--	--	--
8/4/2019	275	--	--	--	--	--	--	--	--	--	--	--	--	--
8/11/2019	10	36.4	--	--	--	--	--	--	--	--	--	--	--	--
8/18/2019	--	--	--	--	--	--	565	--	97	--	41	--	30	--
8/25/2019	--	--	--	--	--	--	435	--	345	--	31	--	24196	--
9/1/2019	--	--	--	--	--	--	350	--	195	--	63	--	813	--
9/8/2019	--	--	--	--	--	--	836	--	161	--	2.5	--	19863	--
9/15/2019	--	--	--	--	--	--	637	539.7	201	184.0	2.5	13.8	41	863.7
10/27/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--
11/3/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--
11/10/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--
11/17/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--
11/24/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table A-5. *E. coli* (MPN/100 mL) Concentrations Observed at Priority 3 Riverside County and San Bernardino County Sites during the 2019 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)	
	Result	Geomeans	Result	Geomeans
5/5/2019	110	--	--	--
5/12/2019	190	--	--	--
5/19/2019	75	--	--	--
5/26/2019	140	--	--	--
6/2/2019	81	--	--	--
6/9/2019	38	--	--	--
6/16/2019	56	--	--	--
6/23/2019	39	--	--	--
6/30/2019	48	--	--	--
7/7/2019	39	--	--	--
7/14/2019	38	--	480	--
7/21/2019	25	--	540	--
7/28/2019	78	--	700	--
8/4/2019	74	--	1100	--
8/11/2019	31	--	99	--
8/18/2019	130	--	110	359.9
8/25/2019	17	--	--	--
9/1/2019	50	--	--	--
9/8/2019	26	--	--	--
9/15/2019	26	--	--	--
10/27/2019	31	--	--	--
11/3/2019	34	--	--	--
11/10/2019	23	--	--	--
11/17/2019	31	--	--	--
11/24/2019	14	--	--	--

Table A-6. *E. coli* (MPN/100 mL) Concentrations Observed at SAR Reach 4 (P3-SBC1) (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 (Single Sample)	SAR Reach 4 (Rolling Geomean)
5/5/2019	110	--
5/12/2019	190	--
5/19/2019	75	--
5/26/2019	140	--
6/2/2019	81	112
6/9/2019	38	91
6/16/2019	56	71
6/23/2019	39	62
6/30/2019	48	50
7/7/2019	39	43
7/14/2019	38	43
7/21/2019	25	37
7/28/2019	78	43
8/4/2019	74	46
8/11/2019	31	44
8/18/2019	130	57
8/25/2019	17	52
9/1/2019	50	48
9/8/2019	26	39
9/15/2019	26	38
9/22/2019	31	28
9/29/2019	41	34
10/6/2019	27	30
10/13/2019	24	29
10/20/2019	42	32
10/27/2019	31	32
11/3/2019	34	31
11/10/2019	23	30
11/17/2019	31	32
11/24/2019	14	25

Table A-7. Total Suspended Solids (mg/L) Concentrations Observed at Priority 1 Sites during the 2019 Dry Season (BDL: below detection limit)

Week Beginning Date	Canyon Lake	Lake Elsinore	Lake Perris	Big Bear Lake	Mill Creek Reach 2	Lytle Creek	SAR @ MWD Crossing	SAR @ Pedley Avenue
	(P1-1)	(P1-2)	(P1-3)	(P1-4)	(P1-5)	(P1-6)	(WW-S1)	(WW-S4)
5/5/2019	4	45	2	10	BDL	BDL	6	9
5/12/2019	4	28	BDL	18	BDL	BDL	100	210
5/19/2019	2	40	24	20	BDL	BDL	100	120
5/26/2019	2	31	10	74	BDL	BDL	120	110
6/2/2019	3	33	26	11	2	BDL	78	73
6/9/2019	4	32	3	5	BDL	BDL	18	48
6/16/2019	4	39	2	13	BDL	BDL	26	35
6/23/2019	4	29	2	18	BDL	BDL	14	24
6/30/2019	4	25	4	15	BDL	10	7	26
7/7/2019	4	16	4	40	BDL	BDL	6	16
7/14/2019	6	26	5	8	2	BDL	13	22
7/21/2019	4	26	13	20	BDL	BDL	12	12
7/28/2019	2	26	20	14	BDL	4	10	12
8/4/2019	5	18	8	42	BDL	2	14	10
8/11/2019	6	16	2	51	2	2	6	8
8/18/2019	2	23	7	14	BDL	BDL	5	6
8/25/2019	2	33	16	26	BDL	BDL	6	7
9/1/2019	3	22	6	40	BDL	BDL	11	5
9/8/2019	3	20	3	23	BDL	BDL	6	6
9/15/2019	3	22	4	78	BDL	BDL	4	3
10/27/2019	5	44	280	8	BDL	2	4	7
11/3/2019	4	34	10	8	2	4	4	5
11/10/2019	29	6	3	2	BDL	BDL	2	6
11/17/2019	4	30	4	6	BDL	2	6	5
11/24/2019	3	24	BDL	24	BDL	BDL	4	6

Table A-8. Total Suspended Solids (mg/L) Concentrations Observed at Priority 2 Sites during the 2019 Dry Season (BDL: below detection limit)

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)
5/5/2019	25	2	6	6	9
5/12/2019	16	4	4	100	210
5/19/2019	16	BDL	12	100	120
5/26/2019	BDL	2	6	120	110
6/2/2019	20	2	8	78	73
6/9/2019	13	5	6	18	48
6/16/2019	18	2	4	26	35
6/23/2019	12	2	2	14	24
6/30/2019	12	4	6	7	26
7/7/2019	13	4	6	6	16
7/14/2019	12	5	2	13	22
7/21/2019	5	4	2	12	12
7/28/2019	13	2	2	10	12
8/4/2019	8	3	3	14	10
8/11/2019	12	4	3	6	8
8/18/2019	9	4	4	5	6
8/25/2019	10	4	4	6	7
9/1/2019	16	6	7	11	5
9/8/2019	20	8	7	6	6
9/15/2019	20	5	6	4	3
10/27/2019	38	8	6	4	7
11/3/2019	19	22	6	4	5
11/10/2019	12	16	2	2	6
11/17/2019	14	11	5	6	5
11/24/2019	26	12	8	4	6

Table A-9. Total Suspended Solids (mg/L) Concentrations Observed at Priority 3 Sites in Orange County during the 2019 Dry Season (Note: Borrego Creek and Los Trancos were dry during all sample events)

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 2 (P3-OC9)	Serrano Creek (P3-OC11)
5/5/2019	--	--	19	--	12	--	--	--	--
5/12/2019	--	--	18	--	12	--	--	--	--
5/19/2019	--	--	10	--	7	--	--	--	--
5/26/2019	--	--	9	--	10	--	--	--	--
6/2/2019	--	--	12	--	BDL	--	--	--	--
6/9/2019	--	--	--	--	--	--	--	--	--
6/16/2019	--	--	--	--	--	--	--	--	--
6/23/2019	--	--	--	--	--	--	--	--	--
6/30/2019	--	--	--	--	--	--	--	--	--
7/7/2019	--	--	--	--	--	--	--	--	--
7/14/2019	BDL	--	--	--	--	--	--	--	--
7/21/2019	BDL	--	--	--	--	--	--	--	--
7/28/2019	BDL	--	--	--	--	--	--	--	--
8/4/2019	BDL	--	--	--	--	--	--	--	--
8/11/2019	BDL	--	--	--	--	--	--	--	--
8/18/2019	--	--	--	--	--	15.3	25.3	2.3	8.2
8/25/2019	--	--	--	--	--	25.7	21	0.8	3.8
9/1/2019	--	--	--	--	--	19	32	2.4	8.4
9/8/2019	--	--	--	--	--	22.7	38.9	2.4	4.2
9/15/2019	--	--	--	--	--	41.8	33.7	8.2	4.6
10/27/2019	--	--	--	--	--	--	--	--	--
11/3/2019	--	--	--	--	--	--	--	--	--
11/10/2019	--	--	--	--	--	--	--	--	--
11/17/2019	--	--	--	--	--	--	--	--	--
11/24/2019	--	--	--	--	--	--	--	--	--

Table A-10. Total Suspended Solids (mg/L) Concentrations Observed at Priority 3 Sites in Riverside County and San Bernardino County during the 2019 Dry Season

Week Beginning Date	SAR Reach 4 (P3-SBC1)	Goldenstar Creek (P3-RC1)
5/5/2019	BDL	--
5/12/2019	1200	--
5/19/2019	48	--
5/26/2019	89	--
6/2/2019	39	--
6/9/2019	6	--
6/16/2019	2	--
6/23/2019	2	--
6/30/2019	BDL	--
7/7/2019	3	--
7/14/2019	2	2
7/21/2019	4	2
7/28/2019	3	4
8/4/2019	BDL	3
8/11/2019	4	3
8/18/2019	2	--
8/25/2019	3	--
9/1/2019	4	--
9/8/2019	2	--
9/15/2019	2	--
9/22/2019	2	--
9/29/2019	2	--
10/6/2019	2	--
10/13/2019	2	--
10/20/2019	2	--
10/27/2019	5	--
11/3/2019	2	--
11/10/2019	4	--
11/17/2019	2	--

Table A-11. Dissolved Oxygen (mg/L) Concentrations Observed at Priority 1 Sites during the 2019 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)
5/5/2019	11.6	7.5	9.2	7.1	9.4	9.6	8.9	8.7
5/12/2019	15.1	9.3	9.2	6.9	9.1	9.6	9.0	8.8
5/19/2019	10.2	11.4	10.2	9.3	9.0	9.7	8.4	8.7
5/26/2019	10.3	9.7	10.1	9.3	8.6	9.5	8.4	8.5
6/2/2019	10.3	9.9	9.9	8.9	8.8	8.5	8.6	8.5
6/9/2019	9.1	9.5	9.3	8.0	8.7	9.5	7.7	7.9
6/16/2019	9.0	6.2	8.6	7.5	8.6	9.4	8.3	8.3
6/23/2019	8.1	6.9	8.4	7.2	8.7	9.4	8.6	8.4
6/30/2019	9.0	7.9	8.5	7.2	8.5	9.4	8.1	8.2
7/7/2019	9.5	8.2	9.0	8.4	8.6	9.5	7.8	7.9
7/14/2019	9.3	7.4	8.6	8.6	8.6	9.4	8.0	8.0
7/21/2019	10.7	3.9	9.1	8.5	9.0	9.5	7.6	7.6
7/28/2019	9.1	7.0	8.9	8.0	8.7	9.4	8.5	8.3
8/4/2019	8.5	8.1	8.0	8.5	8.7	9.4	8.5	8.2
8/11/2019	7.8	6.8	7.7	9.6	8.9	9.6	8.2	8.2
8/18/2019	7.5	7.2	7.7	8.5	8.8	8.5	8.1	7.5
8/25/2019	7.6	9.9	7.8	7.5	8.8	9.5	8.2	7.7
9/1/2019	7.6	7.0	7.7	7.1	8.9	9.5	8.1	7.7
9/8/2019	6.8	5.4	6.9	7.9	8.6	9.5	8.3	8.1
9/15/2019	6.4	7.2	6.7	8.3	9.1	9.5	8.2	8.2
10/27/2019	2.9	5.6	9.0	9.2	9.4	9.9	9.2	9.4
11/3/2019	2.8	9.1	9.6	9.1	9.2	9.7	9.0	9.2
11/10/2019	8.4	2.6	8.7	8.7	9.4	9.8	9.1	9.2
11/17/2019	6.4	5.6	8.9	9.0	9.3	9.7	9.0	9.2
11/24/2019	3.1	4.4	8.4	9.0	9.6	9.8	9.0	9.4

Table A-12. Dissolved Oxygen (mg/L) Concentrations Observed at Priority 2 Sites during the 2019 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)
5/5/2019	9.24	7.5	7.0	8.9	8.7
5/12/2019	9.37	7.5	6.4	9.0	8.8
5/19/2019	10.51	8.2	7.7	8.4	8.7
5/26/2019	9.33	8.4	7.4	8.4	8.5
6/2/2019	9.28	7.6	7.4	8.6	8.5
6/9/2019	8.94	6.6	6.8	7.7	7.9
6/16/2019	8.54	5.9	6.7	8.3	8.3
6/23/2019	8.14	6.8	6.9	8.6	8.4
6/30/2019	8.69	5.4	7.0	8.1	8.2
7/7/2019	8.67	5.7	6.8	7.8	7.9
7/14/2019	7.48	4.8	6.6	8.0	8.0
7/21/2019	5.98	5.3	5.2	7.6	7.6
7/28/2019	7.95	7.77	5.8	8.5	8.3
8/4/2019	7.56	5.7	6.2	8.5	8.2
8/11/2019	7.57	5.7	6.1	8.2	8.2
8/18/2019	7.48	6.3	6.4	8.1	7.5
8/25/2019	7.52	5.4	6.1	8.2	7.7
9/1/2019	8.29	7.3	5.2	8.1	7.7
9/8/2019	8.1	8.3	6.3	8.3	8.1
9/15/2019	8.4	6.2	6.4	8.2	8.2
10/27/2019	10.3	7.2	7.8	9.2	9.4
11/3/2019	11.2	8.5	8.7	9.0	9.2
11/10/2019	11.8	8.5	7.7	9.1	9.2
11/17/2019	9.1	8.7	8.1	9.0	9.2
11/24/2019	11.0	8.0	8.8	9.0	9.4

Table A-13. Dissolved Oxygen (mg/L) Concentrations Observed at Priority 3 Sites in Orange County during the 2019 Dry Season (Note: Borrego Creek and Los Trancos were dry during all sample events)

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 Cr. Reach 1 (P3-OC8)	San Diego Cr. Reach 2 (P3-OC9)	Serrano Creek (P3-OC11)
5/5/2019			9.87		7.15				
5/12/2019			10.02		6.01				
5/19/2019			10.23		7.83				
5/26/2019			11.06		12.13				
6/2/2019			9.95		7.97				
6/9/2019									
6/16/2019									
6/23/2019									
6/30/2019									
7/7/2019									
7/14/2019	5.16								
7/21/2019	3.5								
7/28/2019	3.93								
8/4/2019	4.98								
8/11/2019	2.95								
8/18/2019						10.61	9.28	11.73	13.45
8/25/2019						9.28	5.93	9.67	13.25
9/1/2019						10.14	8.18	13.33	11.8
9/8/2019						11	9.93	13.49	9.61
9/15/2019						9.98	9.24	9.02	9.86
10/27/2019									
11/3/2019									
11/10/2019									
11/17/2019									
11/24/2019									

Table A-14. Dissolved Oxygen (mg/L) Concentrations Observed at Priority 3 Sites in Riverside County and San Bernardino County during the 2019 Dry Season

Week Beginning Date	SAR Reach 4 (P3-SBC1)	Goldenstar Creek (P3-RC1)
5/5/2019	8.62	--
5/12/2019	9	--
5/19/2019	8.59	--
5/26/2019	8.8	--
6/2/2019	8.55	--
6/9/2019	8.34	--
6/16/2019	8.85	--
6/23/2019	8.4	--
6/30/2019	8.38	--
7/7/2019	8.12	--
7/14/2019	8.15	8.53
7/21/2019	8.14	8.6
7/28/2019	8.32	8.64
8/4/2019	8.07	8.59
8/11/2019	7.97	8.8
8/18/2019	7.75	8.81
8/25/2019	7.78	--
9/1/2019	7.72	--
9/8/2019	7.84	--
9/15/2019	7.69	--
9/22/2019	7.79	--
9/29/2019	7.81	--
10/6/2019	7.6	--
10/13/2019	7.78	--
10/20/2019	8.08	--
10/27/2019	8.21	--
11/3/2019	8.36	--
11/10/2019	8.33	--
11/17/2019	8.15	--
11/24/2019	8.24	--

Table A-15. pH (standard units) Observed at Priority 1 Sites during the 2019 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)
5/5/2019	9.4	9.2	8.8	8.1	8.3	7.7	8.1	8.1
5/12/2019	9.3	9.0	8.6	8.1	8.4	7.8	8.0	8.0
5/19/2019	8.8	9.1	8.7	8.1	8.0	10.0	8.1	8.3
5/26/2019	8.9	9.1	8.4	8.6	8.2	8.3	8.3	8.0
6/2/2019	9.0	9.1	8.7	8.6	8.2	8.1	8.1	8.3
6/9/2019	8.9	9.1	8.7	8.3	8.1	7.9	8.2	8.2
6/16/2019	9.1	9.0	8.7	8.6	8.3	8.0	8.1	8.3
6/23/2019	8.8	8.8	8.4	8.5	8.3	7.8	8.1	8.2
6/30/2019	8.9	8.9	8.5	8.3	8.2	8.0	8.1	8.1
7/7/2019	8.9	9.0	8.6	8.7	8.4	7.9	8.2	8.3
7/14/2019	9.0	9.1	8.8	9.0	8.1	7.9	8.1	8.3
7/21/2019	9.1	8.9	8.8	8.8	8.0	8.1	8.2	8.3
7/28/2019	9.0	9.0	8.7	8.9	8.0	8.3	8.1	8.3
8/4/2019	9.0	9.1	8.5	9.1	8.0	8.3	8.2	8.4
8/11/2019	8.9	9.0	0.4	8.2	8.1	8.2	8.1	8.2
8/18/2019	8.8	8.9	3.1	9.0	8.1	8.3	8.1	8.3
8/25/2019	8.7	9.0	8.3	8.9	8.0	8.2	8.1	8.3
9/1/2019	8.5	8.9	8.3	8.7	7.9	8.2	8.1	8.2
9/8/2019	8.8	8.3	8.2	8.5	8.6	8.6	8.1	8.0
9/15/2019	8.6	8.8	8.0	8.1	7.9	8.4	8.1	8.2
10/27/2019	7.4	8.8	8.1	8.4	8.0	8.2	8.1	8.2
11/3/2019	7.7	8.9	8.4	8.5	7.9	8.2	8.1	8.3
11/10/2019	8.0	8.7	8.0	8.4	8.1	8.2	8.0	8.2
11/17/2019	8.0	8.8	8.1	8.5	8.1	8.3	8.3	8.0
11/24/2019	8.1	8.7	7.8	8.3	7.8	7.9	8.1	8.1

Table A-16. pH (standard units) Observed at Priority 2 Sites during the 2019 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)
5/5/2019	9.4	7.6	7.6	8.1	8.1
5/12/2019	9.13	7.6	7.5	8.1	8.2
5/19/2019	10.05	7.6	7.5	8.2	8.2
5/26/2019	9.19	7.5	7.5	8.1	8.2
6/2/2019	9.86	7.4	7.5	8.0	8.1
6/9/2019	7.73	7.6	7.6	8.1	8.2
6/16/2019	9.63	7.6	7.7	8.1	8.2
6/23/2019	8.82	7.6	7.7	8.1	8.3
6/30/2019	9.7	7.7	7.7	8.2	8.3
7/7/2019	9.75	7.5	7.6	8.1	8.2
7/14/2019	8.76	7.6	7.6	8.1	8.2
7/21/2019	7.81	7.5	7.7	8.2	7.9
7/28/2019	9.49	7.5	7.6	8.3	6.8
8/4/2019	8.94	7.6	7.7	8.4	8.2
8/11/2019	9.48	7.9	7.7	8.2	8.1
8/18/2019	8.58	7.8	7.8	8.4	8.2
8/25/2019	8.59	7.9	7.9	8.4	8.2
9/1/2019	9.12	7.8	7.8	8.4	8.2
9/8/2019	8.5	7.7	7.9	8.2	8.2
9/15/2019	9.0	7.4	7.8	8.3	8.5
10/27/2019	9.4	7.5	7.7	8.2	8.2
11/3/2019	9.3	7.6	7.9	8.2	8.1
11/10/2019	9.4	7.8	7.9	8.1	8.0
11/17/2019	7.9	8.0	8.0	8.6	8.5
11/24/2019	8.8	7.6	7.8	8.0	8.3

Table A-17. pH (standard units) Observed at Priority 3 Sites in Orange County during the 2019 Dry Season (Note: Borrego Creek and Los Trancos were dry during all sample events)

Week Beginning Date	Bolsa Chica Channel	Borrego Creek	Buck Gully Creek	Los Trancos Creek	Morning Canyon Creek	Peters Canyon Wash	San Diego Creek Reach 1	San Diego Creek Reach 1	Serrano Creek
	(P3-OC1)	(P3-OC2)	(P3-OC3)	(P3-OC5)	(P3-OC6)	(P3-OC7)	(P3-OC8)	(P3-OC9)	(P3-OC11)
5/5/2019	--	--	7.91	--	7.39	--	--	--	--
5/12/2019	--	--	7.81	--	7.35	--	--	--	--
5/19/2019	--	--	7.86	--	7.44	--	--	--	--
5/26/2019	--	--	7.75	--	7.19	--	--	--	--
6/2/2019	--	--	7.83	--	7.45	--	--	--	--
6/9/2019	--	--	--	--	--	--	--	--	--
6/16/2019	--	--	--	--	--	--	--	--	--
6/23/2019	--	--	--	--	--	--	--	--	--
6/30/2019	--	--	--	--	--	--	--	--	--
7/7/2019	--	--	--	--	--	--	--	--	--
7/14/2019	8.85	--	--	--	--	--	--	--	--
7/21/2019	8.4	--	--	--	--	--	--	--	--
7/28/2019	7.86	--	--	--	--	--	--	--	--
8/4/2019	7.95	--	--	--	--	--	--	--	--
8/11/2019	8.67	--	--	--	--	--	--	--	--
8/18/2019	--	--	--	--	--	8.01	8.64	7.9	10.22
8/25/2019	--	--	--	--	--	8.33	8.28	8.37	9.06
9/1/2019	--	--	--	--	--	8.48	8.41	8.34	8.99
9/8/2019	--	--	--	--	--	8.27	8.33	8.11	8.52
9/15/2019	--	--	--	--	--	8.22	8.34	8.41	9.04
10/27/2019	--	--	--	--	--	--	--	--	--
11/3/2019	--	--	--	--	--	--	--	--	--
11/10/2019	--	--	--	--	--	--	--	--	--
11/17/2019	--	--	--	--	--	--	--	--	--
11/24/2019	--	--	--	--	--	--	--	--	--

Table A-18. pH (standard units) Observed at Priority 3 Sites in Riverside County and San Bernardino County during the 2019 Dry Season

Week Beginning Date	SAR Reach 4 (P3-SBC1)	Goldenstar Creek (P3-RC1)
5/5/2019	7.9	--
5/12/2019	8.2	--
5/19/2019	7.9	--
5/26/2019	7.6	--
6/2/2019	7.8	--
6/9/2019	7.79	--
6/16/2019	8.04	--
6/23/2019	7.76	--
6/30/2019	7.7	--
7/7/2019	7.83	--
7/14/2019	7.58	8.5
7/21/2019	7.77	8.6
7/28/2019	7.77	8.6
8/4/2019	7.75	8.6
8/11/2019	7.69	8.8
8/18/2019	7.65	8.8
8/25/2019	7.68	--
9/1/2019	7.67	--
9/8/2019	7.63	--
9/15/2019	7.69	--
9/22/2019	7.67	--
9/29/2019	7.8	--
10/6/2019	7.61	--
10/13/2019	7.79	--
10/20/2019	7.78	--
10/27/2019	7.74	--
11/3/2019	7.78	--
11/10/2019	7.73	--
11/17/2019	7.74	--
11/24/2019	7.77	--

Table A-19. Turbidity (NTU) Observed at Priority 1 Sites during the 2019 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)
5/5/2019	7.4	31	1.5	5.4	0.9	0.3	1.8	1.7
5/12/2019	6.7	19	2.4	3.5	0.9	2.1	252.7	233.2
5/19/2019	1.4	27	53.5	5	0.2	1.6	21.7	22.2
5/26/2019	1.6	24	14.3	12.1	0.0	0.0	24.1	19.3
6/2/2019	0.7	22	7.5	5	0.0	0.0	16.9	14.9
6/9/2019	2.4	19	0.4	4	0.0	0.0	3.9	5.4
6/16/2019	0.0	22	1.4	3.8	0.0	0.0	4.8	8.9
6/23/2019	2.3	19	2.4	5	0.4	0.4	4.4	4.8
6/30/2019	0.6	12	0.0	6.8	0.0	5.9	1.6	2.9
7/7/2019	1.2	11	3.1	12	0.0	0.0	2.4	4.6
7/14/2019	0.8	9	0.3	4	2	0.5	0.7	2.8
7/21/2019	0.7	12	0.3	11	0.2	0.2	2.5	2.5
7/28/2019	0.0	8	0.2	11	0.2	0.0	2.2	2.6
8/4/2019	1.7	10	2.4	33	0.7	0.3	2.0	0.6
8/11/2019	0.8	11	0.4	0	0.0	0.1	2.0	1.5
8/18/2019	0.4	26	0.4	13.1	0.9	0.4	2.5	1.5
8/25/2019	0.7	30	0.4	18.5	0.4	0.4	2.2	2.3
9/1/2019	1.1	23	0.5	57.1	0.2	0.2	3.6	1.7
9/8/2019	0.8	18	0.8	12.4	1.7	1.0	1.9	0.8
9/15/2019	0.3	24	0.0	46	0.0	0.0	1.3	0.8
10/27/2019	1.2	33	75.7	5.8	0.0	0.0	0.1	0.6
11/3/2019	1.7	32	1.5	4.0	0.4	0.1	1.3	1.1
11/10/2019	2.8	26	1.2	2.7	0.1	0.1	1.8	1.6
11/17/2019	2.3	26	1.3	3	0.2	0.3	0.7	0.5
11/24/2019	1.4	25	0.1	7	1.6	0.3	1.4	0.9

Table A-20. Turbidity (NTU) Observed at Priority 2 Sites during the 2019 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)
5/5/2019	9.5	1.0	2.4	1.8	1.7
5/12/2019	9.1	1.8	1.4	252.7	233.2
5/19/2019	9.6	16.8	2.9	21.7	22.2
5/26/2019	10.3	0.3	1.9	24.1	19.3
6/2/2019	9.6	0.0	2.5	16.9	14.9
6/9/2019	4.2	1.9	4.8	3.9	5.4
6/16/2019	6.3	0.0	0.0	4.8	8.9
6/23/2019	8.3	1.8	1.9	4.4	4.8
6/30/2019	5.2	2.3	0.9	1.6	2.9
7/7/2019	4.7	0.4	2.2	2.4	4.6
7/14/2019	4.4	3.6	0.6	0.7	2.8
7/21/2019	3.7	1.2	1.5	2.5	2.5
7/28/2019	5.6	0.4	1.4	2.2	2.6
8/4/2019	3.5	1.3	3.7	2.0	0.6
8/11/2019	3.3	0.8	1.1	2.0	1.5
8/18/2019	4.5	0.8	1.2	2.5	1.5
8/25/2019	5	1.6	0.7	2.2	2.3
9/1/2019	8.5	1.5	4.5	3.6	1.7
9/8/2019	12.6	1.4	2.0	1.9	0.8
9/15/2019	11.9	1.4	1.8	1.3	0.8
10/27/2019	33.2	6.3	2.1	0.1	0.6
11/3/2019	14.1	15.7	2.1	1.3	1.1
11/10/2019	8.3	9.0	1.1	1.8	1.6
11/17/2019	6.9	1.4	0.6	0.7	0.5
11/24/2019	13.3	2.2	1.0	1.4	0.9

Table A-21. Turbidity (NTU) Observed at Priority 3 Sites in Orange County during the 2019 Dry Season (Note: Borrego Creek and Los Trancos Creek were dry during all sample events)

Week Beginning Date	Bolsa Chica Channel (P3-OC1)	Buck Gully 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 Cr. Reach 1 (P3-OC8)	San Diego Cr. Reach 2 (P3-OC9)	Serrano Creek (P3-OC11)
5/5/2019	--	--	2.9	--	2.2	--	--	--	--
5/12/2019	--	--	4.28	--	2.5	--	--	--	--
5/19/2019	--	--	3.37	--	1.6	--	--	--	--
5/26/2019	--	--	4.83	--	1.9	--	--	--	--
6/2/2019	--	--	5.4	--	1.7	--	--	--	--
6/9/2019	--	--	--	--	--	--	--	--	--
6/16/2019	--	--	--	--	--	--	--	--	--
6/23/2019	--	--	--	--	--	--	--	--	--
6/30/2019	--	--	--	--	--	--	--	--	--
7/7/2019	--	--	--	--	--	--	--	--	--
7/14/2019	1	--	--	--	--	--	--	--	--
7/21/2019	1.8	--	--	--	--	--	--	--	--
7/28/2019	1.2	--	--	--	--	--	--	--	--
8/4/2019	1.73	--	--	--	--	--	--	--	--
8/11/2019	1.6	--	--	--	--	--	--	--	--
8/18/2019	--	--	--	--	--	7.3	16.2	1.2	3.2
8/25/2019	--	--	--	--	--	12.8	13.7	0.9	2.5
9/1/2019	--	--	--	--	--	9.7	2.04	1.56	3.63
9/8/2019	--	--	--	--	--	13.2	27.2	1	5.37
9/15/2019	--	--	--	--	--	11.4	24.9	6.47	1.53
10/27/2019	--	--	--	--	--	--	--	--	--
11/3/2019	--	--	--	--	--	--	--	--	--
11/10/2019	--	--	--	--	--	--	--	--	--
11/17/2019	--	--	--	--	--	--	--	--	--
11/24/2019	--	--	--	--	--	--	--	--	--

Table A-22. Turbidity (NTU) Observed at Priority 3 Sites in Riverside County and San Bernardino County during the 2019 Dry Season

Week Beginning Date	SAR Reach 4 (P3-SBC1)	Goldenstar Creek (P3-RC1)
5/5/2019	0.1	--
5/12/2019	172.8	--
5/19/2019	27.1	--
5/26/2019	31.4	--
6/2/2019	14.7	--
6/9/2019	0.2	--
6/16/2019	0.0	--
6/23/2019	2.7	--
6/30/2019	0.0	--
7/7/2019	0.2	--
7/14/2019	0.3	0.8
7/21/2019	0.2	2.2
7/28/2019	0.0	0
8/4/2019	2.2	1.1
8/11/2019	0.1	0
8/18/2019	0.2	0.3
8/25/2019	0.7	--
9/1/2019	0.3	--
9/8/2019	0.2	--
9/15/2019	0.0	--
9/22/2019	0.0	--
9/29/2019	1.2	--
10/6/2019	0.3	--
10/13/2019	1.2	--
10/20/2019	0.3	--
10/27/2019	0.2	--
11/3/2019	0.4	--
11/10/2019	0.4	--
11/17/2019	0.4	--
11/24/2019	1.1	--

Table A-23. Water Temperature (°C) Concentrations Observed at Priority 1 Sites during the 2019 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)
5/5/2019	19.7	18.3	18.2	15.0	9.9	11.8	18.6	19.0
5/12/2019	22.0	21.7	20.2	16.0	11.8	12.8	18.1	18.8
5/19/2019	21.4	20.7	20.4	14.5	12.4	12.0	20.9	19.8
5/26/2019	20.9	20.5	18.4	16.7	13.9	13.4	21.4	20.6
6/2/2019	23.1	23.1	22.0	16.4	13.7	13.5	20.0	20.2
6/9/2019	26.2	26.4	24.2	17.7	13.9	14.3	26.9	26.2
6/16/2019	25.7	23.5	25.1	20.3	14.6	13.2	22.1	21.9
6/23/2019	25.0	24.3	22.7	20.0	13.3	13.1	20.5	21.4
6/30/2019	25.8	24.6	23.8	20.5	14.8	13.7	24.7	23.5
7/7/2019	26.3	25.8	25.0	20.2	14.6	13.2	27.1	26.3
7/14/2019	27.2	27.0	27.0	21.0	13.5	13.3	24.9	24.9
7/21/2019	27.6	26.0	25.7	21.8	12.6	13.8	28.5	27.5
7/28/2019	28.8	28.7	27.6	22.5	14.5	14.2	21.0	21.8
8/4/2019	27.7	27.4	25.1	22.2	14.0	13.5	20.7	22.1
8/11/2019	26.9	26.0	25.3	12.9	14.3	12.9	24.4	23.5
8/18/2019	25.4	25.3	25.4	19.6	13.5	12.6	24.6	28.0
8/25/2019	26.9	26.9	25.5	21.6	13.8	13.0	24.1	27.8
9/1/2019	27.8	26.7	25.9	21.4	13.7	14.0	24.1	27.2
9/8/2019	26.1	25.2	24.7	19.7	14.4	13.3	22.6	23.3
9/15/2019	25.3	23.6	24.8	17.3	12.6	12.7	23.5	23.8
10/27/2019	17.6	16.7	16.3	8.2	10.3	11.3	17.0	16.5
11/3/2019	16.3	15.9	17.9	9.7	11.6	12.2	18.6	18.1
11/10/2019	16.3	15.4	17.0	8.3	10.8	12.4	17.8	17.8
11/17/2019	16.1	15.8	17.2	8.6	10.9	12.9	17.8	17.5
11/24/2019	15.6	14.9	16.1	5.2	9.0	11.4	17.2	15.6

Table A-24. Water Temperature (°C) Concentrations Observed at Priority 2 Sites during the 2019 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)
5/5/2019	17.4	17.2	19.0	18.6	19.0
5/12/2019	20.9	20.4	19.9	18.1	18.8
5/19/2019	20.7	16.8	19.0	20.9	19.8
5/26/2019	20.3	17.7	19.7	21.4	20.6
6/2/2019	21	18.1	19.3	20.0	20.2
6/9/2019	26.1	20.8	23.4	26.9	26.2
6/16/2019	23.3	19.3	20.8	22.1	21.9
6/23/2019	21.7	19.9	21.2	20.5	21.4
6/30/2019	25.1	19.9	21.5	24.7	23.5
7/7/2019	24.4	20.1	21.5	27.1	26.3
7/14/2019	23.7	21.0	22.4	24.9	24.9
7/21/2019	22.8	21.7	23.3	28.5	27.5
7/28/2019	26.2	19.4	22.7	21.0	21.8
8/4/2019	21.7	20.7	21.7	20.7	22.1
8/11/2019	24.2	19.9	21.1	24.4	23.5
8/18/2019	22.7	19.2	20.1	24.6	28.0
8/25/2019	23.9	21.0	21.5	24.1	27.8
9/1/2019	26	21.4	23.5	24.1	27.2
9/8/2019	23.7	20.0	20.8	22.6	23.3
9/15/2019	21.2	17.8	20.1	23.5	23.8
10/27/2019	15.2	12.4	12.3	17.0	16.5
11/3/2019	14.5	11.3	13.3	18.6	18.1
11/10/2019	16.0	14.1	14.5	17.8	17.8
11/17/2019	16.0	16.9	13.6	17.8	17.5
11/24/2019	14.8	16.8	14.8	17.2	15.6

Table A-25. Water Temperature (°C) Concentrations Observed at Priority 3 Sites in Orange County during the 2019 Dry Season (Note: Borrego Creek and Los Trancos Creek were dry during all sample events)

Week Beginning Date	Bolsa Chica Channel	Borrego Creek	Buck Gully Creek	Los Trancos Creek	Morning Canyon Creek	Peters Canyon Wash	San Diego Cr. Reach 1	San Diego Cr. Reach 2	Serrano Creek
	(P3-OC1)	(P3-OC2)	(P3-OC3)	(P3-OC5)	(P3-OC6)	(P3-OC7)	(P3-OC8)	(P3-OC9)	(P3-OC11)
5/5/2019	--	--	17.7	--	17.6	--	--	--	--
5/12/2019	--	--	17.3	--	17.6	--	--	--	--
5/19/2019	--	--	16.4	--	16.1	--	--	--	--
5/26/2019	--	--	16.1	--	16.5	--	--	--	--
6/2/2019	--	--	17.4	--	17.5	--	--	--	--
6/9/2019	--	--	--	--	--	--	--	--	--
6/16/2019	--	--	--	--	--	--	--	--	--
6/23/2019	--	--	--	--	--	--	--	--	--
6/30/2019	--	--	--	--	--	--	--	--	--
7/7/2019	--	--	--	--	--	--	--	--	--
7/14/2019	23.17	--	--	--	--	--	--	--	--
7/21/2019	25.47	--	--	--	--	--	--	--	--
7/28/2019	24.36	--	--	--	--	--	--	--	--
8/4/2019	23.4	--	--	--	--	--	--	--	--
8/11/2019	22.5	--	--	--	--	--	--	--	--
8/18/2019	--	--	--	--	--	26.8	27.6	26.3	31.3
8/25/2019	--	--	--	--	--	24.4	27.1	24.4	23.4
9/1/2019	--	--	--	--	--	28.03	28.82	29.85	24.52
9/8/2019	--	--	--	--	--	23.21	24.88	27.22	20.53
9/15/2019	--	--	--	--	--	22.89	26.02	27.52	20.74
10/27/2019	--	--	--	--	--	--	--	--	--
11/3/2019	--	--	--	--	--	--	--	--	--
11/10/2019	--	--	--	--	--	--	--	--	--
11/17/2019	--	--	--	--	--	--	--	--	--
11/24/2019	--	--	--	--	--	--	--	--	--

Table A-26. Water Temperature (°C) Concentrations Observed at Priority 3 Sites in Riverside County and San Bernardino County during the 2019 Dry Season

Week Beginning Date	SAR Reach 4 (P3-SBC1)	Goldenstar Creek (P3-RC1)
5/5/2019	22.4	--
5/12/2019	19.4	--
5/19/2019	23.8	--
5/26/2019	19.6	--
6/2/2019	23.6	--
6/9/2019	25.6	--
6/16/2019	25.5	--
6/23/2019	23.8	--
6/30/2019	26.0	--
7/7/2019	26.2	--
7/14/2019	26.0	19.9
7/21/2019	26.1	22.3
7/28/2019	27.3	20
8/4/2019	26.9	19.5
8/11/2019	26.9	18.9
8/18/2019	26.3	18.2
8/25/2019	26.4	--
9/1/2019	26.7	--
9/8/2019	26.9	--
9/15/2019	27.5	--
9/22/2019	26.4	--
9/29/2019	25.5	--
10/6/2019	25.0	--
10/13/2019	25.9	--
10/20/2019	24.8	--
10/27/2019	23.0	--
11/3/2019	24.8	--
11/10/2019	24.3	--
11/17/2019	24.1	--
11/24/2019	23.8	--

Table A-27. Conductivity (µS/cm) Observed at Priority 1 Sites during the 2019 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)
5/5/2019	592	3408	529	387	178	253	1036	1063
5/12/2019	571	3443	537	377	181	255	387	462
5/19/2019	606	3436	522	369	179	251	826	918
5/26/2019	607	3460	518	370	180	253	813	930
6/2/2019	615	3468	522	377	180	253	858	954
6/9/2019	631	3519	526	377	183	257	1051	1050
6/16/2019	639	3488	532	380	182	255	984	1026
6/23/2019	653	3550	527	386	184	258	1019	1055
6/30/2019	653	3395	494	355	142	194	986	1023
7/7/2019	667	3576	525	384	188	256	1027	1085
7/14/2019	634	3660	547	391	184	258	1072	896
7/21/2019	661	3621	526	378	186	255	1012	1060
7/28/2019	682	3677	531	384	192	259	1027	1068
8/4/2019	700	3719	530	376	191	261	1034	1067
8/11/2019	702	3705	521	372	191	260	1026	1061
8/18/2019	735	3721	526	376	190	260	1029	1081
8/25/2019	725	3757	529	381	190	261	1030	1067
9/1/2019	740	3776	529	390	190	263	1056	1077
9/8/2019	757	3858	532	394	192	264	1028	951
9/15/2019	761	3881	533	402	188	264	1042	1082
10/27/2019	756	3812	508	410	181	257	991	997
11/3/2019	776	3936	524	4236	190	264	1025	1031
11/10/2019	767	3882	515	413	187	259	1009	1003
11/17/2019	775	3911	518	418	187	261	1020	1013
11/24/2019	782	3940	523	423	183	260	1069	1020

Table A-28. Conductivity (µS/cm) Observed at Priority 2 Sites during the 2019 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)
5/5/2019	902	1262	874	1036	1063
5/12/2019	1166	914	1047	387	462
5/19/2019	898	1308	837	826	918
5/26/2019	1289	1319	1041	813	930
6/2/2019	902	1236	1040	858	954
6/9/2019	920	1309	1138	1051	1050
6/16/2019	906	1328	1057	984	1026
6/23/2019	1422	1248	1012	1019	1055
6/30/2019	896	1349	920	986	1023
7/7/2019	933	1609	944	1027	1085
7/14/2019	1543	1302	867	1072	896
7/21/2019	1856	1448	1369	1012	1060
7/28/2019	944	849	1100	1027	1068
8/4/2019	1228	1354	1307	1034	1067
8/11/2019	944	1300	1369	1026	1061
8/18/2019	1344	1284	1420	1029	1081
8/25/2019	1282	1644	1515	1030	1067
9/1/2019	998	870	1184	1056	1077
9/8/2019	990	805	1467	1028	951
9/15/2019	1004	1171	1100	1042	1082
10/27/2019	896	1200	1088	991	997
11/3/2019	958	1249	1047	1025	1031
11/10/2019	846	1147	1114	1009	1003
11/17/2019	1443	586	1194	1020	1013
11/24/2019	960	596	886	1069	1020

Table A-29. Conductivity (µS/cm) Observed at Priority 3 Sites in Orange County during the 2019 Dry Season (Note: Borrego Creek and Los Trancos Creek were dry during all sample events)

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)	Serrano Creek (P3-OC11)
5/5/2019	--	--	6182	--	21446	--	--	--	--
5/12/2019	--	--	5138	--	17625	--	--	--	--
5/19/2019	--	--	5012.5	--	21837	--	--	--	--
5/26/2019	--	--	4702	--	9026	--	--	--	--
6/2/2019	--	--	5260	--	13818	--	--	--	--
6/9/2019	--	--	--	--	--	--	--	--	--
6/16/2019	--	--	--	--	--	--	--	--	--
6/23/2019	--	--	--	--	--	--	--	--	--
6/30/2019	--	--	--	--	--	--	--	--	--
7/7/2019	--	--	--	--	--	--	--	--	--
7/14/2019	2690	--	--	--	--	--	--	--	--
7/21/2019	2615.3	--	--	--	--	--	--	--	--
7/28/2019	2899.6	--	--	--	--	--	--	--	--
8/4/2019	2542.9	--	--	--	--	--	--	--	--
8/11/2019	2609.5	--	--	--	--	--	--	--	--
8/18/2019	--	--	--	--	--	2108.6	2866.1	2209.6	1096.7
8/25/2019	--	--	--	--	--	2117.7	2879.1	2263.3	1606.9
9/1/2019	--	--	--	--	--	2070.3	2862.5	2258.27	1198.87
9/8/2019	--	--	--	--	--	2265.1	2966.75	2327.5	1356.17
9/15/2019	--	--	--	--	--	2445.95	2860.3	766.2	717
10/27/2019	--	--	--	--	--	--	--	--	--
11/3/2019	--	--	--	--	--	--	--	--	--
11/10/2019	--	--	--	--	--	--	--	--	--
11/17/2019	--	--	--	--	--	--	--	--	--
11/24/2019	--	--	--	--	--	--	--	--	--

Table A-30. Conductivity (µS/cm) observed at Priority 3 sites in Riverside County and San Bernardino County during the 2019 Dry Season

Week Beginning Date	SAR Reach 4 (P3-SBC1)	Goldenstar Creek (P3-RC1)
5/5/2019	840	--
5/12/2019	240	--
5/19/2019	651	--
5/26/2019	598	--
6/2/2019	676	--
6/9/2019	856	--
6/16/2019	843	--
6/23/2019	850	--
6/30/2019	822	--
7/7/2019	839	--
7/14/2019	766	2171
7/21/2019	840	2123
7/28/2019	843	2167
8/4/2019	848	2184
8/11/2019	833	2158
8/18/2019	840	2155
8/25/2019	841	--
9/1/2019	847	--
9/8/2019	858	--
9/15/2019	852	--
9/22/2019	842	--
9/29/2019	813	--
10/6/2019	848	--
10/13/2019	844	--
10/20/2019	841	--
10/27/2019	816	--
11/3/2019	857	--
11/10/2019	837	--
11/17/2019	760	--
11/24/2019	769	--

Table A-31. Flow (cfs) Observed at Priority 1 Sites during the 2019 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)
5/5/2019	--	--	--	--	NA	NA	76	124
5/12/2019	--	--	--	--	NA	NA	199	338
5/19/2019	--	--	--	--	NA	NA	101	146
5/26/2019	--	--	--	--	55	28	116	149
6/2/2019	--	--	--	--	35	35	105	153
6/9/2019	--	--	--	--	NA	23	33	59
6/16/2019	--	--	--	--	25	15	59	115
6/23/2019	--	--	--	--	43	30	129	99
6/30/2019	--	--	--	--	17.3	12.7	94	185
7/7/2019	--	--	--	--	22.0	10.7	29	64
7/14/2019	--	--	--	--	14	15.4	3	183
7/21/2019	--	--	--	--	24	8.4	44	115
7/28/2019	--	--	--	--	27.5	10	95	123
8/4/2019	--	--	--	--	30	8.9	60	67
8/11/2019	--	--	--	--	19	6	23	59
8/18/2019	--	--	--	--	17.6	12.6	9	62
8/25/2019	--	--	--	--	24.3	18.6	32	69
9/1/2019	--	--	--	--	18.6	6.9	73	144
9/8/2019	--	--	--	--	18.5	10.7	54	89
9/15/2019	--	--	--	--	23.0	8.8	48	79
10/27/2019	--	--	--	--	9.3	5.5	6	118
11/3/2019	--	--	--	--	9.8	7.3	174	133
11/10/2019	--	--	--	--	10.7	5.2	60	57
11/17/2019	--	--	--	--	14.8	6.1	72	77
11/24/2019	--	--	--	--	22.8	14.2	84	53

Table A-32. Flow (cfs) Observed at Priority 2 Sites during the 2019 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)
5/5/2019	2.8	22.3	16	76	124
5/12/2019	3.4	21.9	16.8	199	338
5/19/2019	2.1	12.4	58.1	101	146
5/26/2019	2.7	16.8	10.0	116	149
6/2/2019	2.8	18.0	18.2	105	153
6/9/2019	2.3	6	18.8	33	59
6/16/2019	2.2	4.7	14.4	59	115
6/23/2019	2.9	23	18.0	129	99
6/30/2019	2.2	10.7	28.0	94	185
7/7/2019	1.6	6.3	18.2	29	64
7/14/2019	1.4	8.1	20	3	183
7/21/2019	1.2	7	8.6	44	115
7/28/2019	1.4	23.9	9.1	95	123
8/4/2019	1.2	18.2	7.9	60	67
8/11/2019	0.6	9.8	6	23	59
8/18/2019	6.5	10.4	7	9	62
8/25/2019	1.2	6.5	1	32	69
9/1/2019	1.9	17.6	11.0	73	144
9/8/2019	0.5	26.7	5.7	54	89
9/15/2019	0.6	11.5	10.8	48	79
10/27/2019	1.9	2.0	4.6	6	118
11/3/2019	4.2	2.0	15	174	133
11/10/2019	3.1	13.2	13	60	57
11/17/2019	2.6	30.8	11	72	77
11/24/2019	2.9	21.8	72	84	53

Table A-33. Flow (cfs) Observed at Priority 3 sites in Orange County during the 2019 Dry Season (Note: Borrego Creek and Los Trancos Creek were dry during all sample events)

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)	Serrano Creek (P3-OC11)
5/5/2019	--	--	0.65	--	0.4	--	--	--	--
5/12/2019	--	--	0.59	--	0.5	--	--	--	--
5/19/2019	--	--	0.62	--	0.3	--	--	--	--
5/26/2019	--	--	0.55	--	0.4	--	--	--	--
6/2/2019	--	--	--	--	--	--	--	--	--
6/9/2019	--	--	--	--	--	--	--	--	--
6/16/2019	--	--	--	--	--	--	--	--	--
6/23/2019	--	--	--	--	--	--	--	--	--
6/30/2019	--	--	--	--	--	--	--	--	--
7/7/2019	--	--	--	--	--	--	--	--	--
7/14/2019	0.07	--	--	--	--	--	--	--	--
7/21/2019	0.98	--	--	--	--	--	--	--	--
7/28/2019	1.5	--	--	--	--	--	--	--	--
8/4/2019	1.12	--	--	--	--	--	--	--	--
8/11/2019	0.42	--	--	--	--	--	--	--	--
8/18/2019	--	--	--	--	--	7.9	4.5	0.64	0.1
8/25/2019	--	--	--	--	--	7.5	4.5	0.83	0.1
9/1/2019	--	--	--	--	--	9.7	4.2	0.371	0.1
9/8/2019	--	--	--	--	--	6.3	5.9	0.56	0.2
9/15/2019	--	--	--	--	--	2.0	5.0	0.66	0.7
10/27/2019	--	--	--	--	--	--	--	--	--
11/3/2019	--	--	--	--	--	--	--	--	--
11/10/2019	--	--	--	--	--	--	--	--	--
11/17/2019	--	--	--	--	--	--	--	--	--
11/24/2019	--	--	--	--	--	--	--	--	--

Table A-34. Flow (cfs) Observed at Priority 3 Sites in Riverside County and San Bernardino County during the 2019 Dry Season

Week Beginning Date	SAR Reach 4 (P3-SBC1)	Goldenstar Creek (P3-RC1)
5/5/2019	27.0	--
5/12/2019	NA	--
5/19/2019	NA	--
5/26/2019	NA	--
6/2/2019	NA	--
6/9/2019	42.1	--
6/16/2019	25.0	--
6/23/2019	31.3	--
6/30/2019	31.2	--
7/7/2019	22.7	--
7/14/2019	NA	2.5
7/21/2019	25.3	2.5
7/28/2019	36.0	3.4
8/4/2019	23.2	4
8/11/2019	60.6	0.9
8/18/2019	5.6	2.6
8/25/2019	30.3	--
9/1/2019	2.6	--
9/8/2019	67.5	--
9/15/2019	31.4	--
9/22/2019	26.4	--
9/29/2019	45.4	--
10/6/2019	29.8	--
10/13/2019	22	--
10/20/2019	41	--
10/27/2019	25.5	--
11/3/2019	20.1	--
11/10/2019	24.5	--
11/17/2019	59.1	--
11/24/2019	31.9	--

Table A-35. Water Quality Data from Priority 2 Sites during the 2019-2020 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)								
3/10/2020	280	28	847	10.9	5.0	8.5	16.9	17
3/12/2020	170	16	891	10.2	2.0	9.0	17.1	16
3/13/2020	6,500	18	853	8.2	14.0	7.8	14.9	16
3/16/2020	27	26	893	9.6	4.0	8.6	16.3	7
Chino Creek at Central Avenue (WW-C7)								
3/10/2020	12,000	220	120	10.0	NA	8.6	14.0	50
3/12/2020	510	2	996	8.1	21.0	7.7	17.9	2
3/13/2020	9200	24	106	10.4	NA	8.4	13.2	19
3/16/2020	1	6	1016	8.6	19.3	7.8	17.5	0
Mill-Cucamonga Creek below Treatment Wetlands (WW-M6)								
3/10/2020	5,800	110	179	9.4	NA	9.0	15.5	40
3/12/2020	430	7	767	8.0	41.0	8.4	17.4	3
3/13/2020	5,800	110	374	9.3	NA	8.0	15.5	35
3/16/2020	15	10	845	8.6	NA	8.3	17.2	9
SAR at MWD Crossing (WW-S1)								
3/10/2020	18,000	1,300	265	9.1	NA	7.6	15.5	555
3/12/2020	490	22	914	8.6	78.0	8.0	17.1	9
3/13/2020	7,300	1600	334	9.4	NA	8.0	14.2	760
3/16/2020	5.2	54	915	9.0	109.0	8.1	16.9	17
SAR at Pedley Avenue (WW-S4)								
3/10/2020	7,700	240	255	9.1	NA	8.0	15.7	68
3/12/2020	500	26	931	8.9	142.0	7.9	17.0	13
3/13/2020	10,000	1900	332	9.4	NA	7.9	14.2	887
3/16/2020	24	46	915	9.3	178.0	7.9	16.7	25

Table A-36. 2019 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	0.19	0.66	0.69	0.58	0.56	0.63	0.28	0.30	0.88	0.25	0.26	0.51
2	0.20	382	230	0.64	0.51	0.60	0.67	0.29	2.64	0.25	0.25	0.49
3	0.23	69.1	4.71	0.65	0.58	0.63	1.16	0.23	3.20	0.23	0.25	0.37
4	0.18	139	1.62	0.97	0.52	0.56	0.24	0.22	3.42	0.32	0.30	272
5	51.50	31.4	2.39	0.73	0.46	0.58	0.25	0.26	1.59	0.28	0.30	1.15
6	17.90	1.28	340	0.88	0.64	0.61	0.22	0.41	1.26	0.24	0.32	8.68
7	2.65	0.95	47.7	1.15	0.61	0.60	0.20	0.28	1.16	0.26	0.31	11.2
8	0.32	1.29	2.15	0.50	0.59	0.51	0.27	0.30	2.04	0.31	0.31	15.3
9	0.28	30.2	1.36	0.45	0.60	0.50	0.24	0.30	2.97	0.29	0.23	0.88
10	0.28	27.6	1.16	0.40	0.61	0.56	0.26	0.23	4.61	0.29	0.27	0.52
11	0.48	2.13	1.31	0.43	0.48	0.59	0.27	0.34	5.74	0.35	0.30	0.31
12	69.10	1.24	1.79	0.41	0.44	0.58	0.30	0.26	7.11	0.28	0.25	0.29
13	1.34	3.37	1.21	0.40	0.51	0.55	0.23	0.27	3.21	0.95	0.37	0.29
14	107.0	953	0.93	0.50	0.50	0.52	0.20	0.41	2.25	0.38	0.32	0.43
15	135.0	26.9	0.82	0.38	0.53	0.45	0.26	0.74	3.32	0.54	0.24	0.27
16	251.0	3.54	0.77	0.42	37.3	0.41	0.37	0.54	1.12	0.28	0.48	0.20
17	464.0	7.43	0.86	0.46	0.78	0.56	0.28	0.55	1.62	0.29	0.94	0.44P
18	3.19	1.97	0.79	0.45	0.58	0.75	0.35	0.45	4.36	0.25	0.19	0.40P
19	2.27	1.08	1.16	0.42	7.34	0.77	0.29	0.55	5.18	0.26	0.19	0.14P
20	1.70	11.8	31.4	0.45	1.33	0.76	0.21	0.48	5.24	0.26	13.7	0.17P
21	1.48	7.98	0.92	0.44	0.65	0.72	0.21	0.41	5.79	0.59	0.61	0.16P
22	1.05	1.03	0.77	0.43	222	0.48	0.26	0.47	6.06	0.46	0.30	0.19P
23	0.36	0.78	0.78	0.47	2.06	0.40	0.30	0.36	3.22	0.55	0.35	161P
24	0.28	0.74	0.75	0.53	2.07	0.56	0.44	0.32	0.38	0.44	0.58	1.02P
25	0.69	0.76	0.74	0.53	2.11	0.38	0.23	0.28	1.38	0.41	0.30	25.0P
26	0.30	0.87	0.68	0.55	18.5	0.43	0.29	0.36	0.30	0.34	0.26	644P
27	0.31	0.70	0.67	0.56	1.16	0.36	0.18	0.40	0.33	0.32	76.6	1.61P
28	0.30	0.79	0.66	0.58	0.95	0.37	0.21	0.39	0.31	0.35	470	0.94P
29	0.50		0.66	1.35	0.55	0.27	0.31	0.53	0.27	0.33	10.8	0.67P
30	0.30		0.64	0.53	0.62	0.26	0.37	1.85	0.27	0.45	1.35	0.60P
31	108		0.58		0.58		0.35	0.47		0.28		0.48P
COUNT	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00
MAX	464.0	953.0	340.0	1.35	222.0	0.77	1.16	1.85	7.11	0.95	470.0	644.0
MIN	15.10	31.10	4.71	1.02	1.67	0.38	0.03	0.08	1.37	3.24	9.15	4.49

[P] Data is considered "Provisional data subject to revision"

Table A-37. 2019 Daily Mean Flow (cfs), Cucamonga Creek near Mira Loma, as Measured by the USGS (Data are provisional)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	49.8	62.7	89.6	58.7	11.1	13.1	46.2	5.82	2.75	6.27	5.82	4.89
2	48.3	725	438	49.3	5.70	7.38	34.4	4.84	29.0	15.4	8.94	6.91
3	56.5	239	107	51.1	5.82	7.95	24.9	6.48	36.9	13.1	11.8	6.28
4	63.2	390	86.0	50.4	9.30	8.53	32.1	7.07	6.41	2.62	9.04	281
5	70.0	208	92.8	42.8	16.2	8.68	30.1	4.81	27.5	17.0	5.19	65.0
6	97.3	86.3	444	44.2	15.0	9.03	40.7	3.88	38.9	11.8	6.12	65.5
7	73.8	69.2	209	44.0	11.0	4.33	39.6	3.02	3.04	10.0	13.0	39.2
8	64.9	59.1	71.8	46.5	9.83	6.41	37.1	2.69	1.66	4.53	3.42	27.6
9	58.1	110	71.1	28.7	12.5	11.1	34.3	2.15	2.72	0.84	0.93	28.3
10	63.4	164	111	20.4	12.2	2.91	28.8	4.24	5.35	0.36	0.00	15.8
11	73.6	71.7	125	29.4	6.13	1.63	28.9	7.05	6.07	0.70	0.00	33.2
12	126	67.7	136	31.5	4.69	6.48	19.4	6.41	3.82	1.81	0.00	40.5
13	77.5	69.1	134	43.2	6.89	6.90	31.1	2.26	1.91	1.93	0.00	35.6
14	221	1,930	81.8	45.6	5.84	3.97	28.8	2.03	2.20	2.63	0.00	38.5
15	247	224	54.5	55.5	13.9	2.00	24.1	1.88	5.95	2.86	0.00	35.8
16	535	109	69.9	44.7	90.3	2.81	25.9	1.89	2.88	1.02	0.00	40.7
17	1,540	87.6	70.1	33.2	35.2	1.56	20.7	2.63	4.12	1.70	0.00	40.7
18	103	71.7	77.0	26.0	30.2	0.23	19.5	4.32	2.96	1.43	0.02	30.3
19	75.1	81.8	73.4	31.6	31.1	0.28	36.1	2.92	32.9	2.68	0.05	22.5
20	69.3	90.5	133	41.9	18.9	0.17	23.6	3.84	41.0	2.39	39.5	19.6
21	58.5	74.5	110	41.3	7.23	0.00	28.2	2.21	51.0	3.16	4.45	21.7
22	55.4	61.8	64.2	23.0	94.1	0.01	17.3	2.84	47.5	4.88	0.63	30.5
23	40.2	48.8	63.4	14.4	49.2	0.04	10.5	3.29	40.3	4.86	0.91	125
24	41.9	60.8	65.6	7.62	54.1	0.24	6.14	3.11	33.3	1.30	2.23	34.4
25	38.1	61.3	67.5	16.2	44.6	0.10	7.13	4.15	31.2	1.30	1.31	30.1
26	49.3	67.2	52.5	11.8	68.2	109	4.23	2.37	36.3	4.77	2.15	692
27	53.9	70.9	56.3	10.2	53.9	37.5	5.27	2.14	10.8	5.61	72.7	54.2
28	60.5	83.2	51.0	14.8	48.5	44.2	15.3	2.15	18.2	4.27	688	58.6
29	61.7		50.9	23.3	36.8	51.4	10.4	1.86	14.5	4.02	79.6	54.2
30	69.8		53.3	15.6	22.0	35.9	10.0	2.47	10.2	6.47	12.7	42.7
31	166		53.6		9.03		7.51	1.60		7.74		36.3
COUNT	31	28	31	30	31	30	31	31	30	31	30	31
MAX	1,540	1,930	444	58.7	94.1	109	46.2	7.07	51	17	688	692
MIN	38.1	48.8	51	8	5	0	4	2	2	0	0	5

Table A-38. 2019 Daily Mean Flow (cfs), Santa Ana River at MWD Crossing, as Measured by the USGS (Data are provisional)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	50.1	148	76.4	56.0	49.0	92.0	40.6	34.6	34.0	33.5	32.6	61.0
2	49.4	1,200	354	54.9	47.8	91.0	41.1	36.2	32.6	34.1	33.1	46.3
3	50.4	1,210	400	58.5	45.9	88.0	38.8	39.6	31.0	33.4	33.7	45.1
4	52.0	957	118	55.5	45.6	89.4	43.4	40.0	32.9	32.1	32.3	575
5	53.4	1,210	82.0	55.4	46.6	84.1	39.2	40.6	33.4	31.1	31.7	236
6	100	565	410	57.0	48.5	78.0	38.9	39.1	34.8	30.7	38.0	118
7	57.3	364	257	56.2	46.3	61.4	40.4	39.8	35.8	28.6	30.1	104
8	57.2	315	153	54.2	48.2	64.1	44.0	41.0	35.4	29.3	28.7	148
9	56.0	320	116	56.1	47.7	57.8	42.5	41.7	37.2	30.1	28.6	98.0
10	57.7	316	99.0	57.8	50.1	55.1	41.0	40.4	38.5	29.8	29.0	80.0
11	57.9	322	89.8	56.1	73.3	52.0	37.3	39.5	37.4	28.7	30.6	72.0
12	157	277	89.2	55.7	353	53.1	38.4	41.4	36.7	28.5	31.2	58.4
13	91.6	262	81.9	53.6	378	50.0	38.3	39.5	35.0	28.7	26.6	53.9
14	234	7,590	72.5	52.2	391	47.9	37.9	40.1	33.2	28.7	35.2	53.6
15	306	1,210	70.7	56.4	289	46.4	39.5	40.0	32.9	26.8	38.0	55.1
16	1,050	346	68.2	54.7	188	44.7	37.5	37.6	32.5	27.5	37.3	53.3
17	4,510	190	67.8	56.5	98.3	44.7	34.2	39.4	32.1	29.0	36.3	54.0
18	1,020	212	63.9	51.3	103	43.5	36.8	39.5	31.1	29.5	37.3	54.1
19	208	114	64.8	51.8	187	40.2	39.7	37.7	29.9	29.3	36.9	53.1
20	119	97.5	124	53.6	169	42.2	38.3	35.8	31.7	29.3	53.6	51.8
21	101	258	117	54.2	94.2	42.3	36.4	35.2	31.0	28.4	52.9	52.7
22	86.2	117	81.2	55.2	141	41.3	37.3	36.5	28.9	29.1	47.9	53.0
23	80.3	93.9	75.4	50.0	185	41.3	39.1	38.0	27.7	28.0	44.4	150
24	70.8	89.4	75.1	48.8	121	42.0	32.2	33.5	28.8	27.7	43.3	136
25	68.8	82.6	75.3	49.4	102	43.5	35.4	32.9	30.6	33.4	43.5	92.0
26	62.4	82.3	72.0	49.6	105	42.6	38.0	34.1	32.1	31.0	43.1	968
27	59.4	81.7	69.8	47.5	186	44.7	37.3	33.9	33.9	32.6	73.9	422
28	62.3	78.6	66.9	46.8	108	43.9	35.2	33.2	33.1	32.2	963	242
29	61.5		63.7	50.0	92.7	42.4	39.2	32.9	33.3	33.7	590	190
30	57.8		60.0	50.7	90.1	42.5	37.1	33.0	32.7	31.5	130	157
31	212		57.2		94.4		36.6	34.3		31.6		133
COUNT	31	28	31	30	31	30	31	31	30	31	30	31
MAX	4510	7590	410	59	391	92	44	42	39	34	963	968
MIN	49	79	57	47	46	40	32	33	28	27	27	45

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 2019 dry weather monitoring and 2018-2019 storm monitoring. The basis for this evaluation is the approved QAPP.[22]

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 three 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 2019. Completeness is summarized as follows:

- Due to dry conditions at Borrego Creek and Los Trancos Creek during the monitoring events, no field measurements or water quality samples were collected, resulting in 10 uncollected measurements for each parameter.
- An additional sample was collected at Goldenstar Creek (P3-RC1) to support a more robust geomean calculation.
- There are fewer planned flow measurements as flow is measured in stream sites only. As four Priority 1 sites are located in lakes and two Priority 4 sites are located in the tidal zone, there are 238 planned flow measurements (97 less than other field parameters). Ten flow measurements were not collected due to dry conditions. One measurement was not collected due to tidal influence and one was not collected due to time constraints.

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

- Additional samples were collected at Santa Ana River Reach 4 (P3-SBC1) to support future potential de-listing.
- Additional Samples were collected Cucamonga Creek at Hellman Avenue (P4-SBC1) to provide data to support updating the anti-degradation target.

Table B-1. Dry Weather Field Parameter Completeness Summary

Parameter	Planned[1]	Collected	% Complete
Conductivity	371	365	98.4%
Dissolved Oxygen	371	365	98.4%
Flow[2]	271	255	94.1%
pH	371	365	98.4%
Temperature	371	365	98.4%
Turbidity	371	365	98.4%

[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 routine 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 2019 dry weather season, 25 weeks of sampling at eight Priority 1 sites and five Priority 2 sites was planned from the week of May 5, 2019, through the week of November 24, 2019. During the same period, 5 weeks of sampling at eleven Priority 3 sites, with additional sampling frequency at SAR Reach 4,and one week of sampling at five Priority 4 sites are also planned with additional sampling frequency at Cucamonga Creek at Hellman Avenue This

results in 371 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 391 samples during the entire monitoring period covered in this 2018-2019Annual Report.

Holding time requirements for TSS (7 days) and *E. coli* (6 hours) were not exceeded for any samples collected during the 2019-2020 sampling year.

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 26 field/equipment blanks, however, 88 field/equipment blanks were collected as multiple blanks were collected during some weeks. This results in a frequency of 23 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 MPN/100 mL, respectively. These method sensitivity guidelines were met. Field/equipment blank results were all below detectable counts (< 10 MPN/100 mL) for *E. coli*. For TSS, all but one field/equipment blank results were reported below the target reporting limit. The one blank was 4 mg/L while the target reporting limit is 2 mg/L.

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 44 TSS field duplicates and 44 indicator bacteria field duplicates (39 *E. coli* and 5 *Enterococcus*). As a result, the frequency of field duplicate collection was 23 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	29	29	0
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[1]	Borrego Creek	5	0	5
P3-OC3	Buck Gully Creek	5	5	0
P3-OC5[2]	Los Trancos Creek	5	0	5
P3-OC6	Morning Canyon Creek	5	5	0
P3-OC7	Peters Canyon Wash	5	5	0
P3-OC8	San Diego Creek Reach 1	5	5	0
P3-OC9	San Diego Creek Reach 1	5	5	0
P3-OC11	Serrano Creek	5	5	0
P3-RC1	Goldenstar Creek	5	6	0
P3-SBC1	Santa Ana River Reach 4	30	30	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[3]	Santa Ana Delhi Channel in Tidal Prism	1	4	0
P4-OC3	Greenville-Banning Channel in Tidal Prism	1	1	0
P4-SBC1	Cucamonga Creek at Hellman Avenue	12	12	0
Total		391	385	10

[1]Borrego Creek was dry during all five sample vents.

[2] Los Trancos Creek was dry during all five sample events

[3] Additional samples were collected at Santa Ana Delhi Channel in Tidal Prism due to an exceedance of the anti-degradation target

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. Fourteen duplicate pairs exceeded the QAPP's relative percent difference (RPD) goal of ± 25 percent. Two pairs of duplicate samples, collected at Chino Creek below Wetlands on November 17, 2019 and Peters Canyon Wash on September 15, 2019 have a significant RPD resulting in a large difference in concentration (BDL v 11 mg/L and 12.2 mg/L v 41.8 mg/L). This is 5 percent of all QA/QC samples and is within a normal frequency. Twelve pairs with RPD

exceeding ± 25 percent are due to low TSS values; maximum TSS concentration in those pairs is 12 mg/L and the maximum difference in the eight pairs is 10 mg/L. Dividing by the low TSS values artificially results in high RPD values.

To determine the precision of the duplicate analysis for each bacterial indicator the following method was used:[23]

- 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. No samples exceeded Precision Criterion.

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

Table B-4. Results of Field Duplicate Analysis for TSS

Week Beginning Date	Site ID	Site Location	Duplicate Result (mg/L)	Sample Result (mg/L)	RPD (%)
5/5/2019	P1-4	Big Bear Lake	9	10	11%
5/12/2019	P1-5	Mill Creek Reach 2	<2	2	0%
5/19/2019	P1-6	Lytle Creek (Middle Fork)	<2	<2	0%
5/26/2019	P3-SBC1	Santa Ana River Reach 4	80	98	20%
6/2/2019	P1-1	Canyon Lake	4	3	29%
6/9/2019	P1-2	Lake Elsinore	42	32	27%
6/16/2019	P1-3	Lake Perris	4	2	67%
6/23/2019	WW-M6	Mil-Cucamonga Creek below Wetlands	3	2	40%
6/30/2019	WW-C7	Chino Creek at Central Avenue	2	4	67%
7/7/2019	WW-C3	Prado Park Lake	13	13	0%
7/14/2019	P3-RC1	Goldenstar Creek	<2	2	0%
7/21/2019	WW-S1	SAR at MWD Crossing	16	12	29%
7/28/2019	P1-1	Canyon Lake	4	2	67%
8/4/2019	P1-2	Lake Elsinore	22	18	20%
8/11/2019	P1-3	Lake Perris	2	2	0%
8/18/2019	P1-4	Big Bear Lake	15	14	7%
8/25/2019	P1-5	Mill Creek Reach 2	<2	<2	0%
9/1/2019	P1-6	Lytle Creek (Middle Fork)	<2	<2	0%
9/8/2019	WW-C3	Prado Park Lake	17	20	16%
9/15/2019	WW-S1	SAR at MWD Crossing	7	4	55%
9/22/2019	P3-SBC1	Santa Ana River Reach 4	2	2	0%
9/29/2019	P3-SBC1	Santa Ana River Reach 4	3	2	40%
10/6/2019	P3-SBC1	Santa Ana River Reach 4	2	2	0%
10/13/2019	P3-SBC1	Santa Ana River Reach 4	6	2	100%
10/20/2019	P3-SBC1	Santa Ana River Reach 4	2	2	0%
10/27/2019	WW-S1	SAR at MWD Crossing	2	4	67%
11/3/2019	WW-S4	Santa Ana River Reach 3 at Pedley Avenue	6	5	18%
11/10/2019	WW-M6	Mil-Cucamonga Creek below Wetlands	2	2	0%
11/17/2019	WW-C7	Chino Creek at Central Avenue	<2	11	138%
11/24/2019	WW-C3	Prado Park Lake	24	26	8%
12/1/2019	P4-SBC1	Cucamonga Creek at Hellman Avenue	4	4	0%
5/5/2019	P3-OC3	Buck Gully Creek	8	8	0%

Week Beginning Date	Site ID	Site Location	Duplicate Result (mg/L)	Sample Result (mg/L)	RPD (%)
5/12/2019	P3-OC3	Buck Gully Creek	7	6	15%
5/19/2019	P3-OC3	Buck Gully Creek	24	26	8%
5/26/2019	P3-OC3	Buck Gully Creek	9	8	12%
6/2/2019	P3-OC3	Buck Gully Creek	11	12	9%
7/21/2019	P3-OC1	Bolsa Chica Channel	<5	<5	0%
7/28/2019	P3-OC1	Bolsa Chica Channel	<5	<5	0%
8/4/2019	P3-OC1	Bolsa Chica Channel	<5	<5	0%
8/11/2019	P3-OC1	Bolsa Chica Channel	<5	<5	0%
8/18/2019	P3-OC11	Serrano Creek	6.4	8.2	25%
8/25/2019	P3-OC8	San Diego Creek Reach 1	19	21	10%
9/1/2019	P3-OC7	Peters Canyon Wash	19	20	5%
9/8/2019	P3-OC9	San Diego Creek Reach 1	12.2	12.2	0%
9/15/2019	P3-OC7	Peters Canyon Wash	12.2	41.8	110%

Note: Values with a "<" qualifier reflect results that are below detection limits. For calculation purposes, the value 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 (MPN/100 mL)	Sample Result (MPN/100 mL)	Log of Duplicate Result (L_1)	Log of Sample Result (L_2)	Range of Logs (L_1 - L_2) or (R_{log})
5/5/2019	P1-4	Big Bear Lake	3.1	1	0.4914	0.0000	0.4914
5/12/2019	P1-5	Mill Creek Reach 2	2	<1	0.3010	0.0000	0.3010
5/19/2019	P1-6	Lytle Creek (Middle Fork)	<1	3	0.0000	0.4771	0.4771
5/26/2019	P3-SBC1	Santa Ana River Reach 4	110	140	2.0414	2.1461	0.1047
6/2/2019	P1-1	Canyon Lake	3.1	<1	0.4914	0.0000	0.4914
6/9/2019	P1-2	Lake Elsinore	4.1	6.3	0.6128	0.7993	0.1866
6/16/2019	P1-3	Lake Perris	12	20	1.0792	1.3010	0.2218
6/23/2019	WW-M6	Mil-Cucamonga Creek below Wetlands	98	120	1.9912	2.0792	0.0880
6/30/2019	WW-C7	Chino Creek at Central Avenue	170	200	2.2304	2.3010	0.0706
7/7/2019	WW-C3	Prado Park Lake	41	10	1.6128	1.0000	0.6128
7/14/2019	P3-RC1	Goldenstar Creek	700	480	2.8451	2.6812	0.1639
7/21/2019	WW-S1	SAR at MWD Crossing	41	85	1.6128	1.9294	0.3166
7/28/2019	P1-1	Canyon Lake	<1	<1	0.0000	0.0000	0.0000
8/4/2019	P1-2	Lake Elsinore	6.2	3.1	0.7924	0.4914	0.3010
8/11/2019	P1-3	Lake Perris	5.2	<1	0.7160	0.0000	0.7160
8/18/2019	P1-4	Big Bear Lake	<1	<1	0.0000	0.0000	0.0000
8/25/2019	P1-5	Mill Creek Reach 2	4.1	<1	0.6128	0.0000	0.6128
9/1/2019	P1-6	Lytle Creek (Middle Fork)	1	4.1	0.0000	0.6128	0.6128
9/8/2019	WW-C3	Prado Park Lake	86	63	1.9345	1.7993	0.1352
9/15/2019	WW-S1	SAR at MWD Crossing	180	230	2.2553	2.3617	0.1065
9/22/2019	P3-SBC1	Santa Ana River Reach 4	28	31	1.4472	1.4914	0.0442
9/29/2019	P3-SBC1	Santa Ana River Reach 4	34	41	1.5315	1.6128	0.0813
10/6/2019	P3-SBC1	Santa Ana River Reach 4	24	27	1.3802	1.4314	0.0512
10/13/2019	P3-SBC1	Santa Ana River Reach 4	25	24	1.3979	1.3802	0.0177
10/20/2019	P3-SBC1	Santa Ana River Reach 4	30	42	1.4771	1.6232	0.1461
10/27/2019	WW-S1	SAR at MWD Crossing	260	52	2.4150	1.7160	0.6990
11/3/2019	WW-S4	Santa Ana River Reach 3 at Pedley Avenue	160	160	2.2041	2.2041	0.0000
11/10/2019	WW-M6	Mil-Cucamonga Creek below Wetlands	210	200	2.3222	2.3010	0.0212

Sample Date	Site ID	Site Location	Duplicate Result (MPN/100 mL)	Sample Result (MPN/100 mL)	Log of Duplicate Result (L_1)	Log of Sample Result (L_2)	Range of Logs (L_1 - L_2) or (R_{log})
11/17/2019	WW-C7	Chino Creek at Central Avenue	62	10	1.7924	1.0000	0.7924
11/24/2019	WW-C3	Prado Park Lake	340	430	2.5315	2.6335	0.1020
12/1/2019	P4-SBC1	Cucamonga Creek at Hellman Avenue	27	44	1.4314	1.6435	0.2121
6/2/2019	P3-OC3	Buck Gully Creek	197	38	2.2945	1.5798	0.7147
7/21/2019	P3-OC1	Bolsa Chica Channel	20	<10	1.3010	1.0000	0.3010
7/28/2019	P3-OC1	Bolsa Chica Channel	187	63	2.2718	1.7993	0.4725
8/4/2019	P3-OC1	Bolsa Chica Channel	322	275	2.5079	2.4393	0.0685
8/11/2019	P3-OC1	Bolsa Chica Channel	41	10	1.6128	1.0000	0.6128
8/18/2019	P3-OC11	Serrano Creek	31	30	1.4914	1.4771	0.0142
8/25/2019	P3-OC8	San Diego Creek Reach 1	211	345	2.3243	2.5378	0.2135
9/1/2019	P3-OC7	Peters Canyon Wash	379	350	2.5786	2.5441	0.0346
9/8/2019	P3-OC9	San Diego Creek Reach 1	10	>5	1.0000	0.6990	0.3010
9/15/2019	P3-OC7	Peters Canyon Wash	576	637	2.7604	2.8041	0.0437
						Sum of R_{log}	10.9538
						Mean R_{log}	0.2672
						Precision Criterion (3.27*Mean R_{log})	0.8736

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Appendix C

Laboratory QA/QC Reports

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Quality Assurance / Certification Statement

CDM Smith – SAR Monitoring Program

There were a total of 438 samples submitted, which includes 290 site samples, 74 field duplicate samples and 74 field blanks. Samples were analyzed for Total Suspended Solids, Total Coliform, e. Coli and enterococcus as requested. The sampling period spanned May 2019 through December 2019.

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

All samples were received within acceptable holding times for the analyses requested, except for the following:
Duplicate sample 20190510SAWPADup from 5/10/2019 did not have the container submitted for bacteriological testing.

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

All 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 Name	Lab ID	Sample Date & Time	Analyte	Result	Units
20190603SAWPAFB	B9F0169-04	06/03/2019 11:15:00	Total Coliform	91	MPN/100ml
20190612SAWPAFB	B9F1532-05	06/12/2019 08:01:00	Total Coliform	1.0	MPN/100ml
20190703AWPAFB	B9G0554-05	07/03/2019 10:10:00	Total Coliform	>2400	MPN/100ml
20190710AWPAFB	B9G1284-05	07/10/2019 07:40:00	Total Coliform	23	MPN/100ml
20190729SAWPAFB	B9G3838-04	07/29/2019 08:30:00	Total Suspended Solids	2	mg/L
20190819SAWPAFB	B9H2533-04	08/19/2019 08:30:00	Total Suspended Solids	2	mg/L
20190916SAWPAFB	B9I2069-04	09/16/2019 09:28:00	Total Suspended Solids	2	mg/L
20191001SAWPAFB	B9J0020-02	10/01/2019 10:25:00	Total Suspended Solids	2	mg/L
20191029SAWPAFB	B9J3966-08	10/29/2019 11:40:00	Total Suspended Solids	2	mg/L
20191104SAWPAFB	B9K0188-04	11/04/2019 10:30:00	Total Suspended Solids	2	mg/L
20191112SAWPAFB	B9K1255-08	11/12/2019 08:45:00	Total Suspended Solids	2	mg/L

Field Duplicates

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

Section III

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

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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PUBLIC HEALTH SERVICES
PUBLIC HEALTH WATER QUALITY LABORATORY

DATE: **April 15, 2020**

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

From: **Joseph A. Guzman, Supervising Public Health Microbiologist**

Subject: **SAR Bacterial Monitoring Program**
QA/QC *E. coli* and Enterococcus analysis
Season: July 2019 – December 2019

There were 14 sampling events for the 2019 SAR monitoring. A total of 59 water samples were submitted, including 31 site samples (26 for E. coli and 5 for Enterococcus), 14 field blanks, and 14 field replicates.

I. Sample Transport Conditions

Acceptable transport conditions for this monitoring program per QAPP is ≤ 4°C for each sampling event. Standard Methods (SM) 9060B 1.a indicates transport conditions should be ≤10°C if transport time will be > 1 hour. SM 9060B 1.a sets no temperature requirements if samples are received in the lab ≤ 1 hour of collection. The table below breaks down the transport conditions for the 14 sampling events.

Transport Conditions at time of sample receipt	No. of sampling events (Date of Collection)	Quality Assurance Criteria Applied	Samples accepted and processed
≤ 4°C	10	QAPP	Yes
>4°C but ≤10°C transport time > 1hr	1 (9/18/19)	SM 9060B 1.a	Yes
>4°C but ≤10°C transport time < 1hr	2 (11/18/19 & 12/16/19)	SM 9060B 1.a	Yes
Temperature not recorded transport time < 1hr	1 (10/21/19)	SM 9060B 1.a	Yes

All 59 samples submitted for this monitoring program were accepted and processed. There were 4 sampling events in which the transport conditions did not meet the ≤ 4°C requirement of the QAPP. The 15 samples submitted on those 4 sampling events did meet the SM 9060B 1.a transport requirements. Program will need to determine if the deviation from the QAPP is acceptable.

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 chain of custody (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: 14 field blanks were collected for the SAR Bacterial Monitoring. One field blank was collected for each sampling event.
9 field blanks were tested for other monitoring programs on the same days that SAR Bacterial Monitoring samples were tested.

B. Laboratory Blanks: 111 internal blank samples were tested on the days that SAR samples were tested. The lab ran blank samples at a rate of 22% (111/498). QAPP requires method blanks to be run at a rate of 5% (1/20)

For *E. coli* and Enterococcus the 14 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 9 field blanks collected for other monitoring programs also showed no growth for all bacterial indicators tested. Results for all 111 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% (11/26) for E. coli and 60% (3/5) for Enterococcus. The replicate samples were analyzed for the same parameters as its paired field sample.
4 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 0.6006 (3.27 x 0.01837) was established. Of the 11 replicate samples submitted, 10 samples were within the established precision criteria.

The imprecision for the one sample outside of the precision criteria was determined to be acceptable as the results for the sample and its paired replicate were within the 95% confidence level for the test method.

2. For field replicate samples submitted for Enterococcus by SM 9230D analysis (Enterolert), a precision criteria of 0.9832 (3.27 x 0.3004) was established. Of the 3 replicate samples submitted, all were within the established precision criteria.

All field replicate results for Enterococcus were within the established precision criteria.

3. For the 4 field replicates submitted for other monitoring programs, a precision criteria of 0.1877 (3.27 x 0.0574) was established. All samples were within the established precision criteria values.

All field replicate submitted for other monitoring programs on the same days that SAR monitoring sample were submitted were within the established precision criteria.

B. Laboratory Duplicates

Laboratory duplicates were analyzed on 12% (61/498) 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 61 laboratory duplicates tested, a precision criteria of 0.5456 (3.27 x 0.1668) was established. Two samples had a difference in results outside the established precision criteria.

Although there were 2 laboratory duplicates outside the established precision criteria value, 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 duplicate.

V. Laboratory Accuracy and Method Blanks for Analytical Methods:

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

One lot of Idexx Colilert-18 media was used during the SAR monitoring. There are four parameters tested for with each new lot prior to use:

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.

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

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.
3. pH is checked to make sure it is within specifications.

Two lots of sterile Quanti-tray 2000 trays were used to test for E. coli by SM 9223B. Each new lot is checked for sterility before use.

B. Enterococcus with Enterolert media (SM 9230D)

Two lots of Idexx Enterolert media were used during the SAR monitoring. There are four parameters tested for with each new lot prior to use:

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.

Two lots of sterile 90ml dilution blank water were used to test for Enterococcus by SM 9230D. There are three parameters tested for with each new lot prior to use:

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.
3. pH is checked to make sure it is within specifications.

One lot of sterile Quanti-tray 2000 trays was used to test for Enterococcus by SM 9230D. Each new lot is checked for sterility before use.

All lots of Colilert-18 media, Enterolert media, sterile 90ml dilution water, and Quanti-tray 2000 trays used for the SAR monitoring had acceptable quality control results for all parameters tested. QC records are available.

VI. Laboratory Equipment Maintenance and Calibration

Temperatures for the 35°C and 41°C incubators were recorded twice daily on temperature charts. Both incubators were calibrated by a contracted vendor every 6 months and documentation is available for review.

The Quanti-Tray sealer used to seal the Quanti-tray 2000 trays for E. coli and Enterococcus had routine monthly maintenance performed and documentation is available for review. Each new lot of sterile 10ml pipets are checked for accuracy and results documented.