Santa Clara Valley
Urban Runoff
Pollution Prevention Program

Watershed Monitoring and Assessment Program

Integrated Monitoring Report
Part B: Creek Status Monitoring

Water Years 2014-2019

Submitted in compliance with Provision C.8.h.v of NPDES Permit No. CAS612008, Order No. R2-2015-049

March 31, 2020

PREFACE

In early 2010, several members of the Bay Area Stormwater Agencies Association (BASMAA) joined together to form the Regional Monitoring Coalition (RMC), to coordinate and oversee water quality monitoring required by the Municipal Regional National Pollutant Discharge Elimination System (NPDES) Stormwater Permit (in this document the permit is referred to as the MRP).[1] The RMC includes the following participants:

- Alameda Countywide Clean Water Program (ACCWP)
- Contra Costa Clean Water Program (CCCWP)
- San Mateo Countywide Water Pollution Prevention Program (SMCWPPP)
- Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)
- Fairfield-Suisun Urban Runoff Management Program (FSURMP)
- City of Vallejo and Vallejo Flood and Wastewater District (Vallejo)

This Integrated Creek Status Monitoring Report complies with provision C.8.h.v of the MRP for reporting of all data collected since the previous Integrated Monitoring Report which was submitted on March 31, 2014. It includes data collected in Water Year 2014 through Water Year 2019 (October 1, 2013 through September 30, 2019). Data were collected pursuant to Creek Status Monitoring and Pesticides & Toxicity Monitoring requirements of MRP provision C.8. Data presented in this report were produced under the direction of the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP or Program) and in collaboration with the RMC, using probabilistic and targeted monitoring designs as described herein.

Consistent with the Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012), monitoring data were collected in accordance with the most recent versions of the BASMAA RMC Quality Assurance Project Plan (QAPP; BASMAA, 2016a) and the BASMAA RMC Standard Operating Procedures (SOPs; BASMAA, 2016b). Where applicable, monitoring data were derived using methods comparable with methods specified by the California Surface Water Ambient Monitoring Program (SWAMP) Quality Assurance Program Plan (QAPrP).[2] Data presented in this report were submitted in electronic SWAMP-comparable formats by SCVURPPP to the San Francisco Bay Regional Water Quality Control Board on behalf of SCVURPPP Co-permittees and pursuant to provision C.8.h.ii of the MRP.

[1] The San Francisco Bay Regional Water Quality Control Board (SFRWQCB or Regional Water Board) issued the MRP to 76 cities, counties and flood control districts (i.e., Permittees) in the Bay Area on October 14, 2009 (SFRWQCB 2009). On November 19, 2015, the Regional Water Board updated and reissued the MRP (SFRWQCB 2015). The BASMAA programs supporting MRP Regional Projects include all MRP Permittees as well as the cities of Antioch, Brentwood, and Oakley, which are not named as Permittees under the MRP but have voluntarily elected to participate in MRP-related regional activities.

[2] The current SWAMP QAPrP is available at: https://www.waterboards.ca.gov/water_issues/programs/swamp/qapp/swamp_QAPrP_2017_Final.pdf

LIST OF ACRONYMS

ACCWP	Alameda Countywide Clean Water Program
AFDM	Ash Free Dry Mass
AFS	American Fisheries Society
ASCI	Algae Stream Condition Index
BASMAA	Bay Area Stormwater Management Agency Association
BMI	Benthic Macroinvertebrate
BMP	Best Management Practice
CCCWP	Contra Costa Clean Water Program
CDF	Cumulative Distribution Function
CEDEN	California Environmental Data Exchange Network
COLD	Cold Freshwater Habitat
CSBP	California Stream Bioassessment Protocol
CSCI	California Stream Condition Index
DF	Detection Frequency
DO	Dissolved Oxygen
DPR	Department of Pesticide Regulation
EMAP	Environmental Monitoring and Assessment Program
FSURMP	Fairfield Suisun Urban Runoff Management Program
GIS	Geographic Information Systems
GM	Geometric Mean
GRTS	Generalized Random Tessellation Stratified
GSI	Green Stormwater Infrastructure
IBI	Indices of Biotic Integrity
IDDE	Illicit Discharge Detection and Elimination
IMR	Integrated Monitoring Report
IPI	Index Physical Habitat Integrity
IPM	Integrated Pest Management
IWRMP	Integrated Water Resources Management Plan
LID	Low Impact Development
MDL	Method Detection Limit
MIGR	Fish Migration
MMI	Multimetric Index
MPC	Monitoring and Pollutants of Concern Committee
MPN	Most Probable Number
MRP	Municipal Regional Permit
MS4	Municipal Separate Storm Sewer System
MUN	Municipal and Domestic Water Supply Beneficial Use
MWAT	Maximum Weekly Average Temperature
MWMT	Maximum Weekly Maximum Temperature
NMFS	National Marine and Fisheries Services
NPDES	National Pollution Discharge Elimination System
O/E	Observed to Expected
PAH	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PEC	Probable Effects Concentrations
PHAB	Physical Habitat Assessment

pMMI	Predictive Multimetric Index
PSA	Perennial Streams Assessment
QAPP	Quality Assurance Project Plan
QAPrP	Quality Assurance Program Plan
QA/QC	Quality Assurance/Quality Control
RARE	Preservation of Rare and Endangered Species
RM	Reporting Module
RMC	Regional Monitoring Coalition
RWB	Reachwide Benthos
RWQC	Recreation Water Quality Criteria
SAFIT	Southwest Association of Freshwater Invertebrate Taxonomists
SCAPE	Stream Classification and Priority Explorer
SCCWRP	Southern California Coastal Water Research Project
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SCVWD	Santa Clara Valley Water District
SFRWQCB	San Francisco Bay Regional Water Quality Control Board
SMC	Southern California Monitoring Coalition
SMCWPPP	San Mateo County Water Pollution Prevention Program
SOP	Standard Operating Protocol
SPoT	Stream Pollution Trends
SPWN	Fish Spawning
SSID	Stressor/Source Identification
STORMS	Strategy to Optimize Resource Management of Storm Water
STV	Statistical Threshold Value
SURF	Surface Water Database
SWAMP	Surface Water Ambient Monitoring Program
SWPP	Surface Water Protection Program
TEC	Threshold Effects Concentrations
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TST	Test of Significant Toxicity
TU	Toxicity Unit
UCMR	Urban Creeks Monitoring Report
USEPA	Environmental Protection Agency
WARM	Warm Freshwater Habitat
WQO	Water Quality Objective
WY	Water Year

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1.0 INTRODUCTION

This *Integrated Monitoring Report (IMR) Part B: Creek Status Monitoring*, *Water Year*[3] *(WY) 2014 through WY 2019* was prepared by the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP or Program), on behalf of its 15 member agencies (13 cities/towns, the County of Santa Clara, and the Santa Clara Valley Water District), which are subject to the National Pollutant Discharge Elimination System (NPDES) stormwater permit for Bay Area municipalities referred to as the Municipal Regional Permit (MRP). The MRP was first adopted by the San Francisco Regional Water Quality Control Board (SFRWQCB or Regional Water Board) on October 14, 2009 as Order R2-2009-0074 (SFRWQCB 2009; referred to as MRP 1.0). On November 19, 2015, the Regional Water Board updated and reissued the MRP as Order R2-2015-0049 (SFRWQCB 2015; referred to as MRP 2.0).

This report fulfills the requirements of provision C.8.h.v of MRP 2.0 for comprehensively interpreting and reporting all Creek Status and Pesticides & Toxicity monitoring data collected since the previous IMR. As such, this report includes data collected during WY 2014 through WY 2019.[4] The previous IMR included data collected during WY 2012 and WY 2013 (SCVURPPP 2014). Data presented in this report from WY 2014 and WY 2015 were collected pursuant to water quality monitoring requirements in provisions C.8.c (Creek Status Monitoring) of MRP 1.0 and provisions C.8.d (Creek Status Monitoring) and C.8.g (Pesticides & Toxicity Monitoring) of MRP 2.0.[5] Data presented in this report were submitted electronically to the Regional Water Board by SCVURPPP and may be obtained via the California Environmental Data Exchange Network (CEDEN).

Sections of this report are organized according to the following topics:

- **Section 1.0 –** Introduction including overview of the Program goals, background, monitoring approach, and statement of data quality
- **Section 2.0** – Biological condition assessment and stressor analysis at probabilistic sites
- **Section 3.0** – Continuous water quality monitoring (temperature, general water quality)
- **Section 4.0** – Pathogen indicators
- **Section 5.0** – Chlorine monitoring
- **Section 6.0** – Pesticides & Toxicity monitoring
- **Section 7.0 –** Conclusions and recommendations

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[3] Most hydrologic monitoring occurs for a period defined as a Water Year, which begins on October 1 and ends on September 30 of the named year. For example, Water Year 2019 (WY 2019) began on October 1, 2018 and concluded on September 30, 2019.

[4] The exception is biological condition data which are reported for the WY 2012 through WY 2019 period of record.

[5] Monitoring data collected pursuant to other C.8 provisions (e.g., Pollutants of Concern Monitoring, Stressor/Source Identification Monitoring Projects) are reported in the SCVURPPP Integrated Monitoring Report (IMR) for WY 2014 through WY 2019 to which this Integrated Creek Status Monitoring Report is appended.

1.1 Monitoring Objectives

Provision C.8.d of MRP 2.0 (and provision C.8.c of MRP 1.0) requires Permittees to conduct creek status monitoring that is intended to answer the following management questions:

1. ***Are water quality objectives, both numeric and narrative, being met in local receiving waters, including creeks, rivers, and tributaries?***
2. ***Are conditions in local receiving water supportive of or likely supportive of beneficial uses?***

The first management question is addressed primarily through the evaluation of probabilistic and targeted monitoring data with respect to the triggers defined in the MRP. Sites where triggers are exceeded may indicate potential impacts to aquatic life or other beneficial uses and consideration for future Stressor/Source identification (SSID) projects.

The second management question is addressed by assessing indicators of beneficial uses. For example, the indices of biological integrity based on benthic macroinvertebrate and algae data are direct measures of the condition of aquatic life beneficial uses. Continuous monitoring data (temperature, dissolved oxygen, pH, and specific conductance) are evaluated with respect to COLD and WARM Beneficial Uses. Pathogen indicator data are used to assess REC-1 (water contact recreation) Beneficial Uses.

Creek Status and Pesticides & Toxicity monitoring parameters, methods, occurrences, durations and minimum number of sampling sites are described in provisions C.8.d and C.8.g of the MRP, respectively.

The monitoring requirements in MRP 2.0 (SFRWQCB 2015) are similar to MRP 1.0 (SFRWQCB 2009) requirements (which began implementation on October 1, 2011) and build upon earlier monitoring conducted by SCVURPPP between 2002 and 2009. Creek Status and Pesticides & Toxicity monitoring is coordinated through the Bay Area Stormwater Agencies Association (BASMAA) Regional Monitoring Coalition (RMC). Monitoring results are evaluated to determine whether triggers are met and further investigation is warranted as a potential Stressor/Source Identification (SSID) Project, as described in provision C.8.e of the MRP. Results of Creek Status and Pesticides & Toxicity Monitoring conducted in Water Years 2012 through 2018 are summarized in this report and were detailed in prior reports (SCVURPPP 2019, SCVURPPP 2018, SCVURPPP 2017, SCVURPPP 2016, SCVURPPP 2015, SCVURPPP 2014). Water Year 2019 data are reported for the first time in this IMR.

1.2 Regional Monitoring Coalition

Provision C.8.a (Compliance Options) of the MRP allows Permitees to address monitoring requirements through a regional collaborative effort, their Stormwater Program, and/or individually. The RMC was formed in early 2010 as a collaboration among a number of the BASMAA members and MRP Permittees (Table 1.1) to develop and implement a regionally coordinated water quality monitoring program to improve stormwater management in the region and address water quality monitoring required by the MRP.[6] Implementation of the RMC's

[6] The Regional Water Board issued the first five-year MRP to 76 cities, counties and flood control districts (i.e., Permittees) in the Bay Area on October 14, 2009 (MRP 1.0; SFRWQCB 2009). On November 19, 2015, the Regional Water Board updated and reissued the MRP (MRP 2.0; SFRWQCB 2015). The BASMAA programs supporting MRP

Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012) allows Permittees and the Regional Water Board to improve their ability to collectively answer core management questions in a cost-effective and scientifically rigorous way. Participation in the RMC is facilitated through the BASMAA Monitoring and Pollutants of Concern (MPC) Committee.

Table 1.1. Regional Monitoring Coalition (RMC) participants.

Stormwater Programs	RMC Participants
Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)	Cities of Campbell, Cupertino, Los Altos, Milpitas, Monte Sereno, Mountain View, Palo Alto, San José, Santa Clara, Saratoga, Sunnyvale, Los Altos Hills, and Los Gatos; Santa Clara Valley Water District; and, Santa Clara County
Alameda Countywide Clean Water Program (ACCWP)	Cities of Alameda, Albany, Berkeley, Dublin, Emeryville, Fremont, Hayward, Livermore, Newark, Oakland, Piedmont, Pleasanton, San Leandro, and Union City; Alameda County; Alameda County Flood Control and Water Conservation District; and, Zone 7
Contra Costa Clean Water Program (CCCWP)	Cities of Antioch, Brentwood, Clayton, Concord, El Cerrito, Hercules, Lafayette, Martinez, Oakley, Orinda, Pinole, Pittsburg, Pleasant Hill, Richmond, San Pablo, San Ramon, Walnut Creek, Danville, and Moraga; Contra Costa County; and, Contra Costa County Flood Control and Water Conservation District
San Mateo County Wide Water Pollution Prevention Program (SMCWPPP)	Cities of Belmont, Brisbane, Burlingame, Daly City, East Palo Alto, Foster City, Half Moon Bay, Menlo Park, Millbrae, Pacifica, Redwood City, San Bruno, San Carlos, San Mateo, South San Francisco, Atherton, Colma, Hillsborough, Portola Valley, and Woodside; San Mateo County Flood Control District; and, San Mateo County
Fairfield-Suisun Urban Runoff Management Program (FSURMP)	Cities of Fairfield and Suisun City
Vallejo Permittees	City of Vallejo and Vallejo Flood and Wastewater District

The goals of the RMC are to:

1. Assist Permittees in complying with requirements in provision C.8 (Water Quality Monitoring) of the MRP;
2. Develop and implement regionally consistent creek monitoring approaches and designs in the Bay Area, through the improved coordination among RMC participants and other agencies (e.g., Regional Water Board) that share common goals; and
3. Stabilize the costs of creek monitoring by reducing duplication of effort and streamlining reporting.

The RMC's monitoring strategy for complying with Creek Status Monitoring is described in the RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012). The strategy includes regional ambient/probabilistic monitoring and local "targeted" monitoring. The combination of these two components allows each individual RMC participating program to assess the status of beneficial uses in local creeks within its jurisdictional area, while also contributing data to answer management questions at the regional scale (e.g., differences between aquatic life condition in urban and non-urban creeks). The current MRP, updated and reissued in 2015, specifically prescribes the probabilistic/targeted approach and most of the

Regional Projects include all MRP Permittees as well as the cities of Antioch, Brentwood, and Oakley which are not named as Permittees under the MRP but have voluntarily elected to participate in MRP-related regional activities.

other details of the RMC Creek Status and Long-Term Trends Monitoring Plan. Table 1.2 provides a list of which monitoring parameters are included in the probabilistic and targeted programs in MRP 2.0. This report includes data collected in Santa Clara County under both monitoring components. Data are organized into report Sections that reflect the format of monitoring requirements in the MRP.

Table 1.2. Monitoring parameters of MRP 2.0 provisions C.8.d (Creek Status Monitoring) and C.8.g (Pesticides & Toxicity Monitoring) and associated monitoring component.

Monitoring Elements	Monitoring Component		Report Section
	Regional Ambient (Probabilistic)	Local (Targeted)	
Creek Status Monitoring (C.8.d)			
Bioassessment & Physical Habitat Assessment	X	X[1]	2.0
Nutrients	X	X[1]	2.0
General Water Quality (Continuous)		X	3.0
Temperature (Continuous)		X	3.0
Pathogen Indicators		X	4.0
Chlorine	X	X[2]	5.0
Pesticides & Toxicity Monitoring (C.8.g)			
Water Toxicity		X	6.0
Sediment Toxicity		X	6.0
Sediment Chemistry		X	6.0

Notes:
[1] Provision C.8.d.i.(6) allows for up to 20% of sample locations to be selected on a targeted basis.
[2] Provision C.8.d.ii.(2) provides options for probabilistic or targeted site selection. In WY 2018, chlorine was measured at probabilistic sites.

1.3 Monitoring and Data Assessment Methods

1.3.1 Monitoring Methods

Water quality data were collected in accordance with California Surface Water Ambient Monitoring Program (SWAMP) comparable methods and procedures described in the BASMAA RMC Standard Operating Procedures (SOPs; BASMAA 2016a) and the associated Quality Assurance Project Plan (QAPP; BASMAA 2016b). These documents are updated as needed to maintain their currency and optimal applicability. Where applicable, monitoring data were collected using methods comparable to those specified by the SWAMP Quality Assurance Program Plan (QAPrP)[7], and were submitted in SWAMP-compatible format to the SFRWQCB. The SOPs were developed using a standard format that describes health and safety cautions and considerations, relevant training, site selection, and sampling methods/procedures, including pre-fieldwork mobilization activities to prepare equipment, sample collection, and de-mobilization activities to preserve and transport samples.

[7] The current SWAMP QAPrP is available at: https://www.waterboards.ca.gov/water_issues/programs/swamp/qapp/swamp_QAPrP_2017_Final.pdf

1.3.2 Laboratory Analysis Methods

RMC participants, including SCVURPPP, agreed to use the same laboratories for individual parameters (except pathogen indicators), developed standards for contracting with the labs, and coordinated quality assurance samples. All samples collected by RMC participants that were sent to laboratories for analysis were analyzed and reported per SWAMP-comparable methods as described in the RMC QAPP (BASMAA 2016b). Analytical laboratory methods, reporting limits and holding times for chemical water quality parameters are also described in BASMAA (2016a). Analytical laboratory contractors in WY 2019 included:

- BioAssessment Services, Inc. – Benthic macroinvertebrate (BMI) identification
- EcoAnalysts, Inc. – Algae identification
- CalTest, Inc. – Sediment chemistry, nutrients, chlorophyll a, ash free dry mass
- Pacific EcoRisk, Inc. - Water and sediment toxicity
- Alpha Analytical – Pathogen indicators

1.3.3 Data Analysis Methods

Monitoring data generated during WY 2014 through WY 2019 were analyzed and evaluated to identify potential stressors that may be contributing to degraded or impacted biological conditions, including exceedances of water quality objectives (WQOs). Creek Status Monitoring and Pesticides & Toxicity Monitoring data are evaluated with respect to numeric thresholds (i.e., triggers) specified in the MRP (SFRWQCB 2015, SFRWQCB 2009). Sites with monitoring data that do not meet WQOs and/or MRP trigger thresholds require consideration for further evaluation as part of a Stressor/Source Identification project. SSID projects are intended to be oriented toward taking action(s) to alleviate stressors and reduce sources of pollutants. A stepwise process for conducting SSID projects is described in Provision C.8.e.iii of MRP 2.0.

In compliance with Provision C.8.e.i of MRP 2.0, all monitoring results exceeding trigger thresholds are added to a list of candidate SSID projects that will be maintained throughout the permit term. Follow-up SSID projects are selected from this list.

1.4 Setting

1.4.1 Watersheds Monitored by SCVURPPP

There are 13 major watersheds within the SCVURPPP jurisdictional boundaries and these watersheds comprise most of the Santa Clara Basin. The watersheds are illustrated in Figure 1.1 and their major characteristics are listed in Table 1.3. The Santa Clara Basin, which drains to the Lower South San Francisco Bay, is 840 square miles and bounded by the Diablo Mountains on the east and the Santa Cruz Mountains on the west and south. Elevations range from sea level at the Bay to almost 4,000 feet in the Santa Cruz Mountains. There is a distinct transition in geography and land use at elevations of 600 to 800 feet. Areas above this elevation generally have steeper slopes and are largely forest, rangeland, or open space. Below this elevation threshold, an urbanized landscape dominates. The headwaters of most watersheds begin in the undeveloped mountains and drain north through urbanized areas and into the Lower South Bay. Flows in the lower reaches of most watersheds are controlled by the presence of water supply reservoirs that are managed by Valley Water (formerly Santa Clara Valley Water District) and other agencies. Many of the reservoirs are constructed at the transition between the Santa Clara Valley and the surrounding foothills. Water is captured during the winter rainy season and released in the spring at managed rates to allow for percolation through the stream bed to groundwater aquifers and to protect fish habitat downstream of the reservoirs. To varying degrees, portions of all watersheds within the urban zone have been engineered or placed within underground culverts. The Sunnyvale East and West Channel watersheds contain no natural creek bed at all, as they were constructed in the 1960s strictly for flood control purposes.

Table 1.3. Characteristics of major watersheds within SCVURPPP boundary.

Watershed	Area (miles^2)	# of Tributary Creeks	Natural Creek Bed (Miles)	Engineered Channel (Miles)	Underground Culvert or Stormdrain (Miles)	Impervious Area	Land Use				
							Residential	Industrial/ Commercial	Forest	Rangeland	Other
Adobe	11.0	7	18.8	2.3	12.0	45%	47%	12%	36%	3%	3%
Barron	15.6	5	15.1	7.9	28.6	60%	61%	20%	7%	7%	5%
Calabazas	20.3	6	12.9	14.1	55.5	NA	55%	29%	9%	5%	2%
Coyote	321	53	670	36.4	146	11%	9%	4%	50%	30%	8%
Guadalupe	171	50	207	45.5	265	37%	30%	14%	35%	16%	7%
Lower Penitencia	28.6	13	29.2	20.8	61.6	43%	31%	19%	1%	39%	11%
Matadero	14.0	3	18	NA	NA	60%	57%	6%	9%	8%	20%
Permanente	17.3	7	NA	NA	NA	44%	46%	13%	35%	3%	3%
San Francisquito	42.8	25	90.6	4.8	15.3	21%	30%	5%	45%	15%	6%
San Tomas Aquino	44.8	15	50.5	15.5	79.3	60%	54%	19%	24%	1%	3%
Stevens	29.2	12	54.2	1.1	30.0	29%	25%	9%	49%	13%	5%
Sunnyvale East	7.1	0	0	6.2	26.6	82%	65%	32%	0%	0%	3%
Sunnyvale West	7.6	0	0	6.7	18.7	72%	21%	65%	0%	0%	14%
Totals	**730.3**	**196**	**1166.3**	**161.3**	**738.6**	**27%**	**25%**	**10%**	**38%**	**20%**	**7%**

Source: http://www.scvurppp-w2k.com/watersheds.shtml
NA – not available

1.4.2 WY 2019 Creek Status and Pesticides & Toxicity Monitoring Stations

The complete list of probabilistic and targeted monitoring sites sampled by SCVURPPP in WY 2019 in compliance with provisions C.8.d (Creek Status Monitoring) and C.8.g (Pesticides and Toxicity Monitoring) is presented in Table 1.4. Station ID's for probabilistic sites, generated from the RMC Sample Frame, and station ID's for targeted sites, based on SWAMP station numbering methods (BASMAA 2016a), are provided. Monitoring locations from WY 2019 with monitoring parameter(s) are illustrated in Figure 1.2. Monitoring locations from WY 2014 through WY 2018 are illlustrated in the various parameter-specific sections of this report.

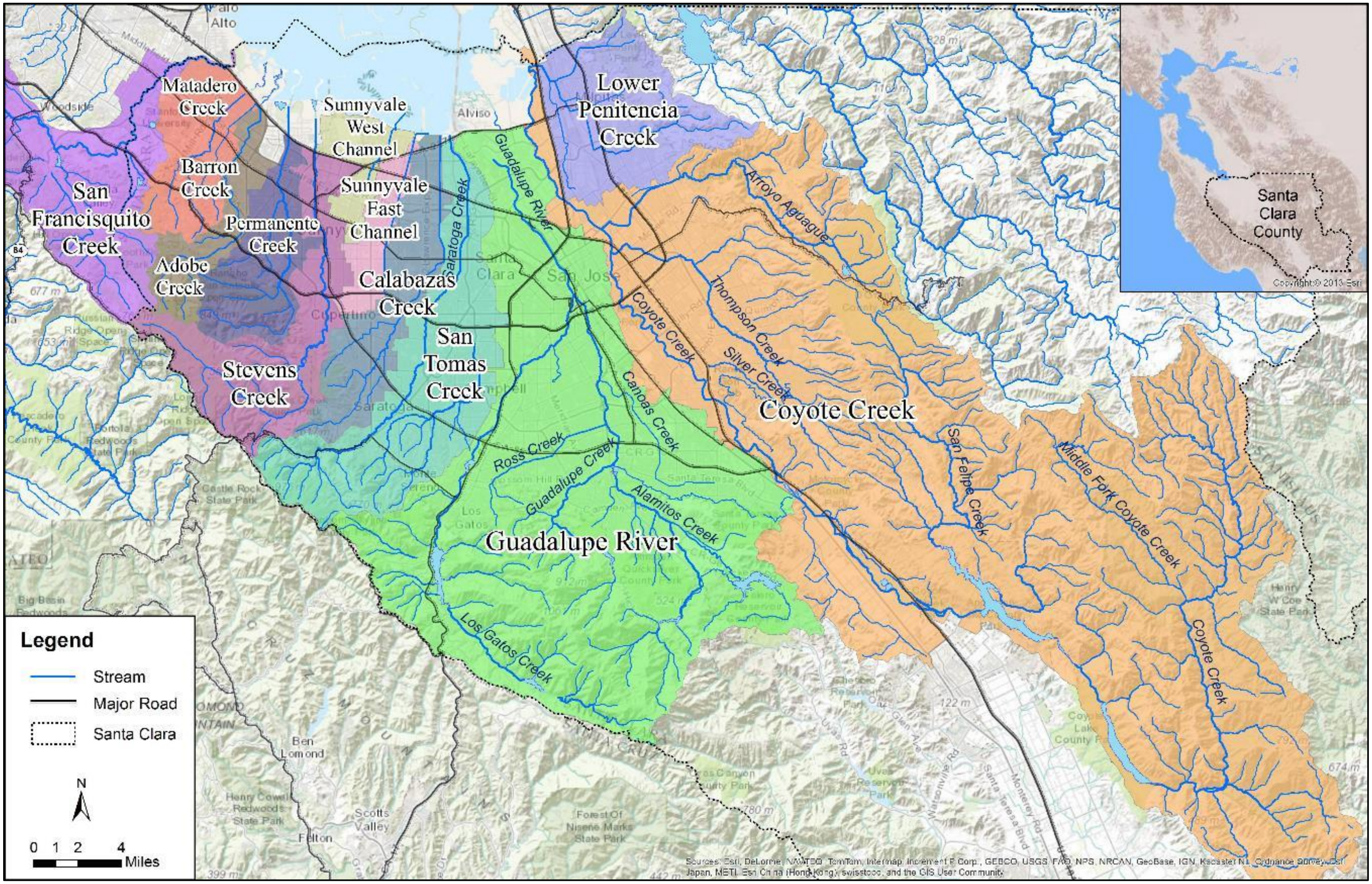

Figure 1.1. Watersheds within SCVURPPP jurisdictional boundaries.

Table 1.4. Sites and parameters monitored in WY 2019 in Santa Clara County.

Map ID [1]	Station ID	Watershed	Creek Name	Land Use	Latitude	Longitude	Probabilistic	Targeted				
							Bioassessment, Nutrients, General WQ	Chlorine	Pesticides & Toxicity	Temp [2]	Cont WQ [3]	Pathogen Indicators
60	205GUA060	Guadalupe River	Los Gatos Creek	U	37.29092	-121.93516	X	X				
251	205GUA251	Guadalupe River	Alamitos Creek	U	37.23306	-121.87054	X	X				
4378	205R04378	Guadalupe River	Los Gatos Creek	U	37.21641	121.98787	X	X				
4395	205R04395	Lower Penitencia Cr	Arroyo de los Coches	U	37.27497	-122.74731	X	X				
4418	205R04418	Coyote Creek	Thompson Creek	U	37.29241	-121.76800	X	X				
4530	205R04530	Coyote Creek	Upper Silver Creek	U	37.29709	-121.79408	X	X				
4537	205R04537	Coyote Creek	Thompson Creek	U	37.274966	-121.74731	X	X				
4591	205R04591	San Tomas Aquino	San Tomas Aquino	U	37.39046	-121.96851	X	X				
4602	205R04602	San Tomas Aquino	Wildcat Creek	U	37.26485	-122.01930	X	X				
4614	205R04614	San Tomas Aquino	San Tomas Aquino	U	37.27361	-121.98240	X	X				
4638	205R04638	Guadalupe River	Guadalupe Creek	U	37.228257	-121.90358	X	X				
4670	205R04670	San Thomas Aquino	Saratoga Creek	U	37.25077	-122.05510	X	X				
455	205COY455	Coyote Creek	Coyote Creek	U	37.166314	-121.64775	X	X				
4274	205R04247	Stevens Creek	Stevens Creek	U	37.325439	-122.06068	X	X				
4271	205R04271	Stevens Creek	Stevens Creek	NU	37.3051	-122.15480	X	X				
4317	205R04317	Coyote Creek	Coyote Creek	U	37.16628	-121.63747	X	X				
4359	205R04359	Adobe Creek	Adobe Creek	U	37.42889	-122.10522	X	X				
4383	205R04383	San Francisquito Cr	San Francisquito Cr	U	37.45462	-122.16078	X	X				
4479	205R04479	San Tomas Aquino	Saratoga Creek	U	37.35448	-121.97338	X	X				
70	205STE070	Stevens Creek	Stevens Creek	U	37.30275	-122.07486	X	X				
033	205LGA033	Guadalupe River	Los Gatos Creek	U	37.29516	-121.93337						X
400	205LGA400	Guadalupe River	Los Gatos Creek	U	37.23869	-121.97088						X
450	205LGA420	Guadalupe River	Los Gatos Creek	U	37.22024	-121.98303						X
330	205COY330	Coyote Creek	Coyote Creek	U	37.29027	-121.81831						X
392	205COY392	Coyote Creek	Coyote Creek	U	37.23504	-121.76105						X
190	205GUA190	Guadalupe River	Guadalupe Creek	U	37.24373	-121.87561				X		
202	205GUA202	Guadalupe River	Guadalupe Creek	U	37.23291	-121.89795				X		
210	205GUA210	Guadalupe River	Guadalupe Creek	U	37.21746	-121.91039				X		
218	205GUA218	Guadalupe River	Guadalupe Creek	U	37.2028	-121.88845				X		
250	205GUA250	Guadalupe River	Alamitos Creek	U	37.23363	-121.87058				X		
255	205GUA255	Guadalupe River	Alamitos Creek	U	37.22607	-121.85842				X		
262	205GUA262	Guadalupe River	Alamitos Creek	U	37.22041	-121.84516				X		
270	205GUA270	Guadalupe River	Alamitos Creek	U	37.20129	-121.82891				X		

Map ID [1]	Station ID	Watershed	Creek Name	Land Use	Latitude	Longitude	Probabilistic	Targeted				
							Bioassessment, Nutrients, General WQ	Chlorine	Pesticides & Toxicity	Temp [2]	Cont WQ [3]	Pathogen Indicators
279	205GUA279	Guadalupe River	Alamitos Creek	U	37.17409	-121.82409				X		
235	205COY235	Coyote Creek	Coyote Creek	U	37.3536	-121.87417					X	
236	205COY236	Coyote Creek	Coyote Creek	U	37.35098	-121.87378					X	
239	205COY239	Coyote Creek	Coyote Creek	U	37.33722	-121.86953					X	
021	205STE021	San Tomas Aquino	Stevens Creek	U	37.40982	-122.06905			X			
010	205STQ010	San Tomas Aquino	San Tomas Aquino	U	37.38863	-121.96853			X			

U = urban, NU = non-urban

[1] Map ID applies to Figure 1.2.

[2] Temperature monitoring was conducted continuously (i.e., hourly) April through September.

[3] Continuous water quality monitoring (temperature, dissolved oxygen, pH, specific conductivity) was conducted during two 2-week periods (spring and late summer).

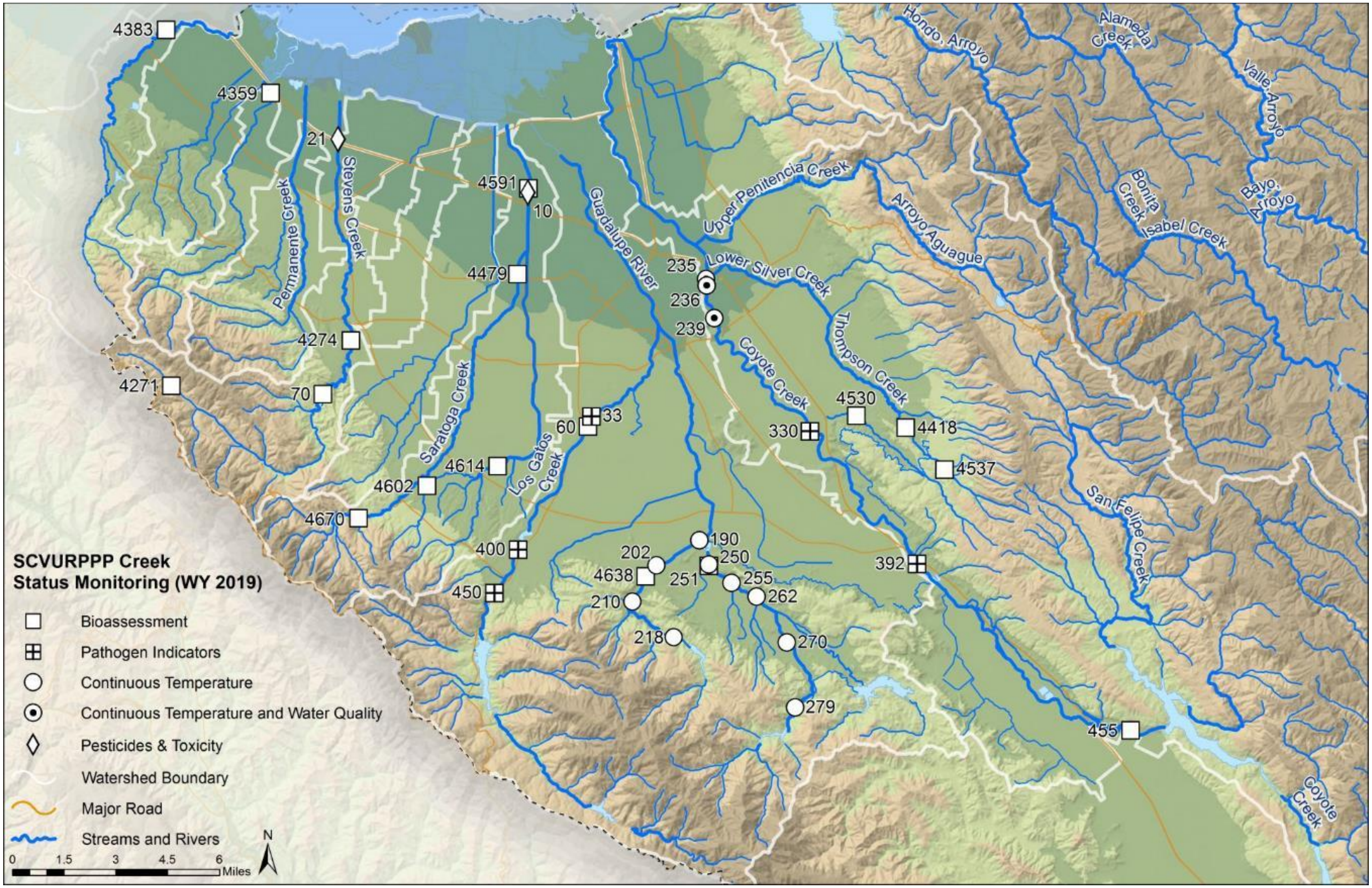

Figure 1.2. Map of SCVURPPP Program Area, major creeks, and sites monitored in WY 2019.

1.4.3 Designated Beneficial Uses

Beneficial Uses in Santa Clara Valley creeks are designated by the SFBRWQCB for specific water bodies and serve as the basis for establishing applicable WQOs designed to protect those uses (SFBRWQCB 2017). All creeks in the Santa Clara Basin are designated as having warm freshwater habitat (WARM) Beneficial Uses. Most creeks, with the exception of Lower Silver Creek, Lower Penitencia Creek, and a few small tributaries, are designated as having cold freshwater habitat (COLD) Beneficial Uses in the Santa Clara Basin, meaning that they either historically or currently a belived to support trout, anadromous salmon, and/or steelhead fisheries. Dissolved oxygen WQOs are more stringent in creeks with COLD Beneficial Uses because these species are relatively intolerant to environmental stresses. Virtually all creeks in the region are designated as having water contact recreation (REC-1) Beneficial Uses such as swimming and wading where ingestion of water is considered reasonably possible. Fecal indicator bacteria WQOs are identified to protect REC-1 Beneficial Uses. Los Gatos Creek is designated as having municipal and domestic supply (MUN) Beneficial Uses. The Basin Plan identifies WQOs for several constituents of concern that apply only to waters with MUN Beneficial Uses.

1.4.4 Climate

The Santa Clara Valley experiences a Mediterranean-type climate with cool, wet winters and hot, dry summers. The area is characterized by microclimates created by topography, ocean currents, fog exposure, and onshore winds. The wet season typically extends from October through April with local long-term, mean annual precipitation ranging from 15 inches near the Bay to over 55 inches along the highest ridges in the Santa Cruz Mountains (PRISM Climate Group 30-year normals, 1981-2010[8]). Figure 1.3 illustrates the geographic variability of mean annual precipitation in the area. It is important to understand that mean annual precipitation depths are statistically calculated or modeled; actual measured precipitation in a given year rarely equals the statistical average. Figure 1.4 illustrates the temporal variability in annual precipitation measured at the Mineta San José International Airport from WY 1946 to WY 2018. Creek Status Monitoring in compliance with the MRP began in WY 2012 which was the first year of a severe statewide drought that persisted through WY 2016. In WY 2018, rainfall was below average but was preceded by a relatively wet year in WY 2017.

The overall Bay Area climate and the specific conditions within any given year are influenced by global climate change. The Climate Change Assessment report for the Bay Area highlights several impacts of climate change that are already being felt: the Bay Area's average annual maximum temperature increased by nearly 1°C from 1950 – 2005, coastal fog along the coast may be less frequent, sea level in the Bay Area has risen over 8 inches (Ackerly et al. 2018). These changes are projected to increase significantly in the coming decades. As a consequence, heat extremes, high year-to-year variability in precipitation, droughts, intense storms, and other events are also predcted to increase.

Climate patterns (e.g., extended droughts) and individual weather events (e.g., extreme storms, hot summers) influence biological communities (i.e., vegetation, wildlife) and their surrounding physical habitat and water quality. They should therefore be considered when evaluating the type of data collected by the Creek Status Monitoring Program. For example, periods of drought (rather than individual dry years) can result in changes in riparian and upland vegetation communities. Long drought periods are associated with increased streambed sedimentation which can persist directly or indirectly for many years, depending on the occurrence and

[8] http://www.prism.oregonstate.edu/normals/

magnitude of flushing flow events. Furthermore, in response to prolonged drought, the relative proportion of pool habitat can increase at the expense of riffle habitat. In addition, during severe droughts, water management agencies (such as the SCVWD) may also decrease the magnitude and duration of reservoir releases.

It is currently uncertain what effect these climatic factors have on biological indices that are calculated using data collected by the Creek Status Monitoring Program, such as benthic macroinvertebrates or algae. A study evaluating 20 years of bioassessment data collected in northern California showed that, although benthic macroinvertebrate taxa with certain traits may be affected by dry (and wet) years and/or warm (and cool) years, indices based on these organisms appear to be resilient (Mazor et al. 2009, Lawrence et al. 2010). However, this study did not specifically examine the impact of *longer periods* of extended drought or heat on biological indices, which would require analysis of a dataset with a much longer period of record. The Herbst Lab at the Sierra Nevada Aquatic Research Laboratory, University of California Santa Barbara recently completed a study exploring how flooding and droughts vary taxa metrics in the Sierra Nevada streams. While species diversity and density remained relatively unchanged during flooding, extreme dry weather conditions significantly impacted benthic macroinvertebrate population structure. These differences were exacerbated with continued exposure to drought (Herbst et al. 2019). Similar changes to the benthic macroinvertebrate community in Santa Clara County streams may have occurred during the WY 2012 – WY 2016 drought, but have not been evaluated.

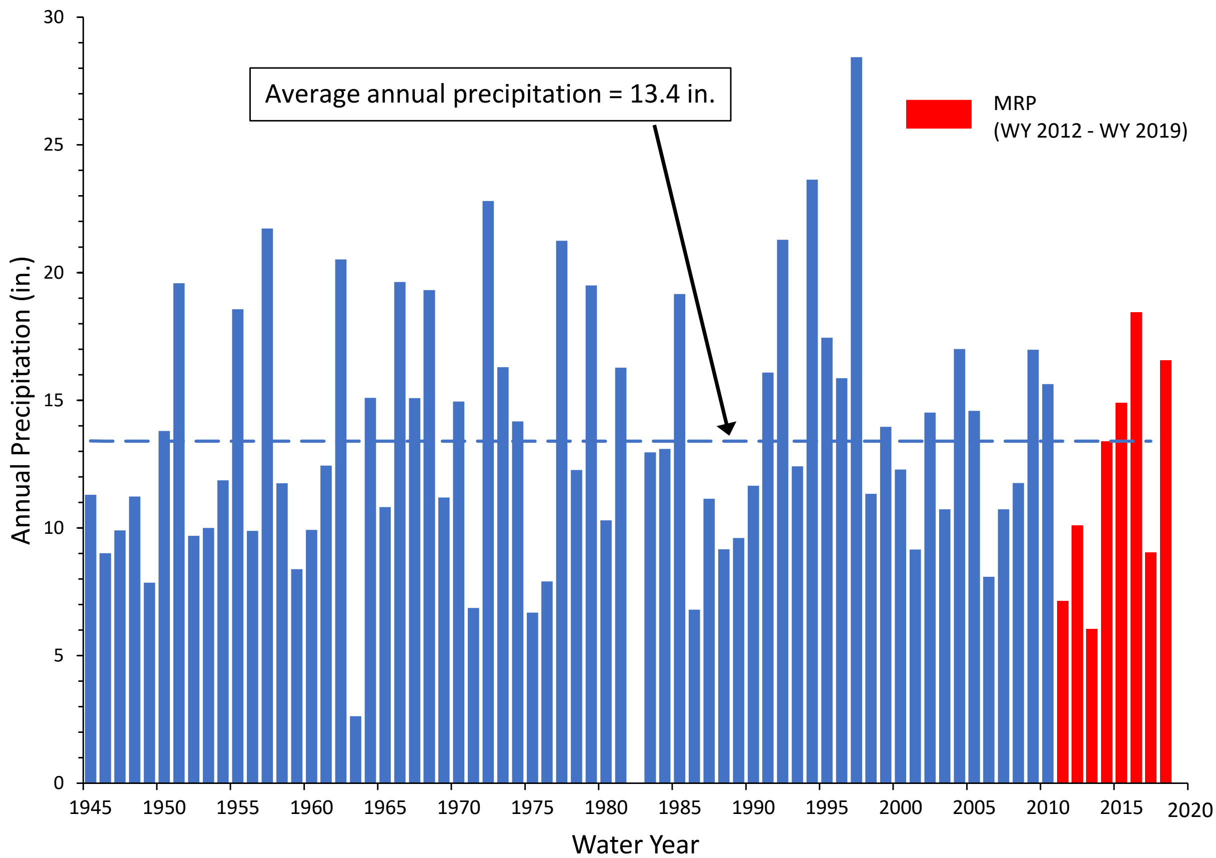

Figure 1.4. Annual rainfall recorded at the San José Airport, WY 1946 – WY 2018.

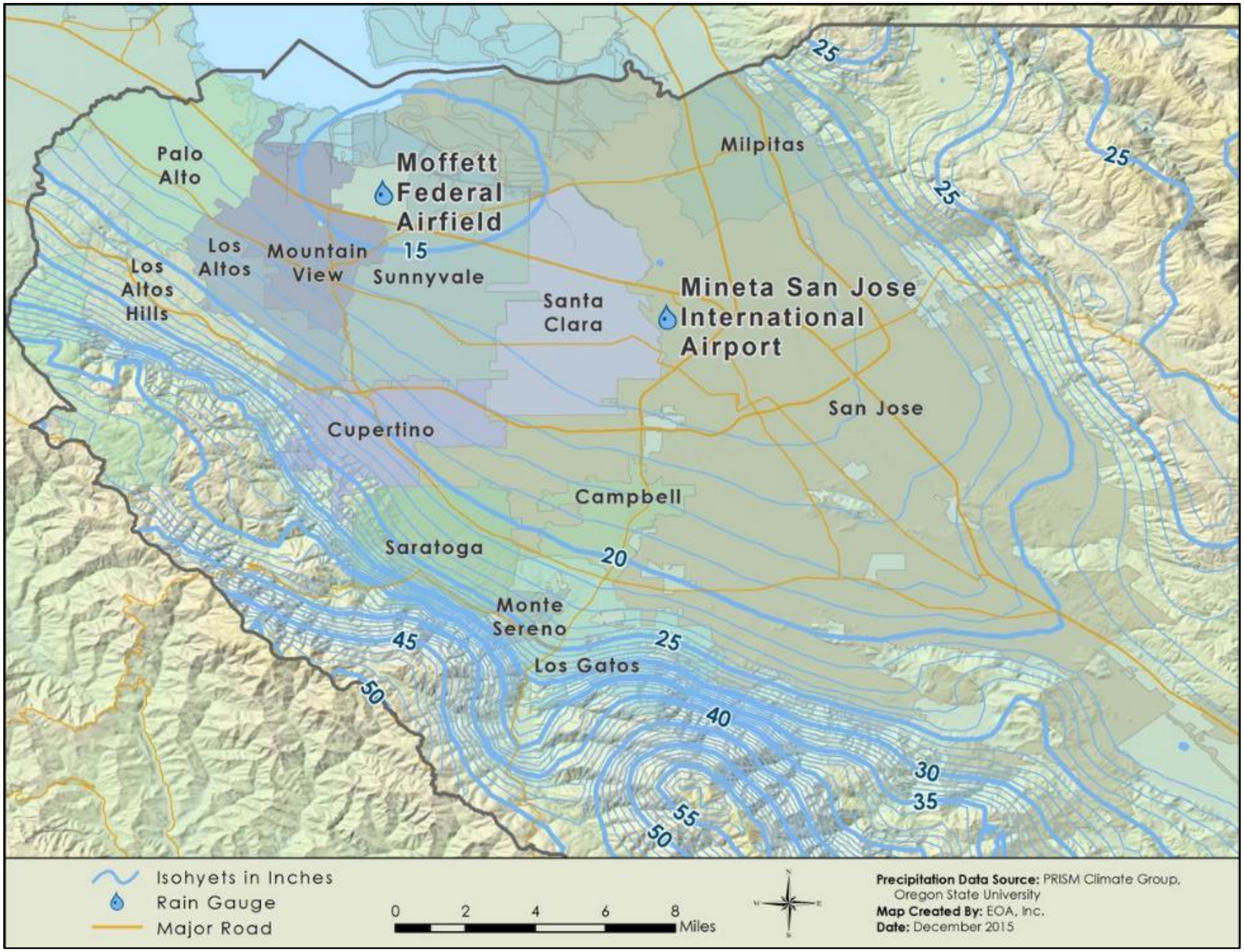

Figure 1.3. Average annual precipitation in Santa Clara Valley, as modeled by the PRISM Climate Group for the period of 1981-2010.

1.5 Statement of Data Quality

A comprehensive Quality Assurance/Quality Control (QA/QC) program was implemented by SCVURPPP covering all aspects of the probabilistic and targeted monitoring. In general, QA/QC procedures were implemented as specified in the BASMAA RMC QAPP (BASMAA, 2016a), which was adapted from the methods detailed by the SWAMP QAPrP[9]. The QAPP was revised twice – once in 2014 and again in 2016 – to conform to changes in the MRP reissuance and changes made to the SWAMP QAPrP. Changes made were minor, and overall methods and protocols remain similar. Each year's monitoring data were compared against objectives in the governing QAPP. Monitoring was performed according to protocols specified in the BASMAA RMC SOPs (BASMAA 2016b), which were also revised with the QAPP.

Overall, the results of the QA/QC reviews suggest that the Creek Status Monitoring data generated during WY 2012 through WY 2019 were of sufficient quality, in comparison to objectives outlined in the QAPP. However, some data were flagged in accordance with quality assurance/quality control protocols, and the following data collected during these Water Years were rejected:

- All of the continuous pH data collected at station 205COY235 during the June 2019 deployment, some of the continuous pH data collected at this site during the September 2019 deployment.
- All continuous pH data collected at site 205COY236 during May/June 2018
- Oxygen field measurements collected at sites 205R02947, 205R02693, 205R03386, 205R00570 in WY 2017.
- Some of the continuous dissolved oxygen data collected at site 205COY114 during April 2016.

A detailed QA/QC report for WY 2019 data is included as Attachment 1. Detailed QA/QC reports for past data are included with their respective water year reports.

[9] The current SWAMP QAPrP is available at:
http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/qapp/swamp_qapp_master090108a.pdf

2.0 BIOLOGICAL CONDITION ASSESSMENT

2.1 Introduction

The Program has conducted bioassessment monitoring since WY 2012 in compliance with Creek Status Monitoring provisions C.8.c of MRP 1.0 and C.8.d.i of MRP 2.0. Nearly all bioassessment monitoring has been performed at sites selected randomly using the probabilistic monitoring design. The probabilistic monitoring design allows each individual RMC participating program to objectively assess overall stream ecosystem conditions within its program area (e.g., County boundary) while contributing data to answer regional management questions about water quality and Beneficial Use condition in San Francisco Bay Area creeks. The survey design provides an unbiased framework for condition assessment of ambient aquatic life uses within known estimates of precision. The monitoring design was developed to address management questions for RMC participating counties and the overall RMC area:

1. *What is the condition of aquatic life in creeks in the RMC area; are water quality objectives met and are Beneficial Uses supported?*
    - i. *What is the condition of aquatic life in the urbanized portion of the RMC area; are water quality objectives met and are Beneficial Uses supported?*
    - ii. *What is the condition of aquatic life in RMC participant counties; are water quality objectives met and are Beneficial Uses supported?*
    - iii. *To what extent does the condition of aquatic life in urban and non-urban creeks differ in the RMC area?*
    - iv. *To what extent does the condition of aquatic life in urban and non-urban creeks differ in each of the RMC participating counties?*
2. *What are major stressors to aquatic life in the RMC area?*
    - i. *What are major stressors to aquatic life in the urbanized portion of the RMC area?*
3. *What are the long-term trends in water quality in creeks over time?*

The first question (i.e., *What is the condition of aquatic life in creeks in the RMC area?*) is addressed by assessing indicators of aquatic biological health at probabilistic sampling locations. Once a sufficient number of samples have been collected, ambient biological condition can be estimated for streams at a regional (or countywide) scale. Over the past eight years (WY 2012 through WY 2019), SCVURPPP and Regional Water Board have sampled 168 probabilistic sites in the Santa Clara Valley, providing a sufficient sample size to estimate ambient biological condition for both urban and non-urban streams.[10] There is still an insufficient number of samples to accurately assess the biological condition for many watersheds and smaller jurisdictional areas (i.e., cities).

The second question (i.e., *What are major stressors to aquatic life in the RMC area?*) is addressed by evaluation of physical habitat and water chemistry data collected at the probabilistic sites, as potential stressors to biological health. The stressor levels can be compared to biological indicator data through correlation and random forest models. Assessing

[10] For each of the strata, it is necessary to obtain a sample size of at least 30 in order to evaluate the condition of aquatic life within known estimates of precision. This estimate is defined by a power curve from a binomial distribution (BASMAA 2012).

the extent and relative importance of stressors in predicting biological condition can help prioritize stressors at a regional scale and inform local management decisions.

The third question (i.e., *What are the long-term trends in water quality in creeks over time?*) is addressed by assessing the change in biological condition over several years. Changes in biological condition over time can help evaluate the effectiveness of management actions. Although, long-term trend analysis for the RMC probabilistic survey will require more than eight years of data collection, preliminary trend analysis of biological condition may be possible for some stream reaches using a combination of historical targeted data with the probabilistic data.

MRP 2.0 allows for up to 20% of bioassessment surveys at targeted sites to address other types of management questions, provided a statistically representative dataset (i.e., 30 samples) has already been collected. In WY 2019, SCVURPPP conducted bioassessment surveys at four targeted sites. All four sites were located in creek reaches where in-stream habitat improvement projects were recently completed or planned by Valley Water.

This section of the report presents bioassessment results from WY 2019, as well as a comprehensive evaluation of the probabilistic bioassessment data collected in the Santa Clara Valley from WY 2012 through WY 2019. In addition, in compliance with Provision C.8.d.i.(8) of MRP 2.0, WY 2019 data are compared to triggers and water quality objectives identified in the MRP. Sites with results exceeding trigger thresholds are added to the list of candidate SSID projects.

2.2 Methods

2.2.1 Probabilistic Survey Design

The RMC probabilistic design was created using the Generalized Random Tessellation Stratified (GRTS) approach developed by the United States Environmental Protection Agency (USEPA) and Oregon State University (Stevens and Olsen 2004). GRTS offers multiple benefits for coordinating among monitoring entities, including the ability to develop a spatially balanced design that produces statistically representative data with known confidence intervals. The GRTS approach has been implemented in California by several agencies including the statewide Perennial Streams Assessment (PSA) conducted by Surface Water Ambient Monitoring Program (Ode et al. 2011) and the Southern California Stormwater Monitoring Coalition's (SMC) regional monitoring program conducted by municipal stormwater programs in Southern California (SCCWRP 2007).

Sample sites were selected using the GRTS approach from a sample frame consisting of a creek network geographic information system (GIS) data set within the 3,407-square mile RMC area (BASMAA 2012). The sample frame includes non-tidally influenced perennial and non-perennial creeks within five management units representing areas managed by the stormwater programs associated with the RMC (listed in Table 1.1). There is approximately one site for every stream kilometer in the sample frame. The National Hydrography Plus Dataset (1:100,000) was selected as the creek network data layer to provide consistency with both the Statewide PSA and the SMC, and the opportunity for data coordination with these programs.

Once the master draw was performed, the list of sites was classified by county and land use (i.e., urban and non-urban) to allow for comparisons between these strata. Urban areas were delineated by combining urban area boundaries and city boundaries defined by the U.S. Census (2000). Non-urban areas were defined as the remainder of the RMC area. Some sites classified as urban fall near the non-urban edge of the city boundaries and have little upstream development. For the purposes of consistency, these urban sites were not re-classified. Therefore, data values within the urban classification represent a wide range of conditions.

The RMC participants decided to partition their annual sampling efforts so that approximately 80% are in urban areas and 20% in non-urban areas. In addition, between WY 2012 and WY 2015, the SFRWQCB SWAMP conducted 34 bioassessments throughout the RMC region at non-urban sites selected from the sample frame, including 12 sites in Santa Clara County.[11]

2.2.2 Site Evaluations

Sites identified in the regional sample draw are evaluated by each RMC participant in chronological order using the process described in RMC Standard Operating Procedure FS-12 (BASMAA 2016a) which is consistent with the procedure described by Southern California Coastal Water Research Project (SCCWRP 2012). Each site is evaluated to determine if it meets RMC sampling location criteria (e.g., not tidally influenced, sufficient flow, safe accessibility, landowner permission to access site). Site evaluation information is stored in a database and analyzed to determine the statistical significance of average ambient conditions calculated from the multi-year dataset.

2.2.3 Field Sampling Methods

Bioassessment survey methods were consistent with the BASMAA RMC QAPP (BASMAA 2016b) and SOPs (BASMAA 2016a). In accordance with the RMC QAPP (BASMAA 2016b) bioassessments were planned during the spring index period (approximately April 15 – July 15) with the goal to sample a minimum of 30 days after any significant storm (defined as at least 0.5-inch of rainfall within a 24-hour period). The 30-day grace period allows diatom and soft algae communities to recover from peak flows that may scour benthic algae from the bottom of the stream channel.[12]

Over the eight-year monitoring period, one or two small but significant storms (i.e., 0.5 inches in 24-hour period) typically occurred during the first two weeks of April. Generally, bioassessment sampling was conducted 20-30 days following the storm event to allow recovery time for the algal community. However, due to drought or below average rainfall conditions that characterized the WY 2012 – WY 2016 period, bioassessments at selected sites (i.e., small streams less impacted by storm) were conducted approximately 10 days after the significant storm event to ensure that flow would still be present. During WY 2019, a significant storm occurred late in the season (May 20, 2019). Bioassessment sampling was paused until June 3, 2019 (approximately two weeks after the storm). All algae data collected prior to the 30-day grace period were flagged.

Each bioassessment sampling site consisted of an approximately 150-meter stream reach that was divided into 11 equidistant transects placed perpendicular to the direction of flow. Benthic macroinvertebrate (BMI) and algae samples were collected at 11 evenly spaced transects using the Reachwide Benthos (RWB) method described in the SWAMP SOP (Ode et al. 2016). The most recent SWAMP SOP (i.e., Ode et al. 2016) combines the BMI and algae methods

[11] As of WY 2016, the SFRWQCB SWAMP is no longer conducting RMC-related bioassessment monitoring at probabilistic sites.

[12] The BASMAA 30-day grace period is more conservative than the 21-day grace period described in the SWAMP SOP (Ode et al. 2016).

referenced in the MRP (Ode 2007, Fetscher et al. 2009), provides additional guidance, and adds two new physical habitat analytes (assess scour and engineered channels). The full suite of physical habitat data was collected within the sample reach using methods described in Ode et al. (2016).

Immediately prior to biological and physical habitat data collection, water samples were collected for nutrients, conventional analytes, ash free dry mass, and chlorophyll a analysis using the Standard Grab Sample Collection Method as described in SOP FS-2 (BASMAA 2016a). Water samples were also collected and analyzed in the field for free chlorine and total chlorine residual using a Pocket Colorimeter™ II and DPD Powder Pillows according to SOP FS-3 (BASMAA 2016a) (see Section 5.0 for chlorine monitoring results). In addition, general water quality parameters (dissolved oxygen, pH, specific conductance and temperature) were measured at or near the centroid of the stream flow using a pre-calibrated multi-parameter probe.

Biological and water samples were sent to laboratories for analysis. The laboratory analytical methods used for BMIs followed Woodard et al. (2012), using the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) Level 1 Standard Taxonomic Level of Effort, with the additional effort of identifying chironomids (midges) to subfamily/tribe instead of family (Chironomidae). Soft algae and diatom samples were analyzed following SWAMP protocols (Stancheva et al. 2015). The taxonomic resolution for all data was compared SWAMP master taxonomic list. All BMI and algal taxa identified in samples collected over the eight-year monitoring period were consistent with the taxa listed on the SWAMP Master List, which was then included in the data submittal each year.

2.2.4 Data Analysis

Biological condition indicator and stressor data for all bioassessment sites surveyed in WY 2012 – WY 2019 were compiled into a master spreadsheet for data analyses. The master spreadsheet is included with this report as Attachment 2. BMI and algae data were analyzed to assess the biological condition (i.e., aquatic life Beneficial Uses) of the sampled reaches using condition index scores. Physical habitat data were used to assess biological condition and were evaluated as potential stressors. Water chemistry data were evaluated as potential stressors to biological health using triggers and water quality objectives identified in the MRP (see Stressor Variable section below). Data analysis methods for biological indicators and stressors are described below.

2.2.4.1 Biological Indicators

<u>Benthic Macroinvertebrates</u>

Benthic (i.e., bottom-dwelling) macroinvertebrates are organisms that live on, under, and around the rocks and sediment in the stream bed. Examples include dragonfly and stonefly larvae, snails, worms, and beetles (Figure 2.1). Each BMI species has a unique response to water chemistry and physical habitat condition. Some are relatively sensitive to poor habitat and pollution; others are more tolerant. Therefore, the abundance and variety of BMIs in a stream indicates the biological condition of the stream.

The California Stream Condition Index (CSCI) is an assessment tool that was developed by the State Water Resources Control Board (State Water Board) to support the development of

California's statewide Biological Integrity Plan[13]. The CSCI translates benthic macroinvertebrate data into an overall measure of stream health. The CSCI was developed using a large reference data set that represents the full range of natural conditions in California and site-specific models for predicting biological communities. The CSCI combines two types of indices: 1) taxonomic completeness, as measured by the ratio of observed-to-expected taxa (O/E); and 2) ecological structure and function, measured as a predictive multimetric index (pMMI) that is based on reference conditions. The CSCI score is computed as the average of the sum of the O/E and pMMI.

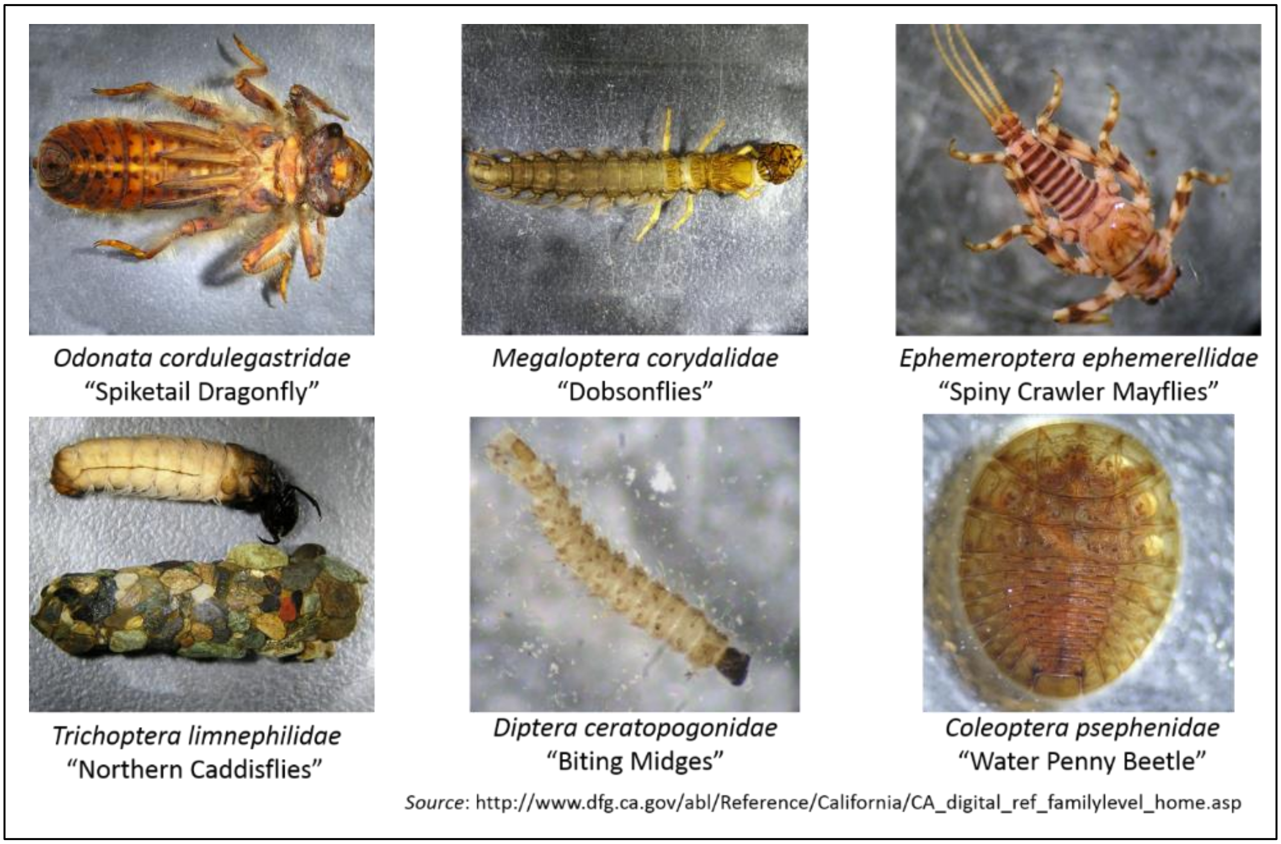

Figure 2.1. Examples of benthic macroinvertebrates.

CSCI scores for each station are calculated using a combination of biological and environmental data following methods described in Rehn et al. (2015). Biological data consist of the BMI data collected and analyzed using the protocols described in the previous section. Environmental predictor data are generated in GIS using drainage areas upstream of each BMI sampling location. The environmental predictors and BMI data were formatted into comma delimited files and used as input for the RStudio statistical package and the necessary CSCI program scripts, developed by Southern California Coastal Water Research Project (SCCWRP) staff (Mazor et al. 2016).

[13] The Biological Integrity Assessment Implementation Plan has been combined with the Biostimulatory Substances Amendment project. The State Water Board is proposing to adopt a statewide water quality objective for biostimulatory substances (e.g., nitrate) along with a program of implementation. A draft policy document for public review is anticipated in late 2019.

The State Water Board is continuing to evaluate the performance of CSCI in a regulatory context. In Provision C.8.d of MRP 2.0, the Regional Water Board defines a CSCI score of 0.795 as a trigger threshold for identifying sites with potentially degraded biological condition that may be considered as candidates for a Stressor/Source Identification project.

Benthic Algae

Similar to BMI's, the abundance and type of benthic algae species living on a streambed can indicate stream health. When evaluated with the CSCI, biological indices based on benthic algae can provide a more complete picture of the stream's biological condition because algae respond more directly to nutrients and water chemistry. In contrast, BMIs are more responsive to physical habitat. Figure 2.2 shows examples of benthic algae common in Bay Area streams.

The State Water Board and SCCWRP recently developed the draft Algae Stream Condition Index (ASCI) which uses benthic algae data as a measure of biological condition for streams in California (Theroux et al. *in prep.).* The ASCI includes both predictive[14] and non-predictive multimetric indices (MMI) used to evaluate ecological conditions. There are three versions of the ASCI MMI: an index for diatoms, one for soft-bodied algae and a hybrid index using both assemblages. Using a statewide data set, all three indices were evaluated by the State Water Board for precision, accuracy, responsiveness, and regional bias The hybrid ASCI was found to be the most sensitive to anthropogenic stressor gradients, emphasizing the value of combining multiple algal assemblages (diatoms and soft bodied algae) to provide a more comprehensive assessment of biological condition (Theroux et al. in prep).

Additional study is needed to determine the best approach to apply the ASCI tools to evaluate bioassessment data. For example, it is not clear if the ASCI should be used as a second line of evidence to understand CSCI scoring results, or if it would be more effective as an independent indicator to evaluate different types of stressors (e.g., nutrients) to which BMIs are not very responsive. The ASCI is currently under review by the Biostimulatory-Biointegrity Policy Science Advisory Panel and the State Water Board.

The algae data collected at 172 sites in Santa Clara Valley creeks/channels during WYs 2012 to 2019 were evaluated using the three ASCI MMIs (diatom, soft algae and hybrid). ASCI scores were generated using the beta version reporting module developed by SCCWRP. These ASCI scores should be considered provisional until the ASCI has been fully evaluated and finalized.

[14] Predictive indices utilize environmental variables that characterize immutable natural gradients as predictors for biological conditions. A predictive algal O/E model was developed and tested, but ultimately not recommended due to low precision and accuracy. Predictive metrics were used for both diatom and hybrid MMIs, but the soft body algae MMI did not incorporate predictive metrics.

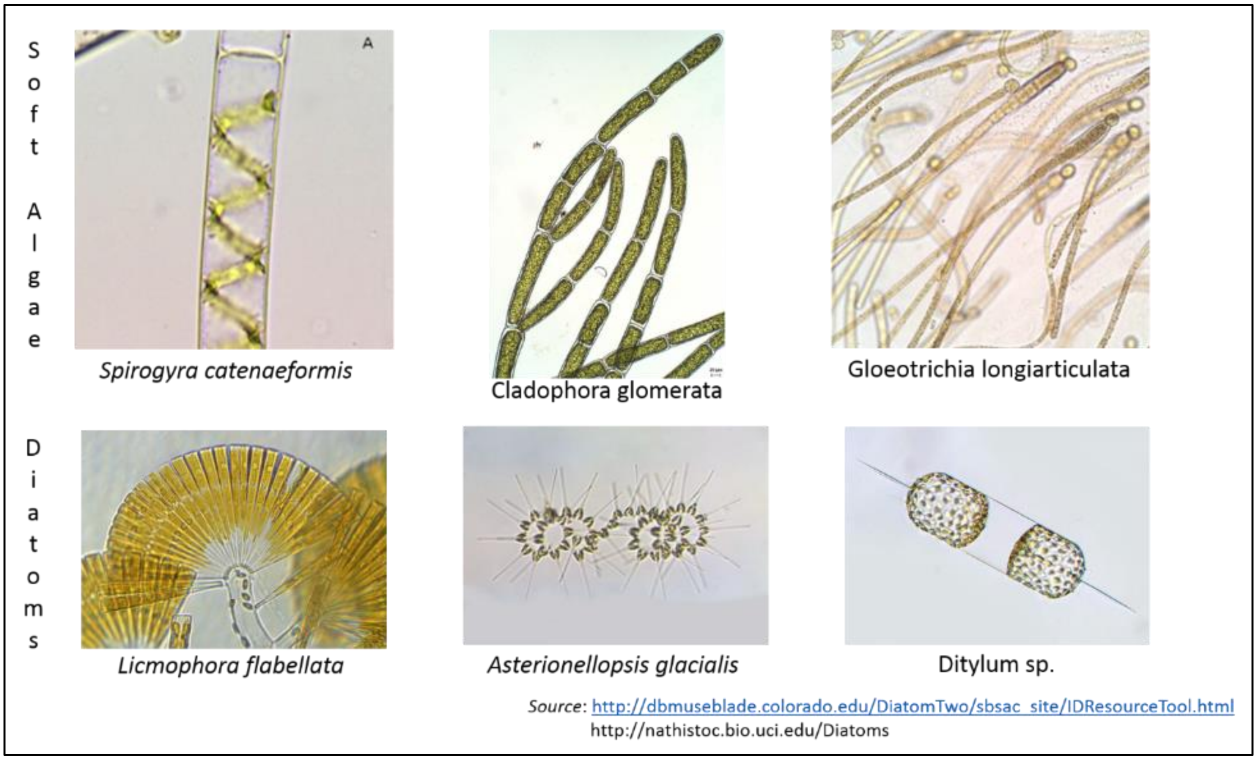

Figure 2.2. Examples of soft algae and diatoms.

2.2.4.2 Physical Habitat Indicators

The condition of physical habitat is a major contributor to stream ecosystem health. Physical habitat components such as streambed substrate, channel morphology, microhabitat complexity, in-stream cover-type complexity, and riparian vegetation cover contribute to the overall physical and biological integrity of a stream. The physical characteristics of a stream reach are affected by both natural factors (e.g., climate, slope, geology) and human disturbance (e.g., channelization, development, stream crossings, hydromodification).

Physical habitat conditions are generally evaluated using endpoint variables, or metrics, which are calculated using reach-scale averages of transect-based measurements and observations. The State Water Board has developed a SWAMP Bioassessment Reporting Module (SWAMP RM), a custom Microsoft Access™ application, that produces approximately 170 different metrics that are based on physical habitat measurements collected using both USEPA's Environmental Monitoring and Assessment Program (EMAP) for freshwater wadeable streams (Kaufmann et al. 1999) and the SWAMP "Full" habitat protocol (Ode 2007) that was implemented by SCVURPPP at bioassessment stations. The metrics are classified into five thematic groups representing different physical attributes: substrate, riparian vegetation (including structure and shading), flow habitat variability, in-channel cover, and channel morphology.

The State Water Board recently developed the Index of Physical Habitat Integrity (IPI) as an overall measure of physical habitat condition. Similar to the CSCI, the IPI is calculated using a combination of physical habitat data collected in the field and environmental data generated in GIS following the methods described in Rehn et al. (2018). The IPI is based on five of the metrics generated by the SWAMP RM. The metrics were selected for their ability to discriminate between reference and stressed sites and provide unbiased representation of waterbodies across the different ecoregions of California. Scoring for these metrics were then calibrated using environmental variables that were associated with drainage areas for each sampling location.

2.2.4.3 Biological and Physical Habitat Condition Thresholds

Existing thresholds for CSCI scores (Mazor 2015) and ASCI scores (Theroux et al. in review) were used to evaluate the BMI and algae data collected in Santa Clara County and analyzed in this report (Table 2.1). Provisional thresholds for IPI scores (Rehn et al 2018) were used to evaluate physical habitat conditions. The thresholds for all three indices were based on the distribution of scores for data collected at reference calibration sites located throughout California. Four condition categories are defined by these thresholds: “likely intact” (greater than 30th percentile of reference site scores); “possibly intact” (between the 10th and the 30th percentiles); “likely altered” (between the 1st and 10th percentiles); and “very likely altered” (less than the 1st percentile).

Table 2.1. Condition categories used to evaluate CSCI, ASCI, and IPI scores.

Biological Indicator	Tool	Likely Intact	Possibly Intact	Likely Altered	Very Likely Altered
BMI	CSCI	≥ 0.92	≥ 0.79 to < 0.92	≥ 0.63 to < 0.79	< 0.63
Diatoms		≥ 0.92	≥ 0.81 to < 0.92	≥ 0.66 to < 0.81	< 0.66
Soft Algae	ASCI	≥ 0.92	≥ 0.80 to < 0.92	≥ 0.65 to < 0.80	< 0.65
Hybrid		≥ 0.95	≥ 0.88 to < 0.95	≥ 0.78 to < 0.88	< 0.78
Physical Habitat	IPI	≥ 0.94	≥ 0.84 to < 0.94	≥ 0.71 to < 0.83	< 0.70

A CSCI score below 0.795 is referenced in the MRP as a threshold indicating a potentially degraded biological community, and thus should be considered for a SSID Project. The MRP threshold is the division between the “possibly intact” and “likely altered” condition categories described in Mazor (2015). Further investigation is needed to evaluate the applicability of this threshold to sites in highly urban watersheds and/or modified channels that are frequent throughout the SCVURPPP study area.

2.2.4.4 Stressor Variables

Physical habitat, landscape characteristics, general water quality, and water chemistry data collected during the bioassessment surveys were compiled and evaluated as potential stressor variables affecting biological condition.

Physical habitat stressor variables include 11 of the metrics developed by the SWAMP RM (described above) that were selected based on their ability to discriminate between reference and stressed sites and also showed little bias among ecoregions (Andy Rehn, personal communication, 2017) (Table 2.2). Additional physical habitat variables include the reachwide qualitative assessment (PHAB) that consists of three separate attributes: channel alteration, epifaunal substrate, and sediment deposition. Each attribute is individually scored on a scale of 0 to 20, with a score of 20 representing good condition. The total PHAB score is the sum of three individual attribute scores with a score of 60 representing the highest possible score.

Table 2.2. Physical habitat metrics used to assess physical habitat data collected at bioassessment sites in Santa Clara County, WY 2012 - WY 2019. The five metrics used to calculate IPI scores are also shown.

Type	Variable Name	Variables used for IPI Score
Channel Morphology	Evenness of Flow Habitat Types	x
	Percent Fast Water of Reach	
Habitat Complexity and Cover	Mean Filamentous Algae Cover	
	Natural Shelter cover - SWAMP	
	Shannon Diversity (H) of Aquatic Habitat Types	x
	Riparian Cover Sum of Three Layers	x
Human Disturbance	Combined Riparian Human Disturbance Index - SWAMP	
Substrate Size and Composition	Evenness of Natural Substrate Types	
	Percent Gravel - coarse	
	Percent Substrate Smaller than Sand (<2 mm)	x
	Shannon Diversity (H) of Natural Substrate Types	x

Landscape variables were generated in GIS using three different scales of drainage area upstream of each sampling location: 1 km, 5 km, and entire watershed. Land use and transportation data layers were overlayed with the drainage areas to calculate landscape variables, including percent urban area, percent impervious area, total number of road crossings, and road density.

Water quality stressor variables include the general parameters measured in the field with sondes (i.e., dissolved oxygen, pH, temperature and specific conductivity), free chlorine and total chlorine residual, and water chemistry analyzed at laboratories (nutrients and anions). Additional water quality variables included chlorophyll a and ash free dry mass, both measured from filtration of the benthic algae composite samples.

Some of the water quality stressor variables used in the analysis were calculated or converted from other analytes or units of measurement:

- Conversion of measured total ammonia to the more toxic form of unionized ammonia was calculated to compare with the 0.025 mg/L annual median standard provided in the San Francisco Basin Water Quality Control Plan (Basin Plan) (SFRWQCB 2017). The conversion was based on a formula provided by the American Fisheries Society (AFS; https://fisheries.org/wp-content/uploads/2016/03/Copy-of-pub_ammonia_fwc.xls). The calculation requires total ammonia and field-measured values of pH, temperature, and specific conductance.
- Total nitrogen concentration was calculated by summing nitrate, nitrite, and Total Kjeldahl Nitrogen concentrations.
- The volumetric concentrations (mass/volume) for ash free dry mass and chlorophyll a (as measured by the laboratory) were converted to an area concentration (mass/area). Calculations required using both algae sampling grab size and composite volume.

Another potential stressor is climate. During the first five years of probabilistic sampling (WY 2012 – WY 2016), average precipitation was lower than average. During the drought, low base flow conditions were further impacted by minimal or complete absence of water releases from upstream reservoirs and diversion pipes bringing imported water from other parts of the State. Drought conditions changed with an above average wet season in WY 2017, followed by average season in WY 2018 and above average in WY 2019. Comparison of sampling results from recent wet years will provide useful information to evaluate the impacts of drought on biological integrity of the streams.

2.2.4.5 Trigger Thresholds

In compliance with Provision C.8.h.iii.(4) of MRP 2.0, water chemistry data collected at the bioassessment sites during WY 2019 were compared to MRP trigger thresholds and applicable water quality standards (Table 2.3). Thresholds for pH, specific conductance, dissolved oxygen (DO), and temperature (for waters with COLD Beneficial Use only) are listed in Provision C.8.d.iv of MRP 2.0. With the exception of temperature and specific conductance, these conform to Water Quality Objectives (WQOs) in the Basin Plan (SFRWQCB 2017). Of the eleven nutrients analyzed synoptically with bioassessments, WQOs only exist for three: ammonia (unionized form), and chloride and nitrate (for waters with MUN Beneficial Use only).

Table 2.3. MRP trigger thresholds for nutrient and general water quality variables.

	Units	Threshold	Direction	Source
Nutrients and Ions				
Nitrate as N [a]	mg/L	10	Increase	Basin Plan
Un-ionized Ammonia [b]	mg/L	0.025	Increase	Basin Plan
Chloride [a]	mg/L	250	Increase	Basin Plan
General Water Quality				
Oxygen, Dissolved	mg/L	5.0 or 7.0	Decrease	Basin Plan
pH		6.5 to 8.5		Basin Plan
Temperature, instantaneous maximum [c]	°C	24	Increase	MRP
Specific Conductance [c]	µS/cm	2000	Increase	MRP

[a] Nitrate and chloride WQOs only apply to waters with MUN designated Beneficial Use
[b] This threshold is an annual median value and is not typically applied to individual samples.
[c] The MRP thresholds (or triggers) for temperature and specific conductance apply when 20 percent of instantaneous results are in exceedance. Application to individual samples is provisional.

2.2.4.6 Stressor Assessment

The association of stressors (physical habitat, landscape, chemistry) with biological indicator scores (CSCI and ASCI) was evaluated using eight years (WY 2012 – 2019) of bioassessment data collected in San Mateo County. Spearman's rank correlation analyses and random forest statistical models were applied to the dataset. A summary of these analyses is provided in Section 2.3.2.

2.2.4.7 SCAPE Modeling to Assess CSCI Scores

Biological conditions, based on CSCI scores, for the 90 bioassessment sampling locations in the Santa Clara Basin were compared to a landscape model developed for streams in California that estimates ranges of likely scores for CSCI scores based on the level of landscape alteration contributing to the sampling reach (Beck et al. 2020). The landscape model was created using data from StreamCat, which is a national dataset that includes attributes characterizing watershed development (Hill at al. 2015).

The predictive model was developed to support management decisions, such as identifying reaches for restoration or enhanced protection based on how observed scores relate to the model expectation. It has been integrated into a publicly available web-based application called the Stream Classification and Priority Explorer (SCAPE). The SCAPE tool can be used to compare measured/calculated CSCI scores with the predictive scores produced by the model (https://sccwrp.shinyapps.io/scape/).

The SCAPE model was obtained from SCCWRP as a GIS shapefile. Stream/channel attributes in the shapefile include stream classifications using three thresholds for CSCI (1st, 10th, and 30th percentile of reference sites) and a prediction interval (ranging from the 10th to the 90th percentiles of the quantile predictions). There are four possible stream classifications in the model: “likely unconstrained”, “possibly constrained”, “possibly unconstrained” and “likely unconstrained”. The model predicts a range of CSCI scores for each stream reach and an expected median score. Observed CSCI scores at a site are compared to the model expectations and characterized as over-scoring, expected or under-scoring. See section 2.3.4 for application of the SCAPE model to CSCI scores at bioassessment sites in Santa Clara County.

2.3 Results and Discussion

The results for bioassessment monitoring in WY 2019, as well as the previous eight years of bioassessment data (WY 2012 – WY 2019), are presented in the section below.

- **Section 2.3.1** presents overall results of biological assessments conducted at twenty sites in Santa Clara County during WY 2019. This section also includes description of purpose and selection of sites for targeted monitoring.

- **Section 2.3.2** provides an overall summary of biological conditions (CSCI and ASCI scores) and exceedances of stressor thresholds for the 172 bioassessment sites sampled in Santa Clara County between WY 2012 and WY 2019. The association between biological conditions and stressor data (land use, water chemistry, physical habitat) for 168 probabilistic sites is evaluated using statistical analyses. The evaluation of bioassessment data is consistent with the approach used in the RMC 5-year Bioassessment Report (BASMAA 2019).

- **Section 2.3.3** presents a comparison of historical BMI data (Pre-MRP; WY 2003 – WY 2009) and BMI data collected in compliance with the MRP (WY 2012 – WY 2019), based on CSCI scores, as one approach using existing data sources to evaluate trends in biological conditions. The Program conducted bioassessments in eight watersheds in Santa Clara County between 2003 and 2009.

- **Section 2.3.4** provides potential approaches to consider for future monitoring design to address requirements for Provision C.8 of the next MRP (i.e., MRP 3.0) that is currently under development and will likely become effective in WY 2022. One approach would be to conduct targeted monitoring at specific watershed/reaches that have identified water quality problems or reduced biological conditions and high potential to mitigate stressor impacts through management actions. Another approach is to identify healthy stream reaches and focus efforts on protecting those resources.

Conclusions and recommendations for this section are presented in Section 7.0.

2.3.1 Bioassessment Results (WY 2019)

This section documents the biological condition and stressor data collected in WY 2019. In WY 2019, the Program conducted bioassessments at 4 targeted sites and 16 probabilistic sites[15] in Santa Clara County. The WY 2019 bioassessment sites are listed in Table 2.4 and mapped in Figure 2.3. The probabilistic sites were derived from the RMC Sample Frame and the four targeted sites were located in creek reaches where in-stream habitat improvement projects were recently completed or planned by Valley Water. Bioassessment data at targeted sites are intended to provide baseline data to evaluate changes in conditions over time. A description of targeted monitoring study is provided in Section 2.3.1.3.

Table 2.4. Bioassessment sampling dates and locations in Santa Clara County in WY 2019.

Station Code	Creek	Sample Date	Elevation (m)	Latitude	Longitude	Probabilistic	Targeted
205COY455	Coyote Creek	04-Jun-19	116	37.16631	-121.64776		x
205GUA060	Los Gatos Creek	08-May-19	49	37.29109	-121.93488		x
205GUA251	Alamitos Creek	29-Apr-19	63	37.23306	-121.87054		x
205STE070	Stevens Creek	05-Jun-19	127	37.30275	-122.07486		x
205R04247	Stevens Creek	05-Jun-19	86	37.32635	-122.06019	x	
205R04271	Stevens Creek	03-Jun-19	457	37.30551	-122.15517	x	
205R04317	Coyote Creek	04-Jun-19	124	37.16628	-121.63747	x	
205R04359	Adobe Creek	12-Jun-19	2	37.42669	-122.10509	x	
205R04378	Los Gatos Creek	08-May-19	110	37.21733	-121.98670	x	
205R04383	San Francisquito Cr	06-Jun-19	15	37.45383	-122.16170	x	
205R04395	Arroyo De Los Coches	02-May-19	126	37.44464	-121.85645	x	
205R04418	Thompson Creek	30-Apr-19	120	37.29217	-121.76741	x	
205R04479	Saratoga Creek	12-Jun-19	19	37.35436	-121.97327	x	
205R04530	Upper Silver Creek	01-May-19	66	37.29639	-121.79295	x	
205R04537	Thompson Creek	30-Apr-19	181	37.27378	-121.74535	x	
205R04591	San Tomas Aquino Cr	07-May-19	5	37.39086	-121.96797	x	
205R04602	Wildcat Creek	01-May-19	123	37.26359	-122.01925	x	
205R04614	San Tomas Aquino Cr	07-May-19	75	37.27327	-121.98247	x	
205R04638	Guadalupe Creek	06-May-19	84	37.22823	-121.90335	x	
205R04670	Saratoga Creek	09-May-19	194	37.25116	-122.05508	x	

2.3.1.1 Biological and Physical Habitat Conditions

Biological condition, as represented by CSCI and ASCI (diatom, soft algae, and hybrid) scores, for the 20 bioassessment sites sampled by SCVURPPP in WY 2019 are listed in Table 2.5. Physical habitat conditions, as represented as IPI Scores, are shown in Table 2.6. All sites

[15] MRP 2.0 allows for up to 20% of bioassessment locations (4 sites) to be targeted; the remaining sites are probabilistic.

were classified as urban land use. Scores in the two higher condition categories (i.e., above the 10th percentile of reference sites) for each indicator are highlighted and bold.

<u>CSCI Scores</u>

The CSCI scores ranged from 0.32 to 1.08 across the 20 bioassessment sites sampled in WY 2019 (Table 2.5). Three of the 20 bioassessment sites (15%) had CSCI scores in the two higher condition categories: "possibly intact" and "likely intact" condition. These combined classifications are above the MRP trigger threshold value of 0.795. Although these three sites are classified as urban in the RMC sample frame, impervious area in their contributing watersheds is relatively low, < 3%.

Three sites (15%) were ranked as "likely altered" (CSCI score 0.63 – 0.795). The remaining 14 sites were ranked as "very likely altered" (CSCI score < 0.63), indicating highly degraded conditions. Nine of these sites were predominantly urban (11% - 38% impervious watershed area). he remaining low scoring sites were either downstream of dams, or in small watersheds with low or no flow conditions during the late summer. Sites with CSCI scores below 0.795 will be considered as candidates for SSID projects.

<u>ASCI Scores</u>

The benthic algae taxa identified in the samples collected in Santa Clara County were used to calculate scores for the provisional statewide ASCI. Scores for three ASCI indices (diatoms, soft algae and hybrid) are shown in Table 2.5. There is no MRP trigger for any of the ASCI index scores.

The diatom and hybrid ASCI scores exhibited similar patterns, with majority of the scores in the top two condition categories occurring at sites with minimal development. Nine of the ten higher scoring sites for ASCI-H (≥ 0.88 score) occurred in watersheds that were ≤ 3% impervious area (Table 2.5). All seven sites with high scores for diatom index were at sites with low development (< 3% impervious area). The ASCI-SB index exhibited high scores at sites with both low and high levels of urbanization. Two sites below dams on Coyote Creek (201COY455 and 205R04318) and Stevens Creek (205R04247 and 205STE070) had very high scores for the soft algae index; 3 of the 4 sites has scores > 1.0.

Table 2.5. Biological condition scores, presented as CSCI and ASCI (diatom, soft algae and hybrid) for 20 probabilistic sites sampled in Santa Clara during WY 2019. Site characteristics related to percent impervious watershed area and flow condition are also presented. Bolded/shaded values indicate scores in the two higher condition categories.

Station Code	Creek	Impervious Watershed Area	Flow[1]	CSCI Score	ASCI Score		
					Diatom	Soft Algae	Hybrid
205R04247	Stevens Creek	3%	P	0.65	**0.97**	**0.87**	**1.01**
205R04271	Stevens Creek	3%	P	**1.08**	**1.09**	**1.28**	**1.10**
205R04317	Coyote Creek	1%	P	0.54	**0.95**	**1.10**	**1.13**
205R04359	Adobe Creek	25%	P	0.32	0.61	0.53	0.68
205R04378	Los Gatos Creek	3%	P	0.64	0.48	**0.96**	**0.96**
205R04383	San Francisquito Cr	13%	NP	0.47	0.79	**0.90**	0.86
205R04395	Arroyo De Los Coches	2%	P	0.67	**0.91**	**1.28**	0.72
205R04418	Thompson Creek	11%	P	0.38	0.62	**0.86**	0.62
205R04479	Saratoga Creek	25%	P	0.58	0.53	0.53	0.80
205R04530	Upper Silver Creek	18%	P	0.53	0.72	0.37	0.65
205R04537	Thompson Creek	3%	NP	0.51	0.46	**1.28**	**0.90**
205R04591	San Tomas Aquino Cr	38%	P	0.50	0.62	0.24	0.52
205R04602	Wildcat Creek	16%	NP	0.50	0.73	**0.96**	0.83
205R04614	San Tomas Aquino Cr	21%	P	0.63	0.62	**0.81**	0.72
205R04638	Guadalupe Creek	3%	P	**0.97**	**0.96**	**0.87**	**0.95**
205R04670	Saratoga Creek	2%	P	**0.99**	**0.94**	0.69	**1.13**
205COY455	Coyote Creek	1%	P	0.58	**0.84**	**0.95**	**1.00**
205GUA060	Los Gatos Creek	12%	P	0.57	0.77	**0.82**	**0.97**
205GUA251	Alamitos Creek	7%	P	0.62	0.69	**0.81**	0.86
205STE070	Stevens Creek	2%	P	0.44	0.66	**1.02**	**1.11**

[1] Flow: P=Perennial, NP=Non-perennial (no flow during dry season)

IPI Scores

Physical habitat conditions, as represented by IPI scores, are listed in Table 2.6 along with CSCI scores and hybrid ASCI scores. The two higher condition categories for all three indices (i.e., above the 10th percentile of reference sites) are shown in shaded cells with bold text. Sixteen of the twenty sites had IPI scores that were in the top two condition categories (> 0.83). The lowest score (0.13) occurred at site 205R04359, which was located within concrete channel section of Adobe Creek.

The qualitative habitat (PHAB) scores, including individual scores for channelization, epifaunal substrate and sedimentation attributes[16], and total PHAB (sum of the three attributes scores)

[16] Channelization is measure of extent of reach that is armored/modified; Epifaunal substrate is measure of quantity and quality of physical habitat features (substrate, wood) that provides structure for colonization of biological communities; Sedimentation is a measure of the amount of sediment that has accumulated in the reach.

are also presented in the table. There appears to be no relationship between IPI and PHAB scores. Biological condition scores for CSCI and the hybrid ASCI are included in the table for comparison.

Table 2.6. IPI scores for 20 probabilistic sites in Santa Clara County sampled in WY 2019. Qualitative PHAB scores are also listed. CSCI and hybrid ASCI scores are provided for comparison. Bolded/shaded values indicate scores in the two higher condition categories.

Station Code	Creek Name	CSCI Score	Hybrid ASCI Score	IPI Score	Channel Alteration	Epifaunal Substrate	Sediment Deposition	Total PHAB
205R04247	Stevens Creek	0.65	**1.01**	**1.10**	11	12	7	30
205R04271	Stevens Creek	**1.08**	**1.10**	**1.17**	20	18	12	50
205R04317	Coyote Creek	0.54	**1.13**	**1.06**	12	13	15	40
205R04359	Adobe Creek	0.32	0.68	0.13	0	1	2	3
205R04378	Los Gatos Creek	0.64	**0.96**	**1.18**	16	16	16	48
205R04383	San Francisquito Cr	0.47	0.86	0.79	2	6	2	10
205R04395	Arroyo De Los Coches	0.67	0.72	**0.85**	17	18	5	40
205R04418	Thompson Creek	0.38	0.62	**0.88**	14	10	8	32
205R04479	Saratoga Creek	0.58	0.80	0.75	4	4	11	19
205R04530	Upper Silver Creek	0.53	0.65	**0.99**	15	9	7	31
205R04537	Thompson Creek	0.51	**0.90**	**0.92**	16	8	8	32
205R04591	San Tomas Aquino Cr	0.50	0.52	0.77	7	2	1	10
205R04602	Wildcat Creek	0.50	0.83	**0.90**	8	10	8	26
205R04614	San Tomas Aquino Cr	0.63	0.72	**0.91**	7	7	10	24
205R04638	Guadalupe Creek	**0.97**	**0.95**	**1.02**	16	15	12	43
205R04670	Saratoga Creek	**0.99**	**1.13**	**1.04**	20	18	17	55
205COY455	Coyote Creek	0.58	**1.00**	**1.13**	15	15	16	46
205GUA060	Los Gatos Creek	0.57	**0.97**	**1.1**	11	10	12	33
205GUA251	Alamitos Creek	0.62	0.86	**1.12**	13	13	12	38
205STE070	Stevens Creek	0.44	**1.11**	**1.00**	18	7	13	38

<u>Overall Condition</u>

The condition categories for each site based on two of the biological indicators (CSCI and hybrid ASCI) and physical habitat indicator (IPI) are listed in Table 2.6 and illustrated in Figure 2.3. There were three sites with scores in the two higher condition categories for all three indices: CSCI, hybrid ASCI and IPI (green and yellow symbols in Figure 2.3). Two of the sites are located in upper reaches of Saratoga Creek (site 205R04670) and Stevens Creek (205R04271). The remaining site is located at the urban boundary of Guadalupe Creek, just downstream of Coleman Av (site 205R04638).

In contrast, there were four sites with scores in the two lower condition categories for all three indices. Two sites were in the highly urban reaches of San Tomas Aquino Creek (site 205R04591) and Saratoga Creek (site 205R04479). The third site was located in concrete channel reach of Adobe Creek (site 205R04359) and the fourth site was located in an intermittent section of San Franciscquito Creek (site 205R04383).

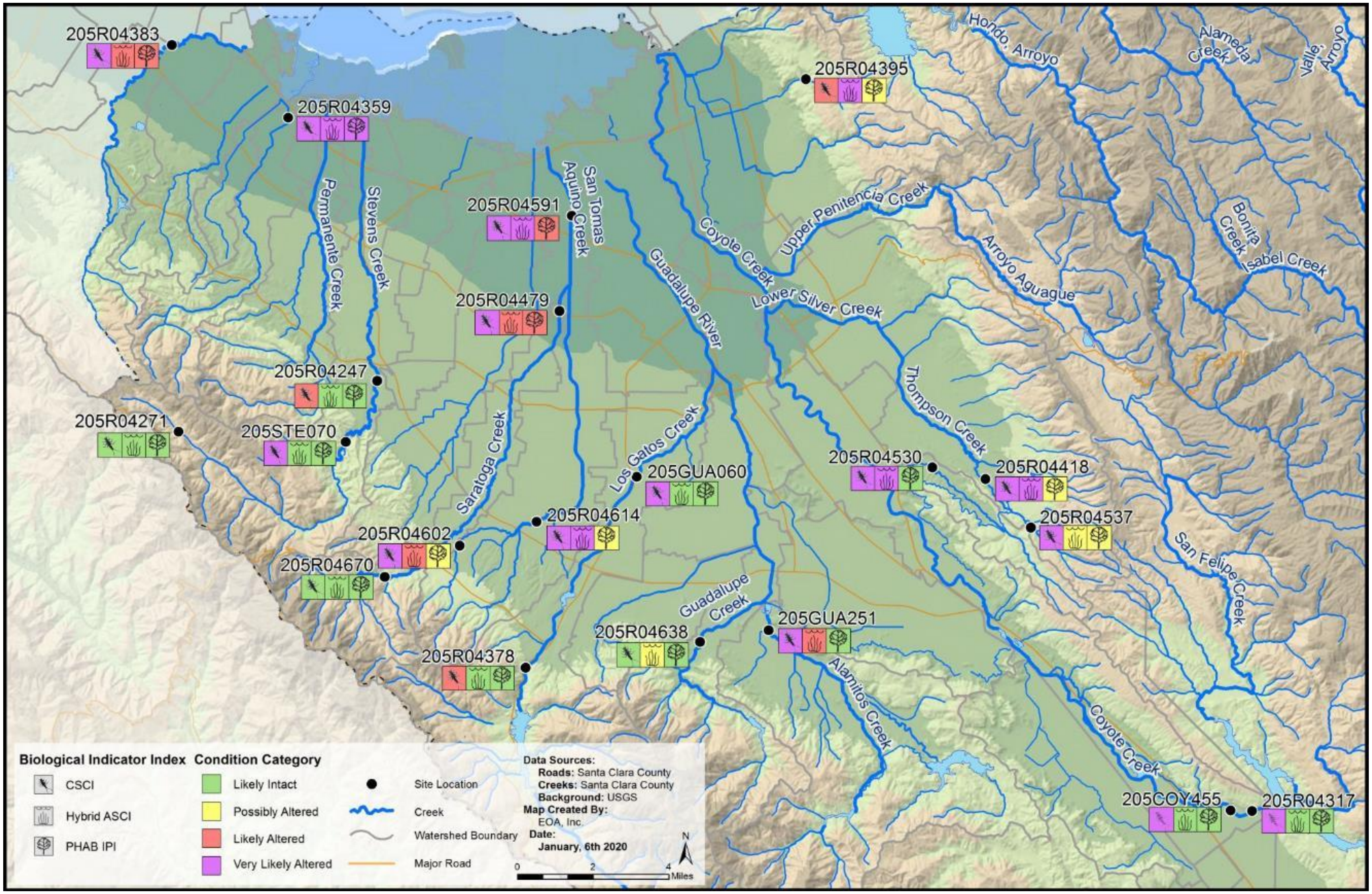

Figure 2.3. Condition category as represented by CSCI, ASCI Hybrid, and IPI scores for 20 probabilistic sites sampled in Santa Clara County during WY 2019.

2.3.1.2 Stressor Assessment (WY 2019)

This section lists results for stressor data collected at the 20 bioassessment sites in WY 2019. The comparison of WY 2019 stressor data to associated MRP triggers and/or WQOs is also documented for the purposes of maintaining the list of sites with trigger exceedances for SSID project consideration.

General Water Chemistry

General water quality measurements sampled at the twenty bioassessment sites in WY 2019 are listed in Table 2.7. None of the water quality measurements exceeded water quality objectives or MRP trigger thresholds.

Table 2.7. General water quality measurements for twenty probabilistic sites in Santa Clara County sampled in WY 2019.

Station Code	Creek Name	Sample Date	DO (mg/L)	Temp (Deg C)	Specific Cond (uS/cm)	pH
205R04247	Stevens Creek	05-Jun-19	12.0	17.2	495	8.3
205R04271	Stevens Creek	03-Jun-19	10.0	12.6	547	8.3
205R04317	Coyote Creek	04-Jun-19	9.2	11.6	315	7.7
205R04359	Adobe Creek	12-Jun-19	8.2	21.2	989	8.1
205R04378	Los Gatos Creek	08-May-19	10.7	11.9	753	8.1
205R04383	San Francisquito Cr	06-Jun-19	6.3	18.1	796	8.3
205R04395	Arroyo De Los Coches	02-May-19	11.0	11.9	908	8.3
205R04418	Thompson Creek	30-Apr-19	10.3	15.1	750	8.3
205R04479	Saratoga Creek	12-Jun-19	10.8	23	1093	7.9
205R04530	Upper Silver Creek	01-May-19	11.5	12.9	1252	8.3
205R04537	Thompson Creek	30-Apr-19	8.4	14	977	7.8
205R04591	San Tomas Aquino Cr	07-May-19	20.5	25.4	1064	8.4
205R04602	Wildcat Creek	01-May-19	9.7	17.4	604	7.8
205R04614	San Tomas Aquino Cr	07-May-19	10.0	13.8	607	8.3
205R04638	Guadalupe Creek	06-May-19	10.8	12.2	370	8.2
205R04670	Saratoga Creek	09-May-19	11.1	12.5	415	8.4
205COY455	Coyote Creek	04-Jun-19	10.7	13.7	314	7.9
205GUA060	Los Gatos Creek	08-May-19	8.5	20	367	8.2
205GUA251	Alamitos Creek	29-Apr-19	9.8	14.8	509	8.1
205STE070	Stevens Creek	05-Jun-19	8.3	15.2	471	7.8

Water Chemistry (Nutrients)

Nutrient and conventional analyte concentrations measured in water samples collected at twenty bioassessment sites in Santa Clara County during WY 2019 are listed in Table 2.8. There were four sites that exceeded Water Quality Objectives for unionized ammonia. Two sites were in Stevens Creek, one site in Arroyo de las Coches and one site in San Tomas Aquino.

Table 2.8. Nutrient and conventional constituent concentrations in water samples collected at 20 sites in Santa Clara County during WY 2019. Bolded values are above water quality objectives.

Station Code	Creek Name	Ammonia as N	Unionized Ammonia (as N)	Chloride	Nitrate as N	Nitrite as N	Total Kjeldahl as N	Total Nitrogen	Ortho-Phosphate as P	Phosphorus as P	Silica	AFDM	Chlorophyll a
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	g/m2	mg/m2
	Water Quality Objective	***NA***	***0.025 [b]***	***250[a]***	***10 [a]***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***
205R04247	Stevens Creek	0.92	**0.056**	19	0.1	0.001 J	0.28	0.4	0.04	0.07	20	106.4	153.5
205R04271	Stevens Creek	0.78	**0.030**	14	0.033 J	<0.001	< 0.07	0.1	0.03	0.03	16	200.1	7.7
205R04317	Coyote Creek	0.83	0.008	15	0.33	0.001 J	0.22	0.6	0.02	0.04	12	48.0	91.8
205R04359	Adobe Creek	0.20	0.009	73	2.2	0.072	0.63	2.9	0.03	0.06	25	135.0	64.3
205R04378	Los Gatos Creek	0.25	0.006	7.1	0.19	0.003 J	0.11	0.3	0.02	0.03	21	10.3	92.9
205R04383	San Francisquito Cr	0.06	0.004	56	0.3	0.006	0.28	0.6	0.02	0.03	11	46.8	110.4
205R04395	Arroyo De Los Coches	0.33	**0.033**	71	2.1	0.006	0.83	2.9	0.23	0.36	47	427.4	20.5
205R04418	Thompson Creek	0.33	0.024	130	0.071	0.001 J	0.77	0.8	0.10	0.10	25	133.2	17.1
205R04479	Saratoga Creek	0.06	0.002	95	1.6	0.019	0.19	1.8	0.02	0.03	19	42.2	35.7
205R04530	Upper Silver Creek	0.33	0.015	150	1.4	0.004 J	0.61	2.0	0.15	0.15	47	133.2	13.9
205R04537	Thompson Creek	0.33	0.008	65	1	0.008	0.77	1.8	0.11	0.11	31	78.4	8.8
205R04591	San Tomas Aquino Cr	0.34	**0.039**	81	0.45	0.028	0.8	1.3	0.007 J	0.04	21	223.8	184.2
205R04602	Wildcat Creek	0.33	0.006	73	0.65	0.004 J	0.25	0.9	0.15	0.03	30	133.2	2.0
205R04614	San Tomas Aquino Cr	0.14	0.006	56	0.11	0.002 J	0.25	0.4	0.02	0.02	21	25.5	184.2
205R04638	Guadalupe Creek	0.41	0.012	10	0.095	0.002 J	0.14	0.2	0.02	0.03	19	12.7	184.2
205R04670	Saratoga Creek	0.28	0.014	13	0.16	0.001 J	< 0.07	0.2	0.06	0.08	21	113.3	184.2
205COY455	Coyote Creek	0.76	0.014	15	0.3	0.001 J	0.33	0.6	0.02	0.04	12	15.7	73.6
205GUA060	Los Gatos Creek	0.27	0.015	7.1	0.067	0.003 J	0.11	0.2	0.02	0.03	21	56.7	62.5
205GUA251	Alamitos Creek	0.33	0.009	28	0.32	0.0025 J	0.77	1.1	0.02	0.03	21	133.2	184.2
205STE070	Stevens Creek	0.79	0.013	15	0.029 J	<0.001	0.19	0.2	0.04	0.08	20	37.8	153.1
Number of exceedances		NA	4	0	0	NA	NA	NA	NA	NA	NA	NA	NA

NA = Not Applicable, NR = Not Reported
J = The reported result is an estimate.
[a] Chloride and nitrate WQOs only apply to waters with MUN designated Beneficial Uses.
[b] This threshold is an annual median value and is not typically applied to individual samples.

Total nitrogen concentrations ranged from 0.2 to 2.9 mg/L. The two highest nitrogen concentrations were measured at site 205R04359 in Adobe Creek (2.9 mg/L) and site 205R04395 (2.9 mg/L) on Arroyo Los Coches. Total phosphorus concentrations ranged from <0.03 to 0.36 mg/L. The highest phosphorus concentration was measured at site 205R04395 on Arroyo Los Coches.

2.3.1.3 Targeted Sites (WY 2019)

In WY 2019, SCVURPPP conducted bioassessments at four targeted sites located near recently constructed or planned stream restoration projects (Table 2.9 and Figure 2.4). Planned or completed stream restoration work entailed placement of gravel and wood into the channel for the purpose of increasing the amount of spawning habitat and high flow refugia on the floodplain for salmonid fish populations. The selected monitoring locations were at 4 of the 20 sites identified for potential gravel and wood augmentation projects in Santa Clara County watersheds managed by Valley Water (Rubin et al. 2017).

Table 2.9. Bioassessment site locations during WY 2019.

Station Code	Location	Project data for Gravel/wood placement	Bioassessment sampling dates
205COY455	Coyote Creek at Stream Gage near Boys Ranch	TBD	2015, 2019
205GUA060	Los Gatos Creek at Creekside Way	August 2019	2009, 2019
205GUA251	Alamitos Creek upstream Golf Creek Confluence (upstream Mazzone Dr)	August 2018	2019
205STE070	Stevens Creek at Stevens Creek Park below dam	August 2018	2006, 2014, 2019

The purpose of the bioassessment monitoring conducted at targeted sites in WY 2019 was to establish a baseline dataset on biological conditions at the beginning phase of the restoration projects. Bioassessments would then be repeated at these sites after channel conditions have stabilized to measure changes in biological conditions. Three of the four targeted sites were previously sampled by SCVURPPP before the 2019 sampling event (Table 2.9).

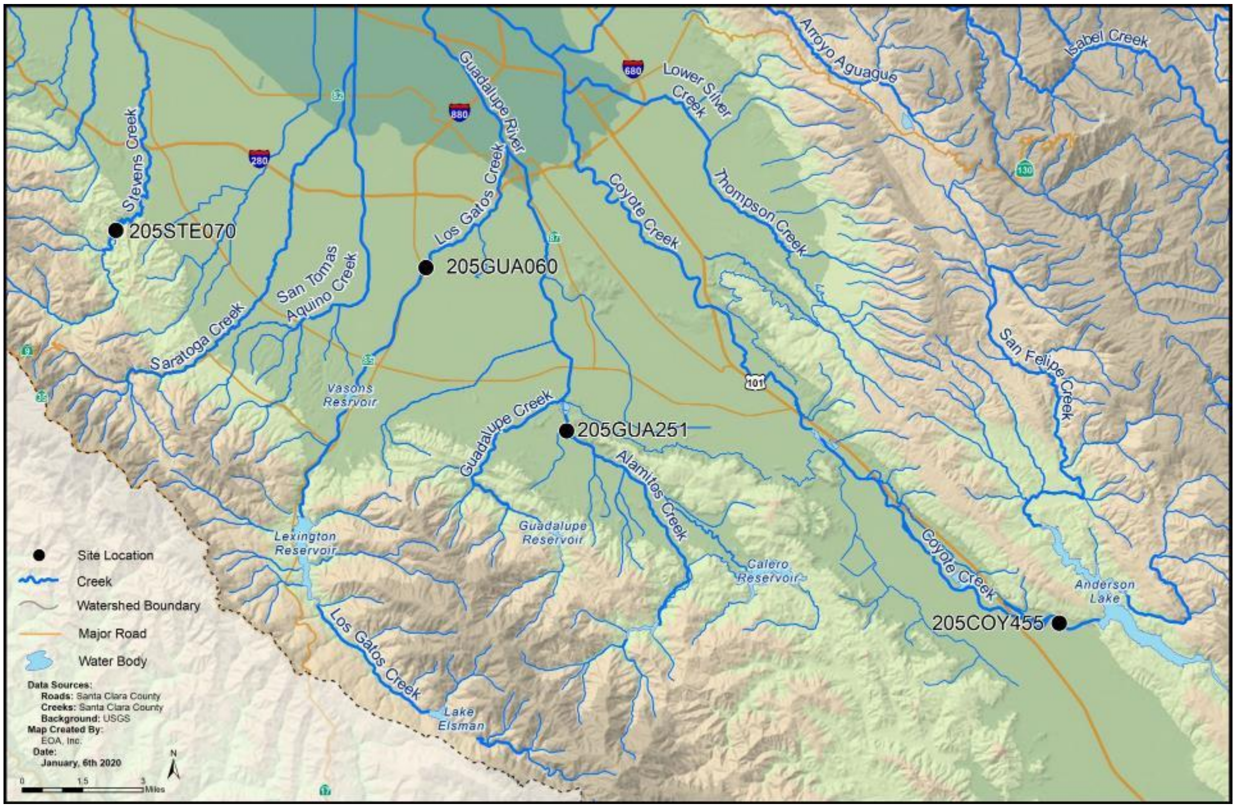

Figure 2.4. Targeted bioassessment sites during WY 2019.

2.3.2 Evaluation of Countywide Bioassessment Results (WY 2012 – 2019)

This section addresses the first two bioassessment monitoring management questions presented at the beginning of Section 2.0 by summarizing WY 2012 through WY 2019 biological condition data and comparing scores to synoptically collected stressor data.

The first bioassessment management question (i.e., *What is the condition of aquatic life in creeks in the RMC?*) is addressed by assessing indicators of aquatic biological health at probabilistic sampling locations. As part of the RMC Bioassessment Monitoring Program, 172 sites were sampled by SCVURPPP (n=160) and SWAMP (n=12) in Santa Clara County between WY 2012 and WY 2019. SCVURPPP sampled 140 urban and 20 non-urban sites and SWAMP sampled 12 non-urban sites. All monitoring sites were derived from the RMC sample frame, except four targeted sites that were sampled during WY 2019.

The bioassessment data collected at probabilistic sites (n=168) were evaluated to assess the current condition of water bodies in the County and identify stressors likely to pose the greatest risk to the health of those streams. The methods used to evaluate bioassessment data were consistent with the approach used to develop the RMC Five-Year Bioassessment Report (BASMAA 2019). A summary of the methods and results is presented below.

The overall range of biological conditions in Santa Clara County streams was estimated using cumulative distribution functions (CDFs). CDF sample weights were calculated as the total stream length in the RMC sample frame divided by the stream length evaluated in each land use category (urban and non-urban). The adjusted sample weights were used to estimate the proportion of stream length (average and 95% confidence interval) represented by CSCI and ASCI scores for all SCVURPPP sites combined, as well as urban sites only. All calculations were conducted using the R-package *spsurvey* (Kincaid and Olsen 2016).

The second bioassessment monitoring management question (i.e., *What are major stressors to aquatic life in the RMC area?*) is addressed by evaluation of physical habitat, land use, and water chemistry data collected at the probabilistic sites, as potential stressors to biological health. Potential stressors to biological condition were evaluated using Spearman's rank correlation analysis and random forest statistical models. The stressor variable list consisted of 50 quantitative environmental variables, related to water quality, physical habitat, and land use factors that could potentially influence biological condition scores. In addition, two categorical factors (Land Use and Strata) were used to evaluate condition scores for different types of streams. Watershed/Sub-watershed Area was used as the strata to evaluate regional differences in biological conditions.

2.3.2.1 Site Evaluations

A total of 514 randomly selected monitoring sites were sampled in the RMC region between 2012 and 2019. Of these, 168 (33%) were located in the Santa Clara Basin, representing a total stream length of 176.9 km. The majority (137 of 168, 81%) were classified as urban streams/channels. A total of 624 sites were initially evaluated to obtain the 168 probabilistic Santa Clara Basin sites that were ultimately sampled. This equates to a rejection rate of about 73%, largely due to lack of flow, tidal influence, or lack of accessibility.

As of the beginning of WY 2020, there are 1,294 sites remaining in the RMC sample draw for the Santa Clara Basin. Of these, 1,191 are non-urban . Assuming a rejection rate of 75%, the sample draw will likely only be sufficient to provide new sites through WY 2020.

2.3.2.2 Countywide Biological Conditions (WY 2012 – WY 2019)

A summary of CSCI and three ASCI index scores from bioassessment sites in Santa Clara County sampled between WYs 2012 and 2019 is presented in Table 2.10 and figure 2.5. A total of 128 of the 172 (74%) bioassessment sites (includes 4 targeted sites) received CSCI scores below the MRP trigger (0.795), which corresponds to the "likely altered" and "very likely altered" categories. Of these 128 sites, 113 (81%) were in streams classified as urban. As a reminder, urban areas were delineated by combining urban area boundaries and city boundaries defined by the U.S. Census (2000). Non-urban areas were defined as the remainder of the RMC area. Some sites classified as urban fall near the non-urban edge of the city boundaries and have little upstream development.

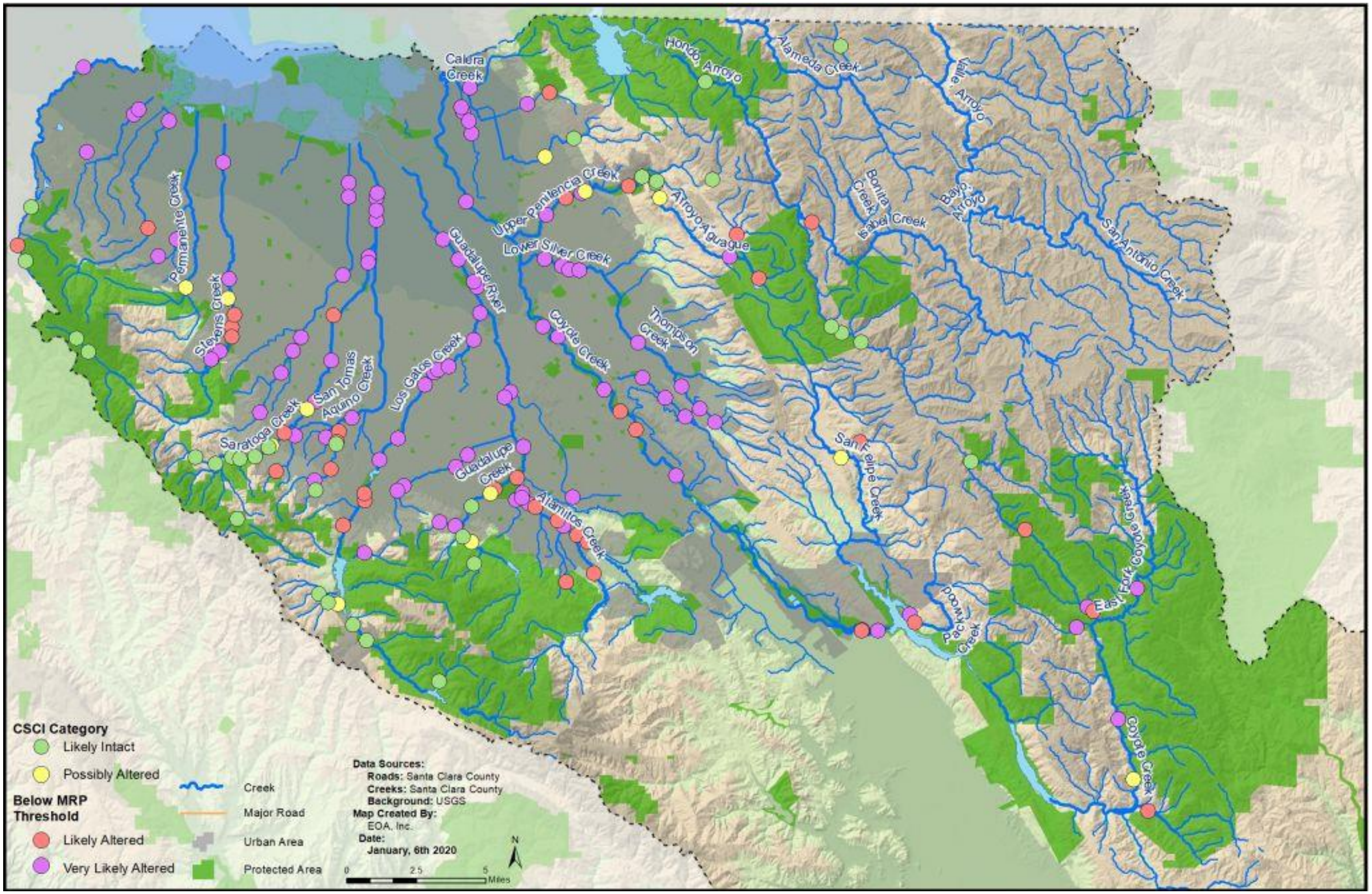

Figure 2.5. Condition categories for CSCI scores at 172 bioassessment sites in Santa Clara County sampled between WY 2012 and WY 2019.

Table 2.10. Number of sites sampled between WYs 2012 and 2019 within each condition category for the four biological indices.

Index[1]	Sites with index score[2]	Land Use	Likely Intact	Possibly Altered	Likely Altered	Very Likely Altered
CSCI	172	Urban	18	9	30	83
		Non-Urban	14	3	9	6
ASCI-D	172	Urban	17	23	46	54
		Non-Urban	17	8	6	1
ASCI-SB	165	Urban	50	34	21	29
		Non-Urban	20	5	6	0
ASCI-H	165	Urban	21	13	24	76
		Non-Urban	22	4	4	1

[1] Indices: CSCI = California Stream Condition Index; ASCI-D = Diatom Algae Stream Condition Index; ASCI-SB = Soft Bodied Algae Stream Condition Index; ASCI-H = Hybrid Algae Stream Condition Index.
[2] Index scores for ASCI-SB and ASCI-H were not calculated for 7 bioassessment sites due to insufficient soft algae taxa needed to calculate score.

The number of sites receiving scores within the lower two condition categories (*likely altered* and *very likely altered*) for the diatom and hybrid ASCI indices was very similar to each other, with 107 and 105 sites, respectively. The number of sites in the two lower condition categories for the soft-bodied algae ASCI was substantially less (56) than the other three indices (Table 2.10). Proportionally, there were more urban sites that had ASCI-SB index scores in the two higher condition categories (63%), compared to the other three indices (ranged 19-29%), indicating that the soft-bodied algae index may not respond well to urban disturbance gradients.

Figure 2.6 includes four plots showing cumulative distribution functions for the four biological condition indicators (CSCI, ASCI-D, ASCI-SB, and ASCI-H). Each plot shows CDFs for urban sites (n=136) all sites (n=168[17]), and non-urban sites (n=32). The CDFs can be used to determine the probability that a random observation will be less than or equal to a certain value. The dashed lines show the uncertainty around these estimates. For example, there is a 65% probability that a random site in the Santa Clara Basin will have a CSCI score below 0.79 (i.e., *likely altered* or *very likely altered*). There is a 80% probability that a random *urban* site in the Santa Clara Basin will have a CSCI score below 0.79 and there is a 48% probability that a random *non-urban* site will have a CSCI score below 0.79.

The CDFs for the various indicators are shaped differently, illustrating the differences in scores in the Santa Clara Basin dataset. The responsiveness or lack of responsiveness of the indicator to urban land uses is illustrated by the separation of the “urban” line from the “all sites” and “non-urban” lines. The CSCI CDFs have the greatest degree of separation between the urban line and the others; whereas, the ASCI-SB CDFs have the smallest degree of separation. As stated previously, the ASCI-SB may not respond to urban disturbance gradients in Santa Clara Basin streams.

[17] CDFs were developed using only the 168 probabilistic sites.

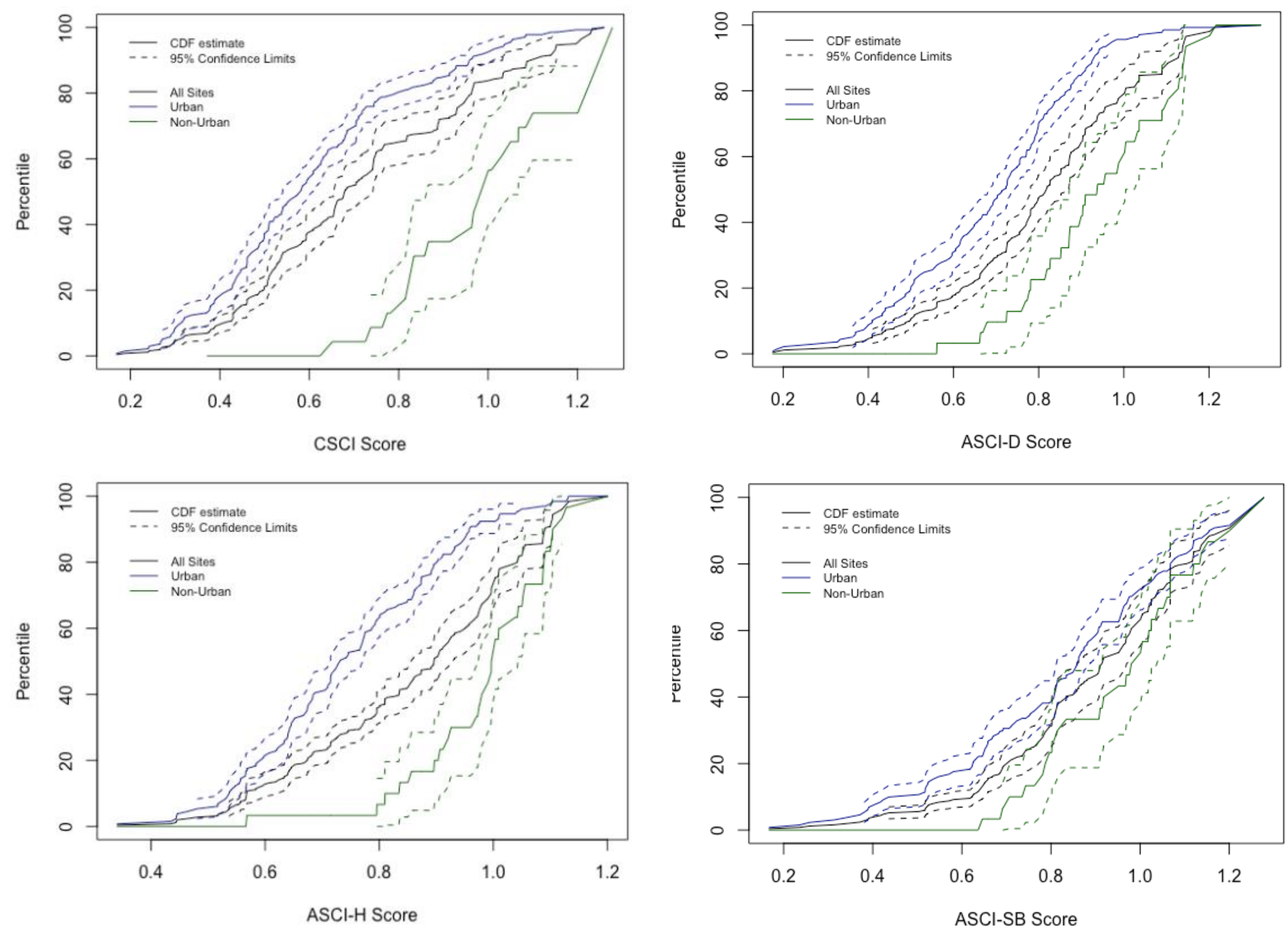

Figure 2.6. Cumulative distribution functions of CSCI, ASCI-D, ASCI-H and ASCI-SB scores in Santa Clara County (n = 168) based on WYs 2012-2019 data.

To further evaluate biological conditions on the watershed and subwatershed scales, biological condition scores were grouped into thirteen different hydrological areas, including major watershed (e.g., Stevens Creek), subwatershed (e.g., Upper Penitencia Creek), combination of subwatersheds (e.g., Silver, which is a combination of Upper Silver and Lower Silver Creeks including Thompson Creek) or portion of major watershed (e.g., Upper Coyote). Several watersheds were not included due to a low number of sampling sites (e.g., Adobe Creek, Permanente Creek). The distribution of CSCI and ASCI-H scores are presented for each of the thirteen hydrological areas in Figures 2.7 and 2.8, respectively. Figure 2.9 shows the proportion of each condition category for the four biological indices (CSCI, ASCI-D, ASCI-SB, ASCI-H) in each of the watershed areas.

The highest median CSCI scores occurred in Upper Penitencia, Guadalupe Creek and Saratoga Creek. The lowest CSCI scores occurred in Lower Penitencia, Guadalupe River, Coyote Creek, Lower and Upper Silver Creeks, and Calabazas Creek. There was very low variability in scores in larger creeks (Coyote Creek and Guadalupe River) and highly urban watersheds (Upper/Lower Silver Creek and Calabazas Creek).

ASCI-H scores grouped by watersheds showed similar patterns to the CSCI scores. Some notable differences were consistently high scores in Saratoga Creek, and generally higher scores compared to CSCI at Los Gatos Creek, Alamitos Creek and Stevens Creek, all of which have impoundments in the upper watershed.

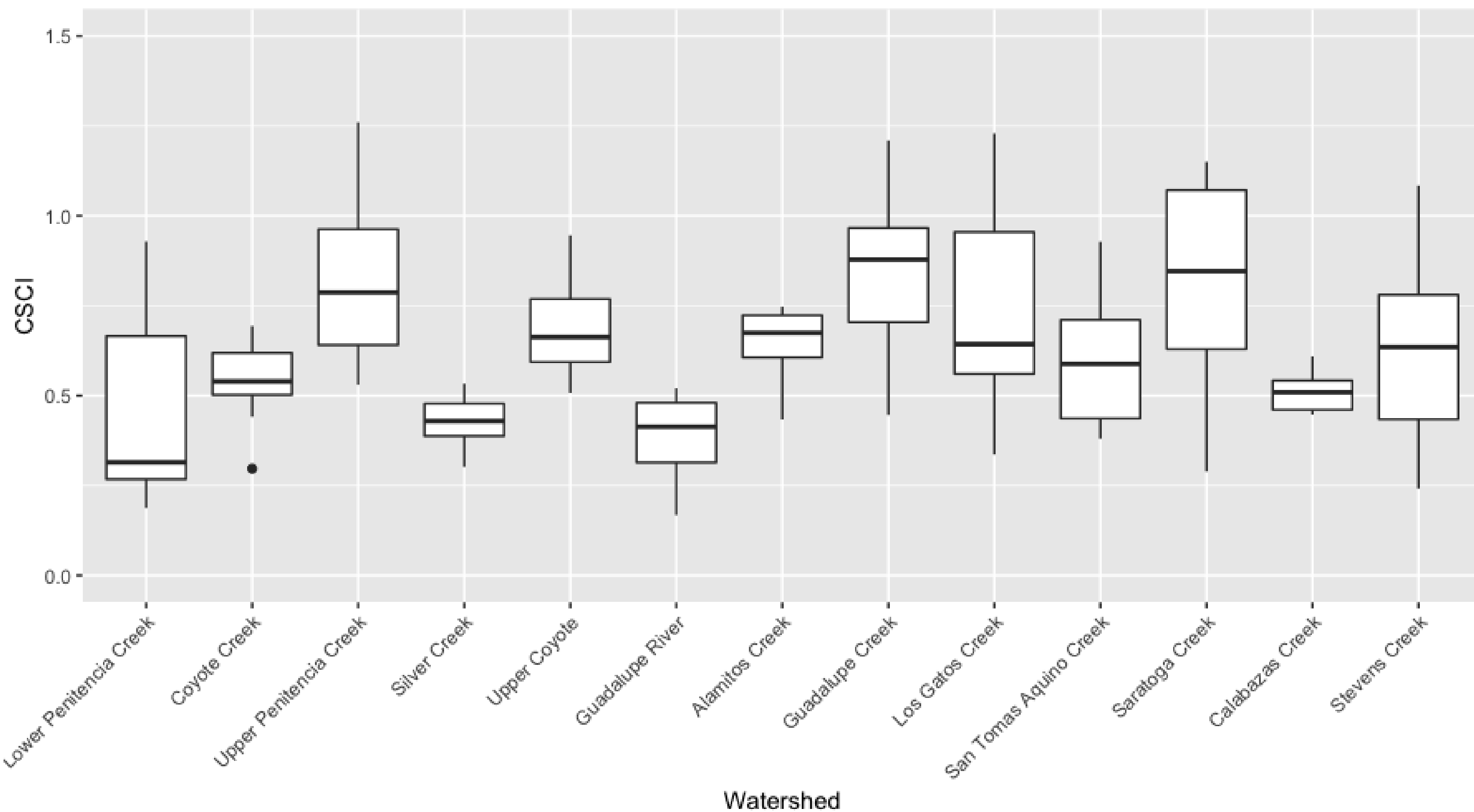

Figure 2.7. Boxplot of CSCI Scores from WY 2012-2019 data, grouped by Watershed.

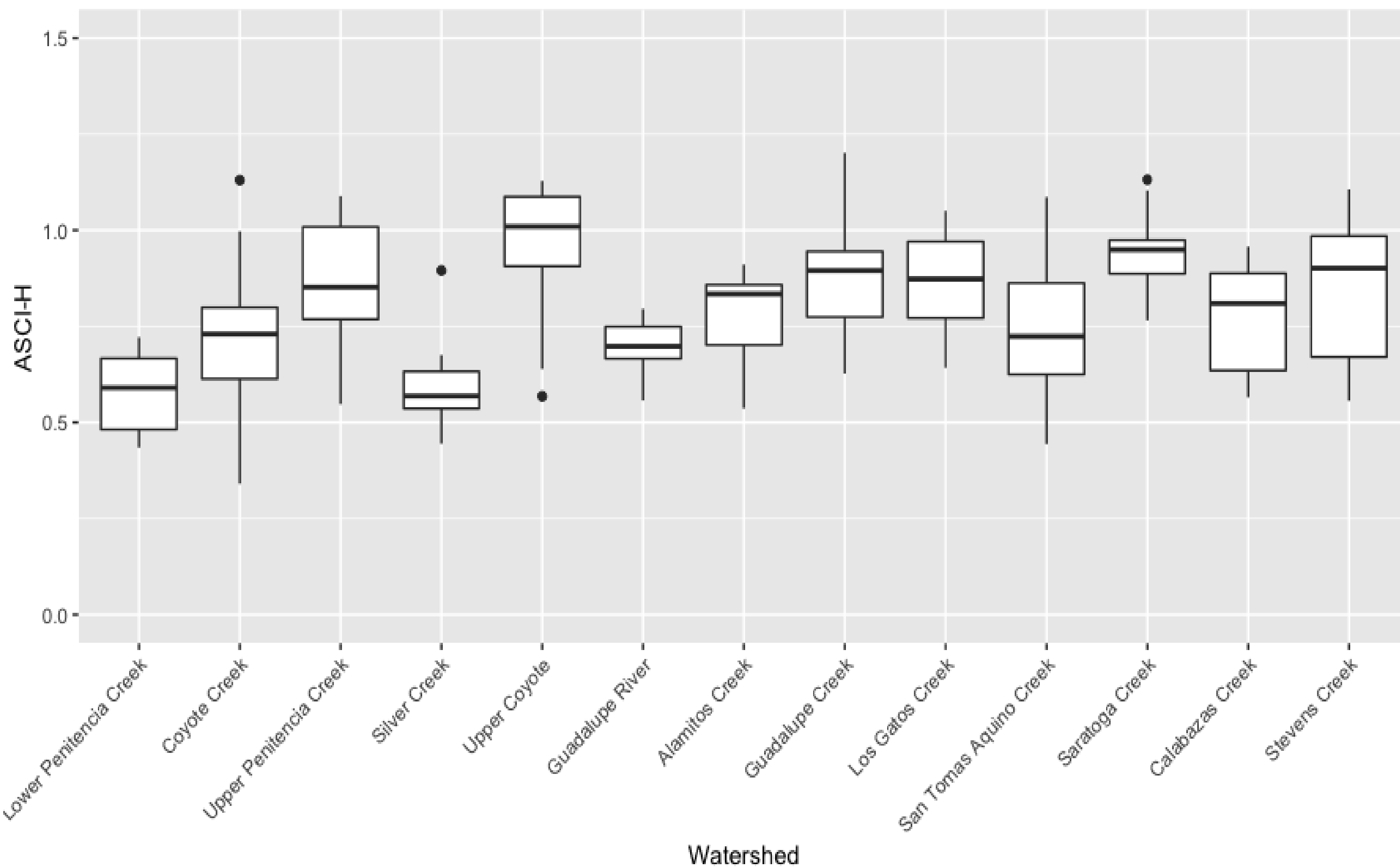

Figure 2.8. Boxplot of ASCI-H Scores from WY 2012-2019 data, grouped by Watershed.

Figure 2.9. All Santa Clara County biological condition scores (WY 2012 – WY 2019) grouped by condition category and watershed (including 4 targeted sites).

2.3.2.3 Stressor Association with Biological Conditions (WY 2012 – WY 2019)

To evaluate the association of stressors with biological condition, Spearman's rank correlation analyses and random forest modeling was performed. The correlation was conducted first to prune the list of 50 potential stressor variables. Twenty-three of the 50 variables exhibited a statistically significant correlation with at least one of the four biological indices (CSCI, ASCI-D, ASCI-SB, ASCI-H). Many of the correlated variables were representative of land use (i.e., road density and urban area). Six variables were related to water quality (e.g., specific conductivity and chloride); and six variables were representative of physical habitat (e.g., boulder density, percent reach smaller than sand, and combined human disturbance index)

Spearman's rank correlation analyses were also performed to evaluate stressors that may differ on a watershed scale. CSCI and the ASCI-H were prioritized for this comparison because they exhibited the best correlation statistics when data were pooled. The results of this analysis suggest that correlations vary greatly among watersheds:

- Biological condition in Coyote Creek, San Tomas Aquino Creek, Saratoga Creek, and Lower/Upper Penitencia Creek was most closely associated with several physical habitat and landscape factors.
- Biological condition in Stevens Creek and Upper Coyote was associated with water quality variables but not with landscape factors. Stevens Creek exhibited one of the highest correlation coefficients between ASCI-H scores and total nitrogen concentration.
- Biological condition in Guadalupe River, Los Gatos Creek, and Silver Creek did not exhibit strong correlations (> 0.8) with any variables.
- Total nitrogen and Total Kjeldahl Nitrogen (TKN) never correlated with CSCI scores at any of the watershed groupings.

The prioritized list of 23 variables was used in random forest model development for CSCI and ASCI-H. Random forest model results indicated similar predictor variables associated with CSCI and ASCI-H index scores. The random forest models showed that 70% of the variability in CSCI scores could be explained with eight predictor (stressor) variables; whereas, only 65% of the variability ASCI-H scores could be explained with the same number of predictors.

The CSCI random forest model indicated that percent boulders and watershed grouping[18] were the two largest contributors to the variance in CSCI scores, followed by a combination of land use and general water quality variables (Table 2.11). The ASCI-H random forest model indicated that three landscape variables, one habitat variable, and three water quality variables (AFDM, total nitrogen and chloride) were the largest contributors to variance in ASCI-H scores (Table 2.12). Overall, landscape variables (e.g., percent impervious in 5k area) were the most important stressor variables for both CSCI and ASCI-H (see Section 2.3.2.4 or more discussion on urban influence on biological conditions).

[18] Indicates that the relationship of index scores to stressors is not independent of watershed (i.e. they would have different slopes/intercept).

Table 2.11. Summary statistics for the CSCI random forest model. Ranking of top eight most influential predictor variables are colored according to: physical habitat (green), land use (orange), and water quality (blue).

Stressor Variable	% Increase MSE	Increase Node Purity
Percent Boulders (> 0.25m)	16.9	0.50
Watershed Strata	15.4	0.65
Chloride	14.8	0.61
Percent Impervious Areas in 5km (PctImp_5K)	14.5	0.47
Specific Conductivity	13.6	0.35
Road Density in Watershed (RdDen_W)	13.3	0.41
Percent Impervious Area of Reach (PctImp)	12.2	0.41
Percent Urban Area of Reach (PctUrb)	12.1	0.41

Table 2.12. Summary statistics for the ASCI-H random forest model. Ranking of top eight most influential predictor variables are colored according to: physical habitat (green), land use (orange), and water quality (blue).

Stressor Variable	% Increase MSE	Increase Node Purity
Road Density in Watershed (RdDen_W)	16.6	0.45
Ash Free Dry Mass (AFDM)	14.9	0.30
Total Nitrogen (TotalN)	14.7	0.30
Chloride	13.7	0.35
Percent Smaller than Sand (PctSmallSand)	13.0	0.27
Percent Impervious Area in 5km (PctImp_5K)	12.7	0.30
Percent Urban Area in 5km (PctUrb_5K)	11.7	0.30
Watershed Strata	9.5	0.42

The stressor analysis of biological condition in Santa Clara County streams using BMIs (CSCI scores) and algae (ASCI scores) has shown that both types of assemblages correlate with landscape factors, as well as unique sets of water quality and habitat stressors. It should be acknowledged that despite these apparent relationships to stressors, these analyses do not determine causation, particularly as stressors from habitat/landscape factors are often present at the same sites that exhibit water quality impairment.

Comparison of Santa Clara Stressor Assessment to RMC Regional Assessment

The analyses of stressor data association for Santa Clara bioassessment sites was similar to findings in the RMC Five-Year Bioassessment Report (BASMAA 2019). Regional biological condition, based on CSCI scores, was strongly associated with physical habitat variables and land use within the vicinity of the site. The percent of the land area within a 5 km radius of a site that is impervious appears to have the strongest relationship to CSCI scores based on the regional random forest model results. Regional biological condition, based on an algae diatom index, was moderately correlated with water quality variables, and less associated with physical habitat or landscape variables (note: the algae index used for the RMC report was different than the ASCI index used in this report).

However, the RMC report showed that nutrient variables (e.g., nitrate, total nitrogen, orthophosphate, phosphorus) did not correlate strongly with any of the biological indicator scores in the Bay Area, nor were nutrients ranked as important variables via the random forest model. These results are in contrast to the Santa Clara stressor data analyses which found that total nitrogen did significantly correlate to ASCI-H scores.

2.3.2.4 Biological Conditions in Urban Landscapes

The previous section shows that biological indicator scores appear highly sensitive to urbanization. The Spearman's rank correlation and random forest analyses of stressor association with biological conditions indicated that percent impervious area has the strongest relationship with both CSCI and ASCI-H scores. (Figure 2.10).

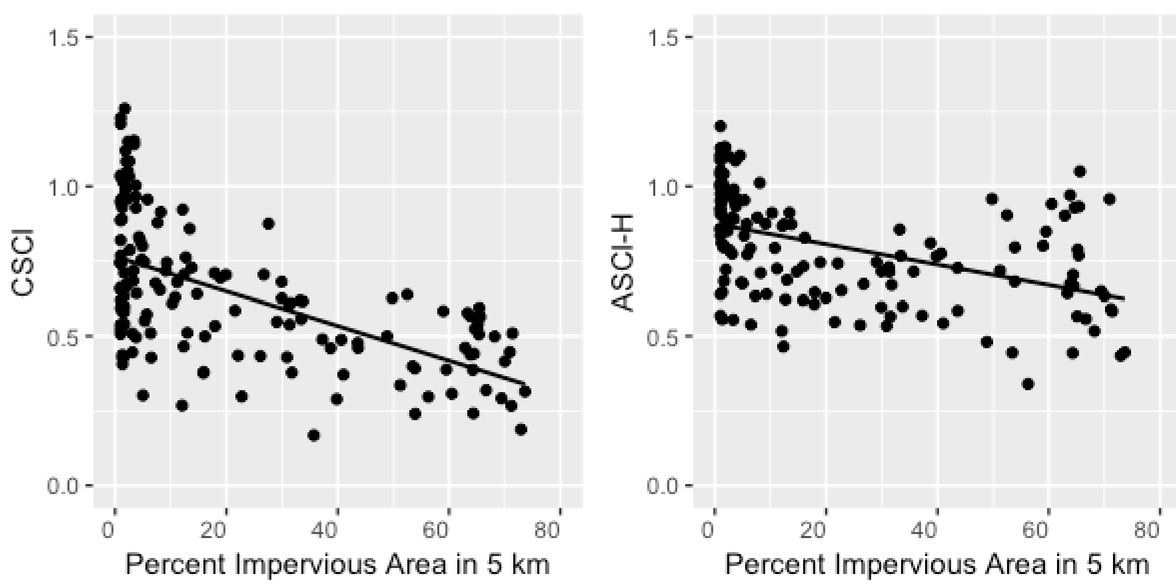

Figure 2.10. Percent Impervious Area in 5 km vs. CSCI and ASCI-H scores.

The distribution of CSCI and ASCI-H scores for the 172 bioassessment sites in the Santa Clara Basin, presented as box plots, is shown for three classes of urbanization, represented by percent watershed imperviousness (Figure 2.11). For highly developed watersheds (>10% impervious area), the median CSCI score was about 0.5 and all but three sites were below the MRP trigger (0.795). The variability in CSCI scores was lower at sites in highly developed watersheds, indicating that BMI communities are consistently impacted by stressors associated with urbanization.

Sites with a moderate level of urbanization (3-10%) had a median CSCI score of about 0.7. These sites ranged 0.3 to 1.2 in CSCI scores, indicating a much wider range of stressor impacts associated with urbanization (and other factors). Sites with a low level of urbanization (<3% impervious area) were generally in good biological conditions, with a median CSCI score of about 0.75. However, there were some low scoring sites, indicating non-urban stressors were impacting those sites.

Although, ASCI-H scores were generally higher compared to CSCI scores, they showed similar patterns with urbanization. The median ASCI-H score for highly developed watersheds was 0.68; for moderate levels of urbanization (0.77); and for lower levels of urbanization (0.97). The ASCI-H scores ranged 0.55 to 1.2 at sites in low urbanized watersheds, indicating that non-urban stressors impact biological conditions at some sites.

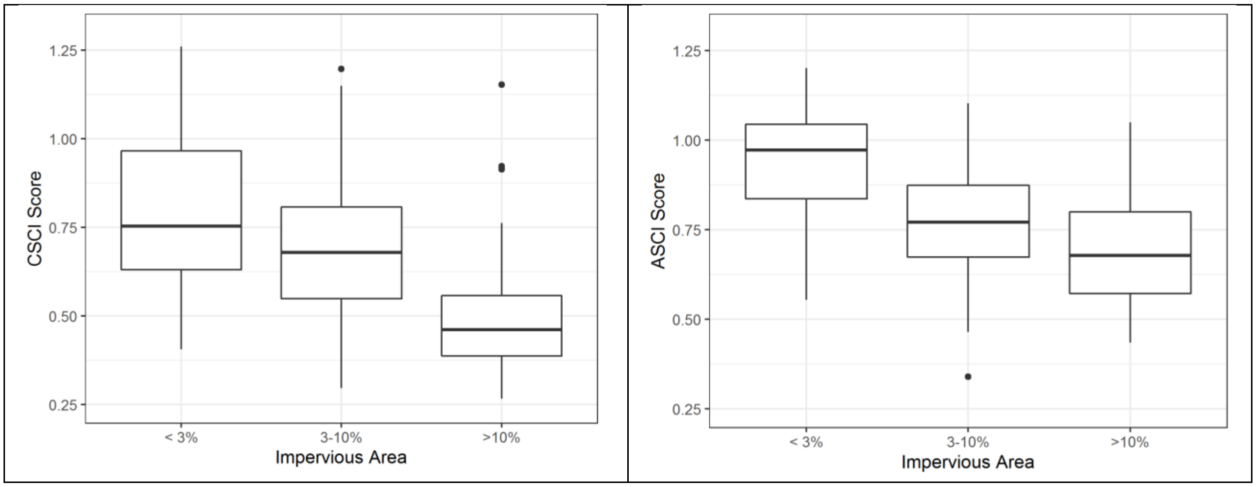

Figure 2.11. Box plots showing the distribution of CSCI and ASCI-H scores for 90 bioassessment sites in the Santa Clara Basin, grouped by three classes of percent watershed imperviousness.

2.3.3 Trend Analysis

This section addresses the third bioassessment monitoring management question presented at the beginning of Section 2.0 (i.e., *What are the long-term trends in water quality in creeks over time?*) by assessing the change in biological condition over several years. Changes in biological condition over time can help evaluate the effectiveness of management actions. For example, control measures, such as green stormwater infrastructure (GSI), implemented to disconnect impervious areas, should result in improved stream condition and water quality. Many of these measures are still in the planning phase and it may take decades to see their benefits. Therefore, more than eight years of data will be required to evaluate trends. In the interim, a preliminary trend analysis is presented using more recent probabilistic data and historic data collected at targeted sites prior to adoption of MRP 1.0.

Figure 2.12 shows the distribution of CSCI scores calculated for urban sites for each year of MRP monitoring (WY 2012 – WY 2019). Over the eight-year monitoring period, biological conditions, based on CSCI scores, have been highly variable at urban sites (median scores ranging 0.4 to 0.7). These results suggest that there is wide range of biological conditions at urban sites, as well as potential variation in conditions due to changes in environmental conditions from year to year (e.g., precipitation, temperature).

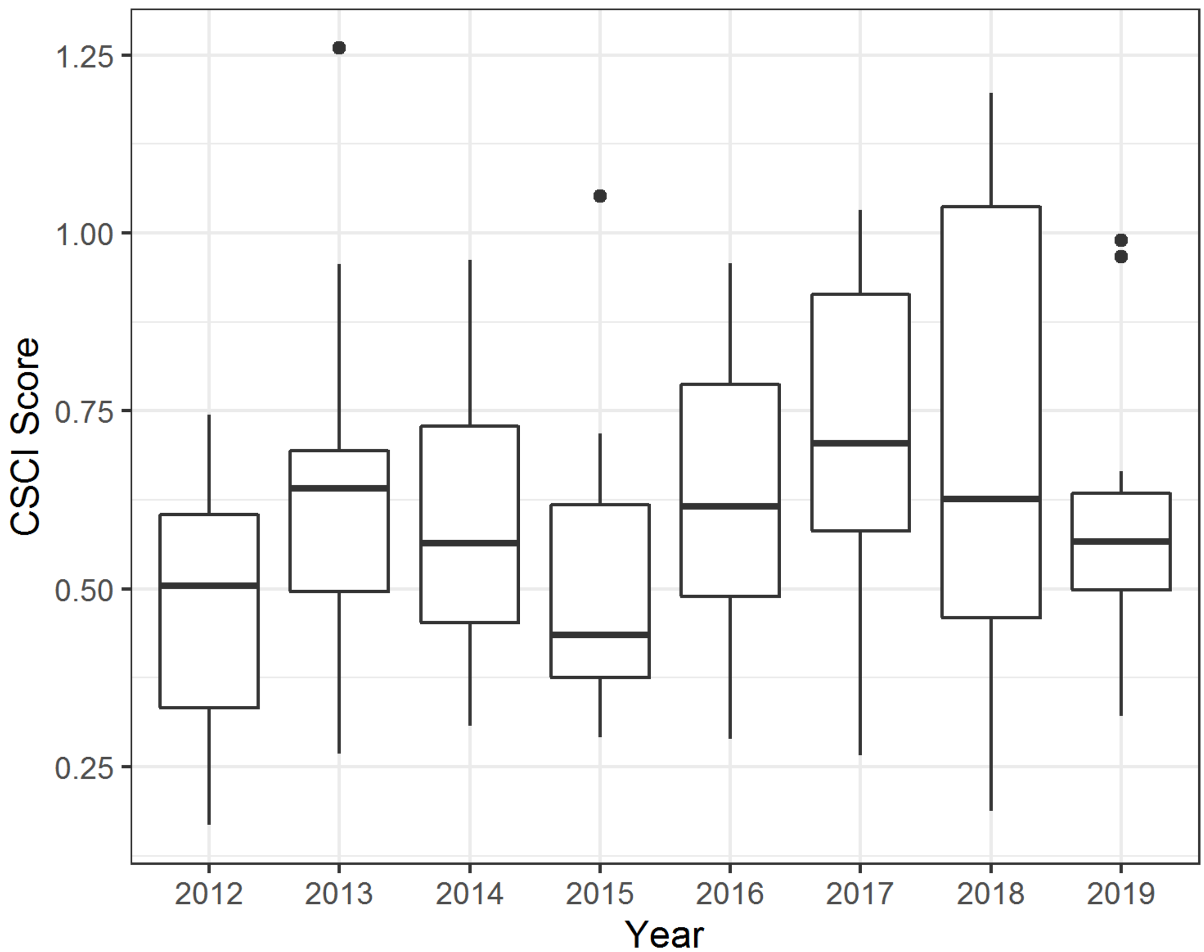

Figure 2.12. Box plots showing the distribution of CSCI scores at urban sites in Santa Clara County, WY 2012 – WY 2019.

<u>Comparison of MRP Data to Historic Data</u>

The Program conducted bioassessments in nine watersheds between 2003 and 2009 as part of watershed assessment and monitoring requirements in its municipal stormwater NPDES Permit (Pre-MRP). There were 76 bioassessment surveys completed in Santa Clara County watersheds during the Pre-MRP time period. The number of sites within each watershed for both Pre-MRP and MRP time periods are shown in Table 2.13.

Bioassessment sampling during the Pre-MRP time period was conducted using the California Stream Bioassessment Protocol (CSBP), a different methodology than the SWAMP Bioassessment Reachwide Protocol which was implemented during the MRP. The CSBP was the standardized methodology developed by California Department Fish and Wildlife for bioassessments conducted in streams throughout California. BMI samples collected using the CSBP method have been shown to produce taxonomic metric scores similar to the SWAMP protocol. In addition, the level of taxonomic identification (SAFIT Level 1+) is consistent for samples collected and analyzed during Pre-MRP and MRP, which allows for a consistent and standard approach to calculate CSCI scores.

Biological conditions based on CSCI scores during the Pre-MRP and MRP time periods were compared for six Santa Clara County watersheds/subwatersheds. The sample time frames were approximately 7-10 years apart. During the Pre-MRP monitoring period, several sites were sampled two consecutive years; the average CSCI score was used for these sites. The distribution of CSCI scores for each watershed, grouped by the Pre-MRP and MRP time periods is shown in Figure 2.13. Median CSCI scores were similar for majority of the watersheds between the two sampling periods, with the exception of Saratoga Creek, with had overall much higher scores during the Pre-MRP sample period. The difference in scores for Saratoga Creek could be explained by different sampling locations in the watershed; the majority of sampling locations in Saratoga Creek during the Pre-MRP were located in the upper reaches, where CSCI scores are expected to be higher.

Table 2.13. Total number of bioassessment surveys conducted by SCVURPPP, grouped by watershed, during Pre-MRP and MRP time periods.

Watershed	Subwatershed Area	Pre-MRP	MRP
Alameda Creek	Upper Alameda Creek	0	6
Lower Penitencia Cr	Lower Penitencia Creek	4	9
Coyote Creek	Coyote Creek Mainstem	12	9
	Upper Penitencia Creek	7	13
	Silver Cr/Thompson Cr	7	11
	Upper Coyote Watershed	0	14
Guadalupe River	Guadalupe River	8	12
	Alamitos Creek	4	11
	Guadalupe Creek	4	9
	Los Gatos Creek	5	19
San Tomas Aquino	San Tomas Aquino	1	14
	Saratoga Creek	7	14
Calabazas Creek	Calabazas Creek	4	7
Permanente Creek	Permanente Creek	6	3
Stevens Creek	Stevens Creek	7	12
Adobe Creek	Adobe Creek	4	3
Matadero Creek	Matadero Creek	4	2
San Francisquito Cr	San Francisquito Creek	0	4
	Total Sites	76	172

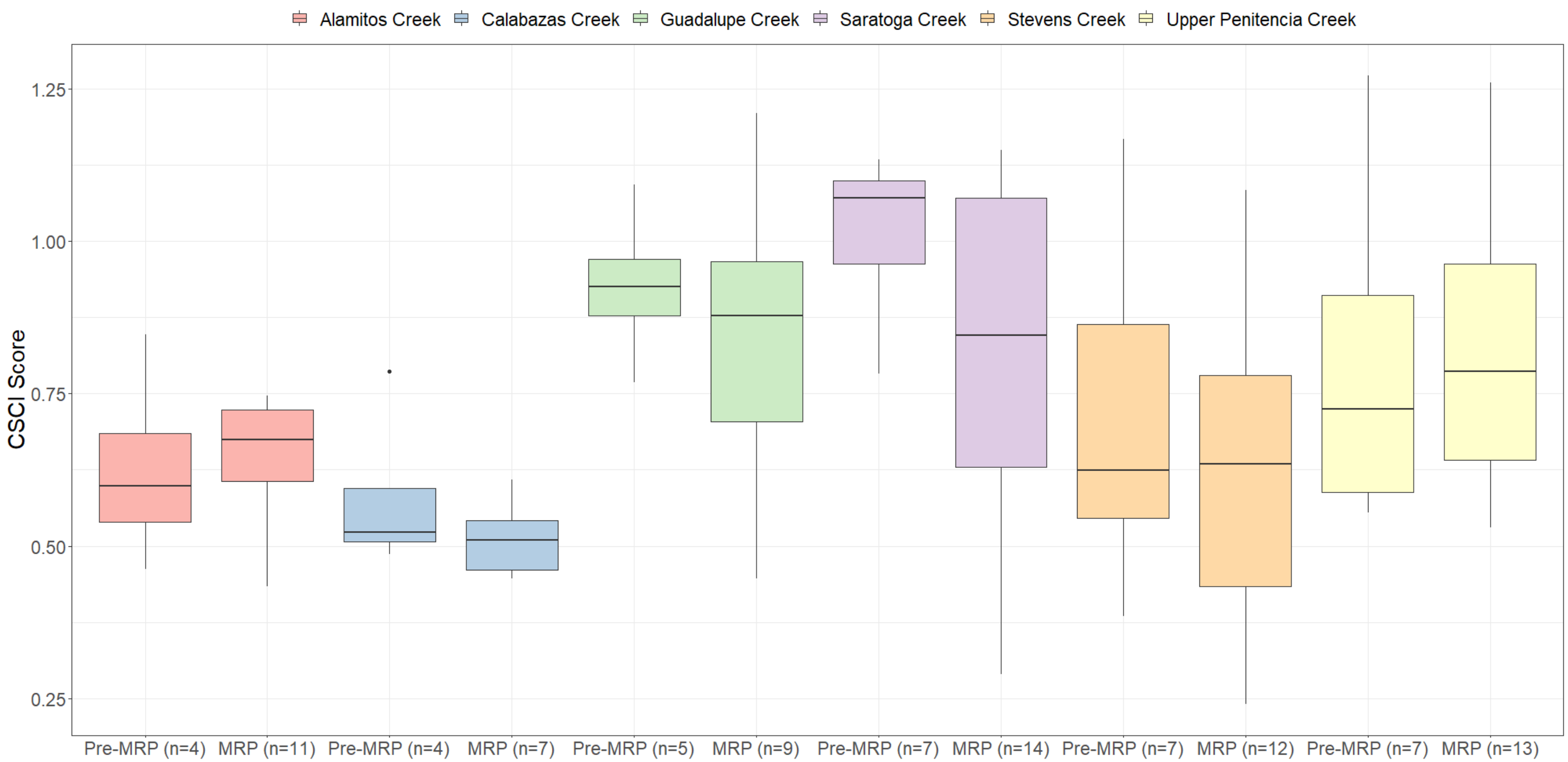

Figure 2.13. Distribution of CSCI scores at sites in six Santa Clara County watersheds that were sampled during Pre-MRP (WYs) and MRP (WYs 2012-2019) time periods.

A comparison of CSCI scores at nine individual sites sampled during the two sampling periods is shown in Table 2.14. Site IDs for pre-MRP and MRP sites vary, but the sites compared for this analysis were generally less than 100 feet apart from each other. Five of the nine sites had very similar scores (< 0.06 points difference). The remaining sites had differences that ranged 0.13 to 0.25 points; of these three sites had lower scores during MRP sampling event and one site had a higher score.

It is important to note that biological condition, based on CSCI scores, can be influenced by many factors that were not evaluated as stressor data. These factors may include the following: timing and magnitude of storm events during sampling index period, variable antecedent conditions (e.g., precipitation, temperature) and changes in management actions (e.g., operations related to water releases from reservoirs or diversions). It is not clear, especially with such a small sample size, what factors might be associated with general temporal trends of improved or reduced biological conditions at these watersheds/sites.

Table 2.14. CSCI scores for bioassessments conducted at nine Santa Clara County sites during two different monitoring periods: Pre-MRP and MRP.

Site	Creek	Date	CSCI
205STE060	Stevens Creek downstream I-680	2006	0.61
205R03235		2017	0.86
205STE070	Stevens Creek at Stevens County Park (below dam)	2006	0.49
205R01187		2014	0.43
205STE070		2019	0.44
205GUA060	Los Gatos Creek at Creekside Way	2009	0.60
205GUA060		2019	0.57
205GUA050	Los Gatos Creek downstream Lincoln Ave	2009	0.57
205R01539		2014	0.58
205GUA330	Arroyo Calero upstream confluence with Alamitos Cr	2009	0.85
205R02422		2016	0.72
205GUA180	Guadalupe River downstream Blossom Hill	2009	0.64
205R00346		2012	0.48
205COY140	Upper Penitencia Creek in Alum Rock Park	2003	1.27
205R00787		2013	1.26
205COY184	Lower Silver Creek at Kammerer Ave	2008	0.54
205R01747		2015	0.37
205COY330	Coyote Creek in Hellyer County Park	2007	0.60
205R00218		2012	0.54

2.4 Considerations for Future Bioassessment Monitoring

The RMC bioassessment dataset provides a comprehensive survey of stream health throughout the San Francisco Bay Area. The probabilistic design allows for an evaluation of ambient stream conditions using biological indicators and stressor data at regional and countywide scales. These data provide stormwater programs with an understanding of existing stream conditions that can assist in the decision-making process for future management actions, as well as baseline conditions that can be re-evaluated over time to assess trends.

The urban sites for most counties within the RMC sample frame will be exhausted (i.e., either sampled or evaluated) following Creek Status Monitoring during WY 2020. As result, the RMC is currently evaluating options for revising the monitoring design to address the Creek Status Monitoring requirements anticipated under MRP 3.0. One of the options under consideration by the RMC is to implement a targeted monitoring design that would focus on specific watersheds or reaches of interest. A watershed approach would provide stormwater programs more flexibility to evaluate priority areas that stakeholders want to improve, protect, or learn more about. The following objectives could be used to guide the monitoring design:

- Address existing problems (e.g., poor biological conditions, water quality issues) at locations where implementation of potential management actions is practical and feasible.
- Evaluate changes in biological conditions and/or water quality at locations that are likely affected by planned management activities.
- Actively monitor and manage areas that are in good condition.

Examples for each of these approaches are provided in section below:

2.4.1 Investigate Sites with Reduced Biological Conditions

The RMC dataset indicates a majority of urban streams are in poor condition. Biological conditions were poor (i.e., lowest two condition categories) at 80% and 75% of the bioassessment sites classified as urban, based on CSCI and ASCI-H scores, respectively. This finding suggests that stressors associated with urban streams (e.g., poor physical habitat, hydromodification) may result in too many constraints to achieve biological conditions that are targeted in the MRP (i.e., greater than CSCI score 0.79). Therefore, stormwater programs may want to focus future monitoring resources on better understanding the biological conditions of urban sites/reaches that have a higher potential for improved conditions due to management actions.

The SCAPE tool (discussed in Section 2.2.4.7) provides a context for evaluating stream health by estimating an expectation of biological condition at a given stream reach relative to landscape constraints. Biological condition, based on CSCI scores, can be compared to the reach expectation. As an example, CSCI scores for 16 sites sampled in Stevens Creek watershed over an eight-year period were compared to the range of scores predicted by the landscape model (Figure 2.14). The predicted range of CSCI scores for these sites fall into three stream classifications: likely constrained (dark red), possibly unconstrained (light blue), likely unconstrained (dark blue). The CSCI scores for bioassessment sites (i.e., Relative Site Score) are represented by either circles or triangles superimposed over the predicted range of CSCI scores estimated by the model. Sites that have CSCI scores higher than model predictions are depicted by an up-pointing triangle symbol (i.e., “over scoring”); sites with CSCI scores lower than model predictions were depicted by an inverted triangle (i.e., under scoring”).

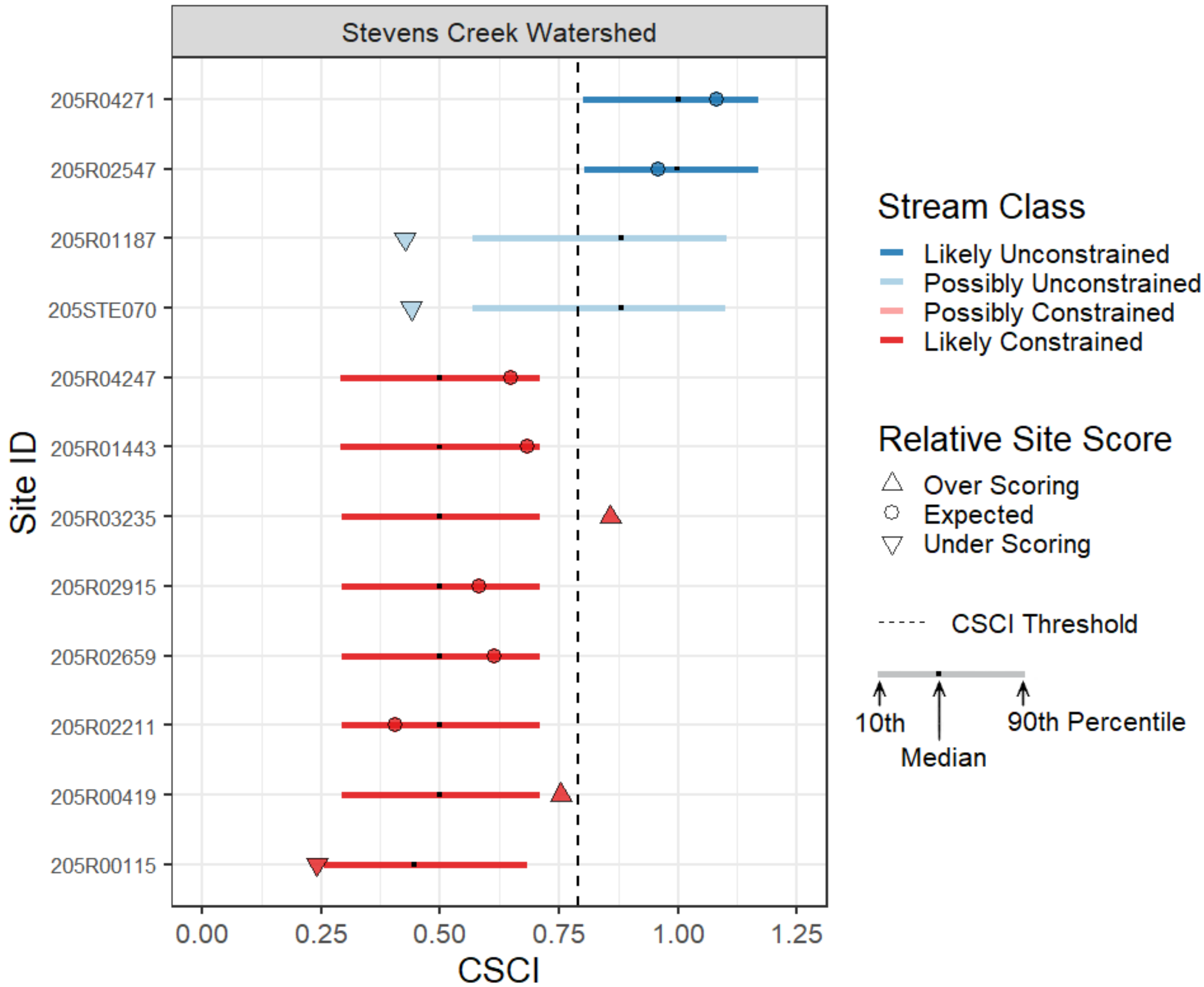

Figure 2.14. Comparison of CSCI scores for 12 sites in the Stevens Creek watershed with predicted model of CSCI scores based on developed landscapes (Beck et al. 2020)

There were three “under scoring” sites in Stevens Creek watershed. Two sites (205R01187 and 205STE070) were below the expected CSCI scores for possibly constrained channel (Figure 2.12). Both of these sites were about half mile downstream of the Stevens Creek dam in Stevens County Park. The third site (205R00115), located upstream of Highway 101, was below the expected score for likely constrained channel. These three sites indicate biological conditions that may have impacts beyond what is predicted from the developed landscape model. These impacts may be associated with physical habitat and water quality issues related to water releases from the reservoir or other factors not associated characteristics included in the model. Follow-up monitoring could be implemented at these sites to evaluate important stressors impacting conditions, and further illuminate management actions that could improve bioligcal condition at these sites.

In addition to the "under scoring" sites, two of the sampling locations in Stevens Creek scored above the expected CSCI score for a likely constrained channel. One site (205R00419) was located at Blackberry Farm (Cupertino), a reach that has recently been restored. The second site (205R03235) was located in highly modified reach downstream of Interstate 280. The highest scoring sites were in likely unconstrained channel within the upper reaches of Stevens Creek in the Monte Bello Open Space District land. Continued monitoring at these sites may provide additional information the importance of restoration projects and other factors when evaluating biological conditions.

2.4.2 Evaluate Sources and Impacts of Potential Stressors

Targeted monitoring design could also focus on sites where bioassessment data exceeded stressor thresholds or water quality objectives. Although not currently a Water Quality Objective or listed as a MRP trigger, nutrient concentrations (e.g., total nitrogen, total phosphorus) and algal biomass indicators (e.g., chlorophyll a) are potential water quality stressors that may impact biological conditions (Sutula et al 2018).

Comparisons of total nitrogen concentrations to CSCI and ASCI-H scores for 172 bioassessment sites sampled in Santa Clara County are presented in Figure 2.15. The random forest model results indicated that total nitrogen was an important stressor contributing to the variability in ASCI-H scores.

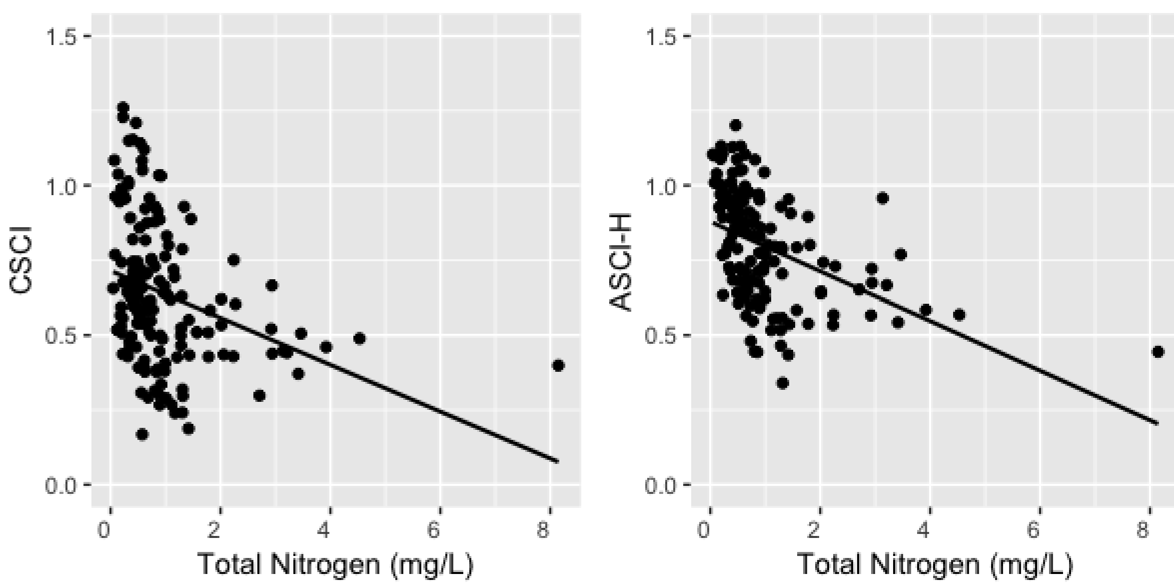

Figure 2.15. Total Nitrogen vs. CSCI and ASCI-H scores for 172 sites in Santa Clara County.

Follow-up monitoring could be conducted to evaluate sites with elevated concentrations of nutrients. Total nitrogen concentrations for 172 bioassessment sites in Santa Clara County are shown in Figure 2.16. There were ten sites that had concentrations of total nitrogen greater than 3.0 mg/L (red symbol on map). Four of the ten sites were in Lower Silver Creek, tributary to Coyote Creek. The Program is currently evaluating sources of nutrients in Lower Silver Creek as part of Stressor Source Identification Project (see Part C of the IMR). Additional studies like the SSID project in Lower Silver Creek may assist with identifying and addressing key water quality stressors via targeted monitoring.

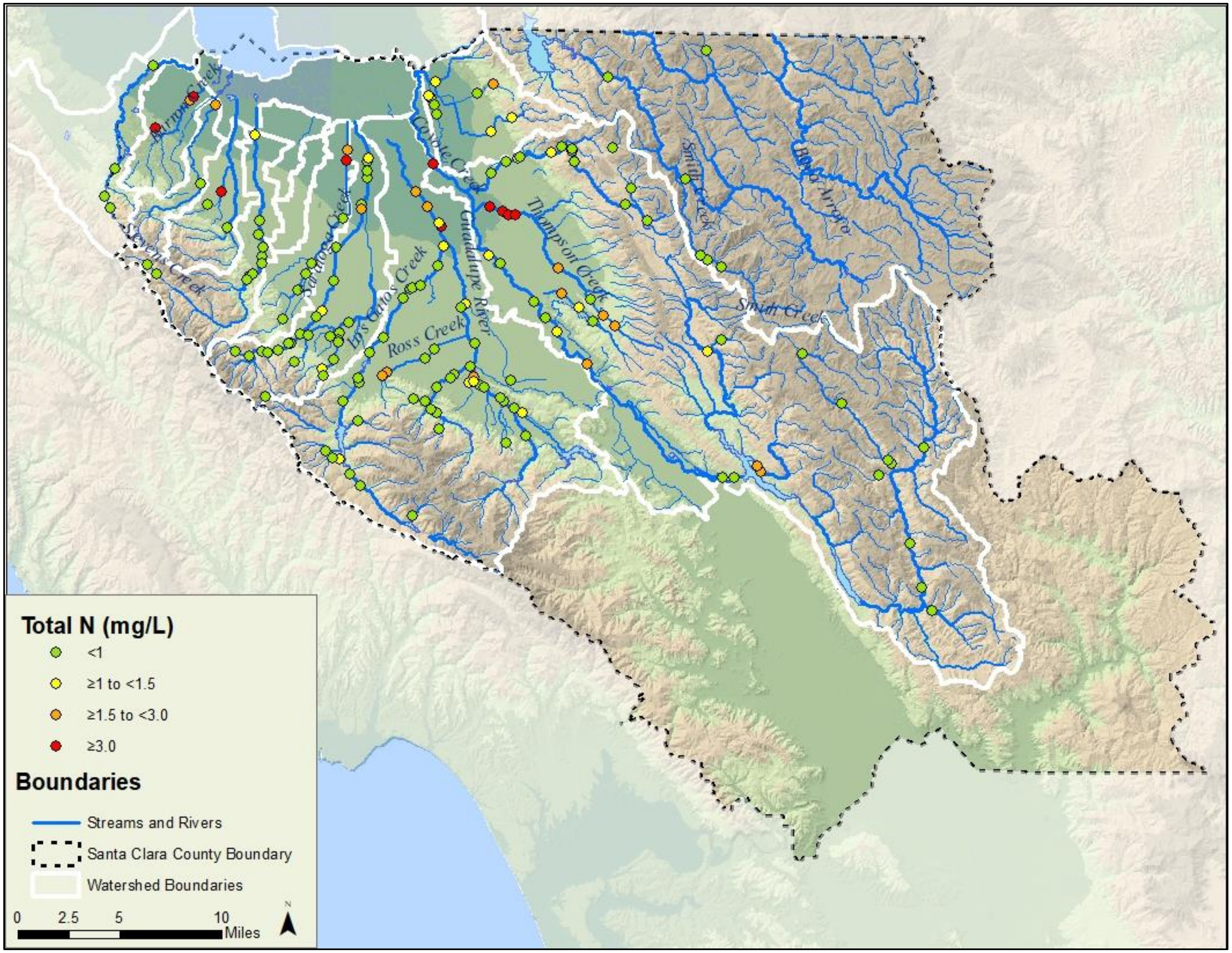

Figure 2.16. Total nitrogen concentrations measured at 172 bioassessment sites in Santa Clara County sampled between WY 2012 and WY 2019.

2.4.3 Evaluate Effectiveness of BMP/Restoration Projects

Bioassessment monitoring could be conducted at stream locations that may be impacted by stream restoration or best management practices (BMPs), such as Green Stormwater Infrastructure (GSI) projects. Benthic macroinvertebrate indicators are often used to evaluate the success of stream restoration projects (Rubin et al. 2017). BMIs can be good indicators that show response to changes in physical habitat, as well as water quality. The CSCI score provides an overall measure of biological conditions, however, individual BMI metrics can provide useful information related to presence or absence of specific stressors (e.g., fine sediment).

The RMC dataset may provide information on baseline conditions at locations where projects are currently planned or recently constructed (see Section 2.3.1.3). Stormwater programs could conduct future bioassessments following the completion of restoration or GSI projects to evaluate if conditions have improved. Effectiveness monitoring should be considered in all restoration projects as one measure of success.

2.4.4 Evaluate Sites in Good Condition

Many of the bioassessment sites sampled by SCVURPPP and SWAMP are located in publicly protected lands that have limited or no urban development. Of the 172 bioassessment sites sampled in the Santa Clara Basin between WY 2012 and 2019, 28 received high biological condition scores for both BMI (CSCI > 0.79) and algae (ASCI-H > 0.88) (Figure 2.17). Six of these sites were located on privately-owned lands.[19] The remaining 22 sites were in public lands, including State Parks, County Parks, City Parks, Open Space Districts, and watersheds protected by water utility agencies (e.g., Valley Water, San Francisco Public Utilities Commission,San Jose Water Company).

Stormwater programs should ensure that information on high quality sites is made available to park and land managers so that these areas can be managed in a way that protects stream health and water quality. Follow-up monitoring may also be conducted to evaluate whether biological conditions are changing over time. Trends monitoring at minimally disturbed sites may also provide useful information related to climate change, and its effects on biological conditions in Santa Clara Basin streams.

[19] Field crews obtained permission to access private property to conduct bioassessment sampling.

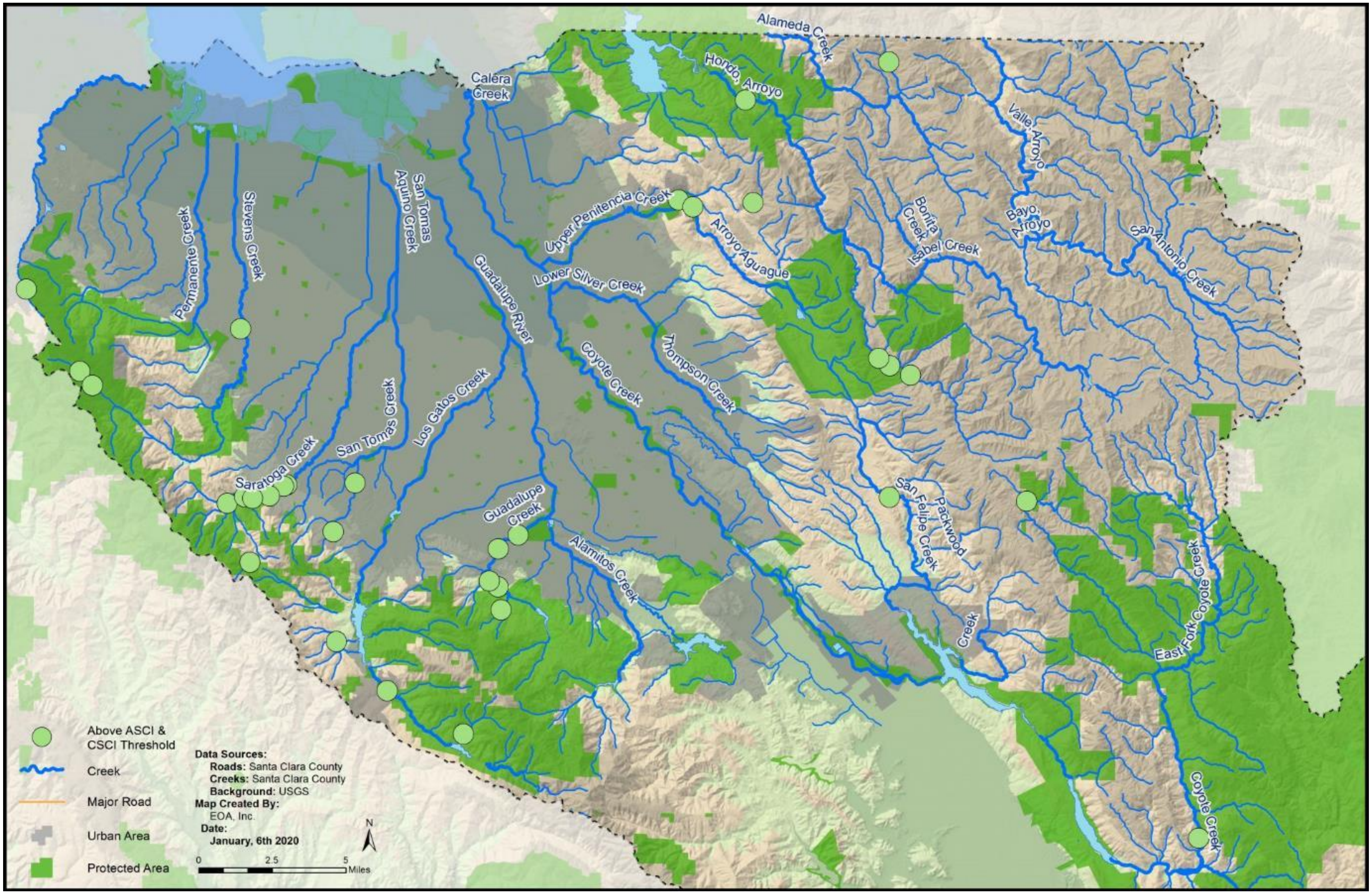

Figure 2.17. Protected areas in Santa Clara County and bioassessment sites with scores in the top two condition categories for CSCI and ASCI-H.

3.0 CONTINUOUS WATER QUALITY MONITORING

3.1 Introduction

This section describes continuous water temperature and general water quality data that were collected during WY 2014 through WY 2019. These parameters were monitored in compliance with Creek Status Monitoring Provisions C.8.c of MRP 1.0 and C.8.d.iii – iv of MRP 2.0. Monitoring was conducted at selected sites using a targeted design based on the directed principle[20] to address the following management questions:

1. *What is the spatial and temporal variability in water quality conditions during the spring and summer season?*
2. *Do general water quality measurements indicate potential impacts to aquatic life?*

The first management question is addressed primarily through evaluation of water quality results in the context of existing aquatic life uses. Temperature and general water quality data were evaluated for potential impacts to different life stages and overall population of fish community present within monitored reaches.

The second management question is addressed primarily through the evaluation of targeted data with respect to water quality objectives and thresholds from published literature. Sites where exceedances occur may indicate potential impacts to aquatic life or other Beneficial Uses and are considered as candidates for future Stressor/Source Identification projects.

The sections below summarize methods and results from continuous temperature and water quality monitoring conducted in WY 2014 – WY 2019. Conclusions and recommendations for continuous monitoring are presented in Section 7.0.

3.2 Methods

In compliance with MRP 1.0 and MRP 2.0, temperature was monitored at a minimum of eight sites each year, and general water quality was monitored at three sites each year. Continuous temperature and water quality data were collected in accordance with SWAMP-comparable methods and procedures described in the BASMAA RMC SOPs (current version is BASMAA 2016a) and associated QAPP (current version is BASMAA 2016b). Data were evaluated with respect to MRP 1.0 provision C.8.c and MRP 2.0 provision C.8.d triggers for each parameter.

3.2.1 Continuous Temperature

Digital temperature loggers (Onset HOBO Water Temp Pro V2) were programmed to record data at 60-minute intervals. The loggers were deployed at targeted sites from April through September. Procedures used for calibrating, deploying, programming and downloading data are described in RMC SOP FS-5 (BASMAA 2016a). SCVURPPP typically deploys temperature loggers at more than the minimum number of sites in anticipation of field equipment being stolen or washed downstream.

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[20] Directed Monitoring Design Principle: A deterministic approach in which points are selected deliberately based on knowledge of their attributes of interest as related to the environmental site being monitored. This principle is also known as "judgmental," "authoritative," "targeted," or "knowledge-based."

3.2.2 Continuous General Water Quality

Water quality monitoring equipment recording dissolved oxygen, temperature, conductivity, and pH (YSI 6600 data sondes) were programmed to record data at 15-minute intervals. The sondes were deployed at targeted sites for two 1 to 2-week events each year: spring season (Event 1) and late-summer season (Event 2). Procedures for calibrating, deploying, programming and downloading data are described in RMC SOP FS-4 (BASMAA 2016a).

3.2.3 Data Evaluation

Continuous temperature and water quality data are analyzed and evaluated to identify potential stressors that may be contributing to degraded or impacted biological conditions, including exceedances of WQOs. The relevant trigger criteria for continuous temperature and water quality data are listed in Table 3.1. Sites with continuous monitoring results exceeding the trigger criteria are identified as candidate SSID projects.

Table 3.1. Water Quality Objectives and trigger thresholds used for evaluation of continuous temperature and water quality data.

Monitoring Parameter	Objective/Trigger Threshold	Units	Source
Temperature	Two or more weekly average temperatures exceed the MWAT threshold of 17.0°C for a Steelhead stream, or when 20% of the results at one sampling station exceed the instantaneous maximum of 24°C.	°C	MRP 2.0 provision C.8.d.iii Sullivan et al. 2000
General Water Quality Parameters	20% of results at each monitoring site exceed one or more established standard or threshold - applies individually to each parameter		
Conductivity	2000	µS/cm	MRP 2.0 provision C.8.d.iii
Dissolved Oxygen	WARM < 5.0, COLD < 7.0	mg/L	SF Bay Basin Plan Ch. 3, p. 3-4
pH	> 6.5, < 8.5 [1]	pH	SF Bay Basin Plan Ch. 3, p. 3-4
Temperature	Same as Temperature (See Above)		

[1]. Special consideration will be used at sites where imported water is naturally causing higher pH in receiving waters.

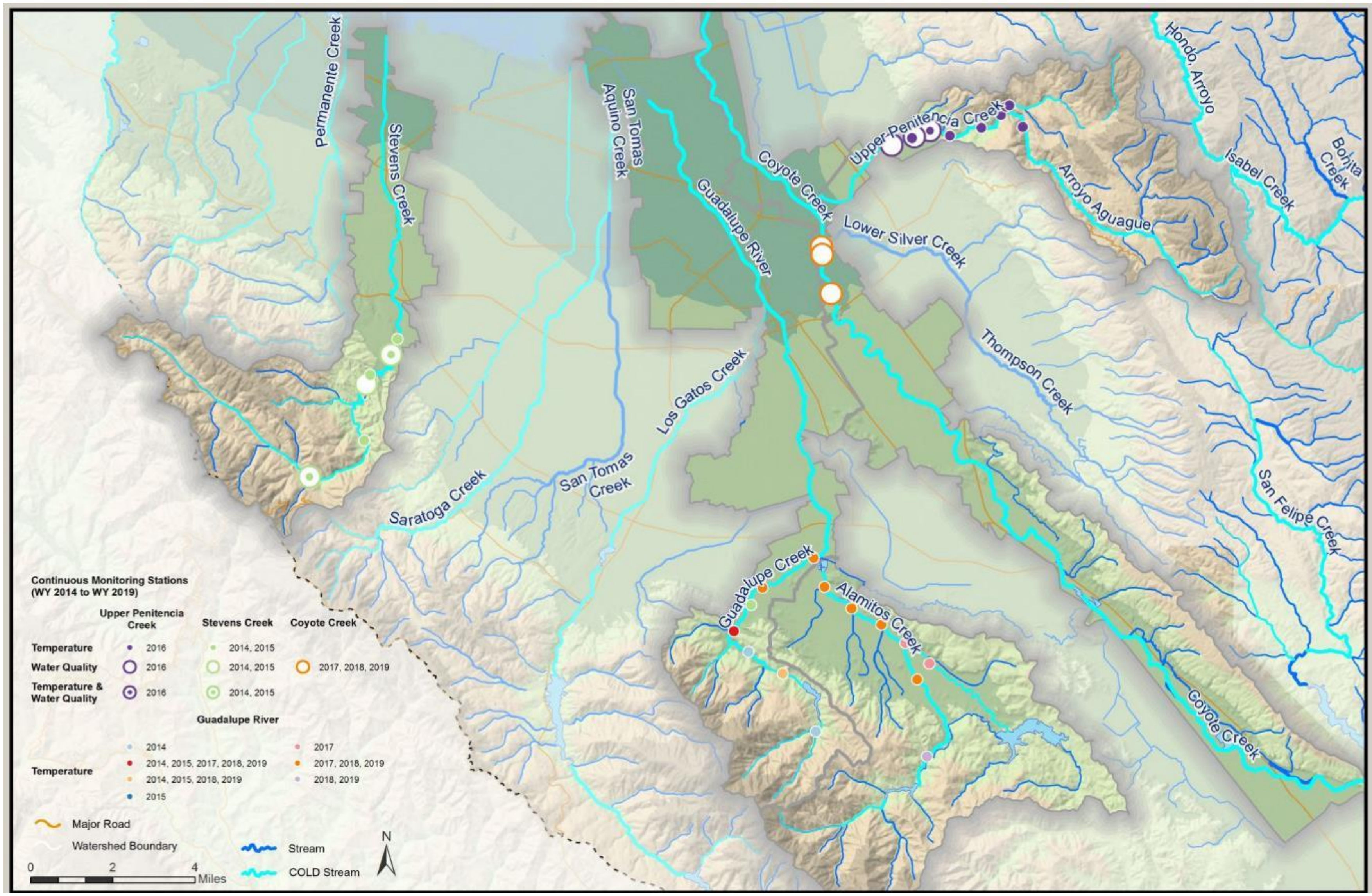

Figure 3.1. Continuous temperature and water quality monitoring stations, Santa Clara Basin, WY 2014 – WY 2019.

3.3 WY 2014 – WY 2019 Overview

Continuous temperature and water quality monitoring sites were selected based on the presence of significant fish and wildlife resources as well as historical and/or recent indications of water quality concerns. The same sites were often monitored for multiple years to gain a better understanding of the range of water quality conditions that may occur over time. In some years, continuous monitoring data were used to support or follow-up on SSID investigations.

Figure 3.1 illustrates the stations and watersheds where continuous temperature and water quality monitoring was conducted during WY 2014 through WY 2019. For reference, Figure 3.1 shows which creeks are designated in the Basin Plan as having COLD Beneficial Uses. Continuous monitoring stations were focused at stream reaches within Stevens Creek Watershed (WY 2014 – WY 2015), Upper Penitencia Creek Watershed (WY 2016), Coyote Creek Watershed (WY 2017 – WY 2019; water quality sondes only), and Guadalupe River Watershed (WY 2014 – WY 2015 and WY 2017 – WY 2019; temperature only).

The sections below summarize monitoring results from WY 2014 – WY 2018. Details are available in the respective UCMRs (SCVURPPP 2015, 2016, 2017, 2018, and 2019). Results from WY 2019 continuous monitoring are detailed in this IMR in Section 3.4.

3.3.1 Stevens Creek Watershed (WY 2014 – WY 2015)

Continuous general water quality data (dissolved oxygen, specific conductance, pH, and temperature) were recorded at three locations in the Stevens Creek watershed (Figure 3.1). during two two-week deployments in WY 2014 and WY 2015 (four total events) (SCVURPPP 2015 and SCVURPPP 2016). Two of the sampling stations were located at WY 2014 probabilistic bioassessment sampling locations within the urban area below Stevens Creek Reservoir. These locations were selected to provide water quality data in a reach that supports both rearing and spawning habitat for the existing steelhead population. The third sampling location was established near the urban boundary approximately three miles upstream of the Stevens Creek Reservoir. The upper station was selected to provide water quality data in a perennial reach of the creek upstream of reservoir influence.

Overall, general water quality conditions measured in Stevens Creek during the four monitoring events were supportive of COLD Beneficial Uses. No triggers for specific conductance or pH were exceeded during the spring and late-summer monitoring events in either year. In WY 2014, dissolved oxygen concentrations were notably lower at the stations below the reservoir compared to the station above the reservoir and the trigger was exceeded (> 20% of results were below 7 mg/L). However, in WY 2015, no dissolved oxygen triggers were exceeded, suggesting that low dissolved oxygen conditions below the reservoir do not occur every year and may be associated with, climatic variations, reservoir operations, or ambient water quality conditions in the reservoir. In general, dissolved oxygen was higher in the spring compared to late summer when water temperatures were warmer. Temperatures rarely exceeded the 24°C acute threshold for salmonids; however, the maximum weekly average temperature (MWAT) threshold of 17°C was exceeded at the stations below the reservoir during the late summer event in both years.

3.3.2 Stevens Creek/Guadalupe Creek Temperature Comparison (WY 2014 – WY 2015)

In WY 2014 and WY 2015, temperature logging devices were deployed from April through September at five stations in the Stevens Creek Watershed (two above and three below the reservoir) and five stations in the Guadalupe Creek Watershed (one above and four below the reservoir) (SCVURPPP 2015 and SCVURPPP 2016). The logger installed above the Guadalupe Reservoir was not found or retrieved in WY 2015. Median water temperatures were generally coolest at the sites directly below the reservoirs, gradually increasing at each site in the downstream direction. The maximum instantaneous trigger threshed of 24°C was not exceed at any station in either year. However, the MWAT trigger of 17°C was exceeded at multiple stations downstream of the reservoirs in both creeks.

3.3.2 Upper Penitencia Creek Watershed (WY 2016)

In WY 2016, all continuous monitoring was conducted in the Upper Penitencia Creek watershed. Reaches within Alum Rock Park, in the upper watershed, are perennial and support both rearing and spawning habitat for steelhead, as well as other native fishes (Stillwater 2006). The lower watershed is characterized by urban development, unconfined geology conducive to infiltration, and seasonal flows that are supplemented by releases of imported water from the Robert Gross Percolation Ponds, operated by Valley Water. Pond releases typically begin after the lower watershed has ceased flowing in the spring and persist through late July. The WY 2016 continuous monitoring data were used to support an SSID project in Upper Penitencia Creek by evaluating a range of potential stressors that may cause reduced biological condition. Results from the SSID study are presented in SCVURPPP (2017) and summarized in Part C of this IMR.

Monitoring results from WY 2016 indicate that the upper reaches of Upper Penitencia Creek in Alum Rock Park have temperatures that support juvenile steelhead populations through the dry season. The MWAT (17°C) threshold for steelhead was generally not exceeded at the four upper elevation sites. However, temperatures at the four lower elevation sites do not appear to be optimal for juvenile steelhead rearing habitat.

Continuous water quality data were collected at three locations within Upper Penitencia Creek during a two-week event in April 2016 and a two-week event in June in 2016. Dissolved oxygen and specific conductivity results were generally within ranges supportive of aquatic life. Dissolved oxygen concentrations, however, dropped below WQOs for WARM freshwater habitat at the lowest elevation station, possibly in response to low flow conditions. The MRP trigger for pH was exceeded at two monitoring stations, possibly as a result of water releases from upstream percolation ponds into the creek.

3.4 WY 2017 - WY 2019 Results

3.4.1 Continuous Temperature Study Area (Guadalupe River Watershed)

In WY 2017 – WY 2019, continuous (hourly) water temperature measurements were collected from April through September at locations in the Guadalupe River watershed. In WY 2017, monitoring was conducted in three creeks: Alamitos Creek, Arroyo Calero, and Guadalupe Creek (Figure 3.2). All three creeks are impounded by large dams located at the base of the Santa Cruz Mountains. The temperature monitoring locations were downstream of the reservoirs in reaches flowing through the Santa Clara Valley. The upper watershed areas for these creeks include rangeland and forested land uses within Almaden Quicksilver County Park and the Sierra Azul Open Space Preserve. The lower watershed areas are primarily residential land uses within the City of San José. Guadalupe Creek and Alamitos Creek support spawning and rearing habitat for steelhead, although fish are less abundant in the unshaded, warm section of Guadalupe Creek downstream of Camden Avenue (Smith 2013).

In WY 2018, monitoring in Arroyo Calero at stations 205GUA225 and 205GUA340 was eliminated and two stations, closer to the reservoirs on Guadalupe Creek and Alamitos Creek, were added. These new sites were selected to evaluate water temperatures in reaches closer to the reservoirs. Both reservoirs are owned and operated by Valley Water and are primarily used for water supply, although they also provide some flood protection by containing runoff during the wet season. Releases during the late summer also improve water quality and aquatic habitat conditions in lower reaches of the creeks that would otherwise go dry.

In WY 2019, temperature loggers were deployed at nine sites in the Guadalupe River watershed (Figure 3.2) on April 9, 2019, checked and downloaded on July 3, 2019, and removed on September 19, 2019 (24 weeks).

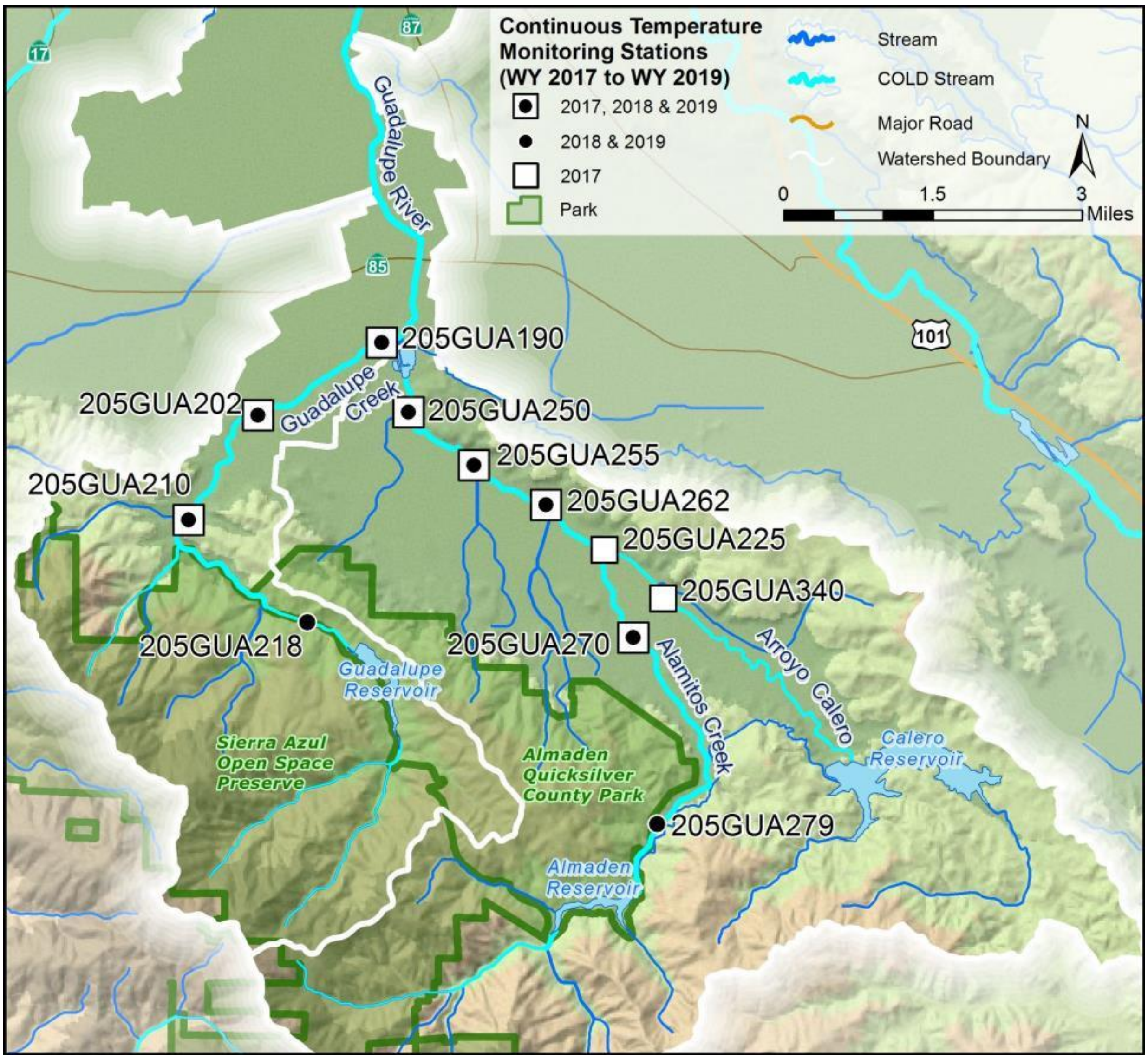

Figure 3.2. Continuous temperature stations in the Guadalupe River watershed, WY 2017 - WY 2019.

3.4.2 Continuous Temperature Results and Discussion

Summary statistics for continuous water temperature data collected at the nine sites monitored in WY 2019 are listed in Table 3.2. The number and percent of measurements from each site that exceed the instantaneous maximum temperature trigger of 24°C is shown in the table. Temperatures greater than 24°C were recorded in Guadalupe Creek at station 205GUA190 (in July and August) and in Alamitos Creek at station 205GUA250 (during the month of August). However, these temperatures comprised <1% of the total measurements recorded. Therefore, the trigger threshold for instantaneous maximum temperature at these sites was not exceeded.

Weekly average temperature values calculated for each of the nine WY 2019 monitoring sites are listed in Table 3.3. Consistent with MRP 2.0 requirements, the values were calculated for non-overlapping, seven-day periods. Weekly average temperatures across all the sites ranged from lows of 11.7°C (205GUA218) to 15.7°C (205GUA250) recorded during the month of April to highs of 20.3°C (205GUA210) to 22.4°C (205GUA218) recorded during the month of September. Similar to the results from WY 2017 and 2018, the MWAT trigger was exceeded in two or more weeks at all sampling locations in WY 2019. As a result, all nine sites were added to the list of potential sites considered for SSID projects.

WY 2017 – WY 2019 instantaneous temperature data (hourly) for monitoring sites in Guadalupe Creek and Alamitos Creek are shown in Figures 3.3 and 3.4, respectively. WY 2019 weekly average temperature values for sites in Guadalupe Creek and Alamitos Creek are shown in Figures 3.5 and 3.6, respectively. These time series figures illustrate how water temperatures generally increase throughout the summer months of June through August followed by a slow decline by mid/late September. Figures 3.3 and 3.4 show the same general pattern for all three years. Minor differences in the general pattern appear to be explained by large fluctuations in air temperature that differ from year to year. For example, the higher water temperatures recorded in September 2017 coincide with a heatwave that exhibited some of the highest air temperatures for that month on record.

Water temperatures were relatively consistent for all three Water Years, with the exception of the station closest to Guadalupe Reservoir (205GUA218) (Figures 3.3 and 3.4). In WY 2019, median temperatures increased in the downstream direction (Table 3.2). Increasing temperatures are likely associated with a reduction of stream shading within the riparian corridor with increasing urbanization. In addition, the influence of groundwater on the valley floor is also likely to cause increases to stream temperature. However, in WY 2018, the upstream-most sites (205GUA218 on Guadalupe Creek and 205GUA279 on Alamitos Creek) had a higher median temperature than stations farther downstream. A possible explanation for the WY 2018 pattern was that that reservoir releases were warmed by solar radiation, but gradually cooled along the shaded riparian corridor before warming again due to urbanization. It is unknown why the pattern differed from WY 2018 to WY 2019.

Table 3.2. Descriptive statistics for continuous water temperature measured from April through September in 2017, 2018, and 2019 at 11 sites in the Guadalupe River watershed, Santa Clara County. N is number of individual measurements.

WY	Creek		Guadalupe Creek (downstream ------------------------------------ upstream)				Alamitos Creek (downstream --- upstream)					Arroyo Calero (downstream – upstream)	
	Site ID		205GUA190	205GUA202	205GUA210	205GUA218	205GUA250	205GUA255	205GUA262	205GUA270	205GUA279	205GUA225	205GUA340
2017	Start Date		4/3/2017	4/3/2017	4/3/2017		4/3/2017	4/3/2017	4/3/2017	4/3/2017		4/3/2017	4/3/2017
	End Date		9/26/2017	9/26/2017	9/26/2017		9/26/2017	9/26/2017	9/26/2017	9/26/2017		9/26/2017	9/26/2017
	Temperature (°C)	Min	10.6	10.2	10.2		12	11.6	12.4	11.5		11.6	11.6
		Median	18.8	17.7	17		19.2	19.1	18.5	18.9		18.9	19.2
		Mean	18	17.2	16.7		18.8	18.6	18.4	18.3		18.3	18.5
		Max	26.2	23.8	24.1		24.8	24.6	23.7	24.3		23.4	23.2
		Max 7-day mean	21.1	21.3	21.1		21.2	21.4	21.2	21.9		21.1	21.4
	N		4220	4220	4220		4220	4220	4220	4220		4220	4220
	#/% Measurements > 24°C		36	0	2		18	6	0	13		0	0
			1%	**0%**	**0%**		**0%**	**0%**	**0%**	**0%**		**0%**	**0%**
2018	Start Date		4/5/2018	4/5/2018	4/5/2018	4/5/2018	4/5/2018	4/5/2018	4/5/2018	4/5/2018	4/5/2018	--	--
	End Date		9/27/2018	9/27/2018	9/27/2018	9/27/2018	9/27/2018	9/27/2018	6/25/2018	9/27/2018	9/27/2018	--	--
	Temperature (°C)	Min	12.3	9.7	8.7	9.6	12.7	11.9	12.0	10.7	--	--	--
		Median	19.0	17.8	17.1	19.1	19.1	18.6	16.6	17.9	--	--	--
		Mean	18.4	17.2	16.7	18.1	18.7	18.5	16.7	17.5	--	--	--
		Max	23.4	22.6	22.6	24.9	23.4	23.4	22.2	22.0	--	--	--
		Max 7-day mean	21.0	21.1	20.4	22.7	21.4	21.3	19.2	20.6	--	--	--
	N		4196	3451	4196	4197	4195	4194	1939	4195	4195	--	--
	#/% Measurements > 24°C		0	0	0	52	0	0	0	0	0	--	--
			0%	**0%**	**0%**	**1%**	**0%**	**0%**	**0%**	**0%**	**0%**	--	--
2019	Start Date		4/9/2019	4/9/2019	4/9/2019	4/9/2019	4/9/2019	4/9/2019	4/9/2019	4/9/2019	4/9/2019	--	--
	End Date		9/19/2019	9/19/2019	9/19/2019	9/19/2019	9/19/2019	9/19/2019	9/19/2019	9/19/2019	9/19/2019	--	--
	Temperature (°C)	Min	11	10.6	10.3	10.9	13.5	13	12.8	11.7	--	--	--
		Median	18.3	17.3	16.3	15.1	19.5	19.2	18.9	18.4	--	--	--
		Mean	18	17	16.4	16	19.2	18.9	18.6	18	--	--	--
		Max	25.1	22.8	23.1	23.7	24.3	23.7	23.6	22.9	--	--	--
		Max 7-day mean	21	20.4	20.3	22.4	21.4	21.3	21.1	20.6	--	--	--
	N		3913	3911	3911	3911	3910	3911	3910	3911	3912	--	--
	#/% Measurements > 24°C		23	0	0	0	7	0	0	0	0	--	--
			1%	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	--	--

Table 3.3. Weekly average temperature values for water temperature data collected at nine stations in the Guadalupe River watershed in WY 2019, with summary MRP trigger exceedance results from WY 2017 and WY 2018. Values that exceed MRP trigger (17°C) are indicated in bold.

	Guadalupe Creek (downstream ---------------------------- upstream)				Alamitos Creek (downstream -- upstream)				
Station	**205GUA190**	**205GUA202**	**205GUA210**	**205GUA218**	**205GUA250**	**205GUA255**	**205GUA262**	**205GUA270**	**205GUA279**
Date	**Weekly Average Temperature (°C)**								
4/9/2019	13.5	12.8	12.2	11.7	15.7	15.3	15.0	13.9	13.2
4/16/2019	14.4	13.5	12.8	11.9	16.6	16.2	15.8	14.6	13.7
4/23/2019	16.0	14.8	13.8	12.2	**17.9**	**17.5**	16.9	15.7	14.3
4/30/2019	14.8	13.7	12.9	12.0	16.8	16.3	15.9	14.9	14.3
5/7/2019	15.9	14.7	13.8	12.3	**17.7**	**17.3**	16.8	15.8	15.0
5/14/2019	13.7	13.1	12.6	12.0	15.8	15.4	15.3	14.8	15.0
5/21/2019	14.7	13.7	13.1	12.2	16.9	16.5	16.2	15.8	15.7
5/28/2019	16.8	15.4	14.4	12.7	**18.6**	**18.2**	**17.7**	**17.1**	16.3
6/4/2019	**17.6**	15.9	14.6	12.8	**19.2**	**18.6**	**18.1**	**17.9**	16.8
6/11/2019	**18.8**	**17.0**	15.6	13.5	**19.6**	**19.0**	**18.5**	**18.9**	**17.4**
6/18/2019	**18.8**	**17.0**	15.8	14.3	**19.7**	**19.2**	**18.8**	**18.7**	**17.5**
6/25/2019	**17.8**	16.4	15.5	14.9	**19.0**	**18.6**	**18.3**	**17.9**	**17.5**
7/2/2019	**18.3**	16.9	16.2	15.7	**19.5**	**19.0**	**18.8**	**18.3**	**17.9**
7/9/2019	**19.6**	**18.2**	**17.4**	16.8	**20.2**	**19.8**	**19.6**	**19.2**	**18.6**
7/16/2019	**20.0**	**18.6**	**17.9**	**17.6**	**20.4**	**20.1**	**19.8**	**19.4**	**18.9**
7/23/2019	**20.8**	**19.4**	**18.5**	**18.2**	**21.0**	**20.7**	**20.4**	**20.1**	**19.4**
7/30/2019	**19.7**	**19.0**	**18.5**	**18.6**	**20.7**	**20.5**	**20.3**	**19.7**	**19.6**
8/6/2019	**19.8**	**19.2**	**18.8**	**19.4**	**20.8**	**20.6**	**20.5**	**19.7**	**19.9**
8/13/2019	**20.5**	**20.0**	**19.6**	**20.2**	**21.3**	**21.1**	**21.0**	**20.3**	**20.2**
8/20/2019	**21.0**	**20.4**	**20.2**	**20.8**	**21.4**	**21.3**	**21.1**	**20.6**	**20.6**
8/27/2019	**20.9**	**20.3**	**20.3**	**21.5**	**21.3**	**21.2**	**21.0**	**20.4**	**20.8**
9/3/2019	**20.0**	**19.9**	**20.3**	**22.2**	**20.7**	**20.7**	**20.6**	**19.8**	**20.8**
9/10/2019	**19.9**	**19.8**	**20.3**	**22.4**	**20.6**	**20.5**	**20.5**	**19.7**	**21.1**
9/17/2019	**18.3**	**18.5**	**19.2**	**21.8**	**19.5**	**19.5**	**19.6**	**18.6**	**20.7**
2019 Total Weeks	24	24	24	24	24	24	24	24	24
Number >17°C	16	13	11	10	19	19	17	17	15
% Exceed	67%	54%	46%	42%	79%	79%	71%	71%	63%
> MRP Trigger	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
WY 2018 > 17°C	18	11	12	17	19	19	5	16	15
% Exceed	69%	52%	46%	65%	73%	73%	42%	62%	58%
WY 2017 > 17°C	17	15	15	18	20	19	19	18	18
% Exceed	65%	58%	58%	69%	77%	73%	73%	69%	69%

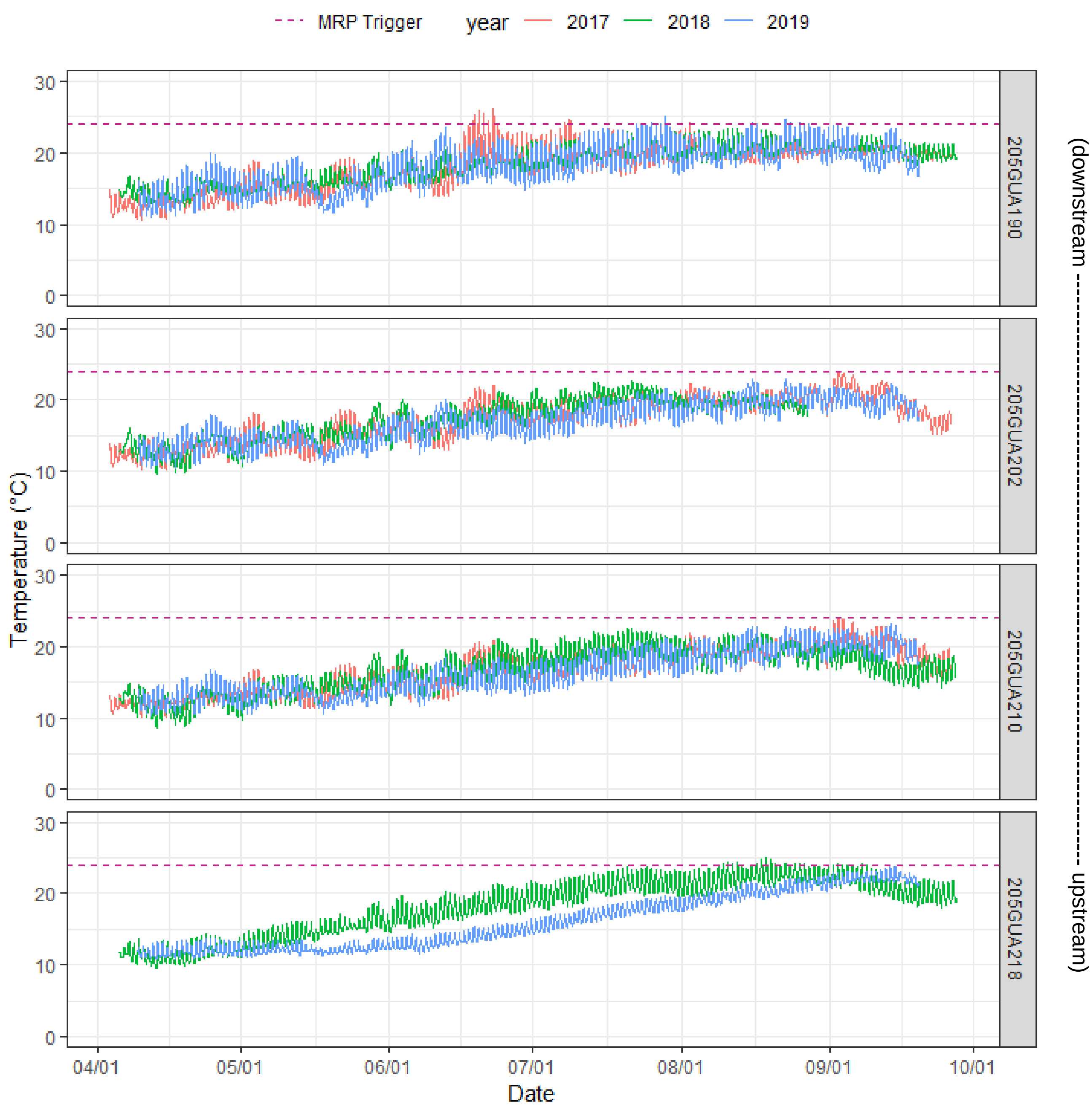

Figure 3.3. Continuous water temperature collected between April and September at four sites in Guadalupe Creek during WY 2017, WY 2018 and WY 2019.[21]

[21] Datalogger at site 205GUA202 malfunctioned at the end of August 2018 with an abrupt jump in temperature from approximately 17 to 20°C with no diurnal variability; these records were excluded. Site 205GUA218 was not monitored in WY 2017.

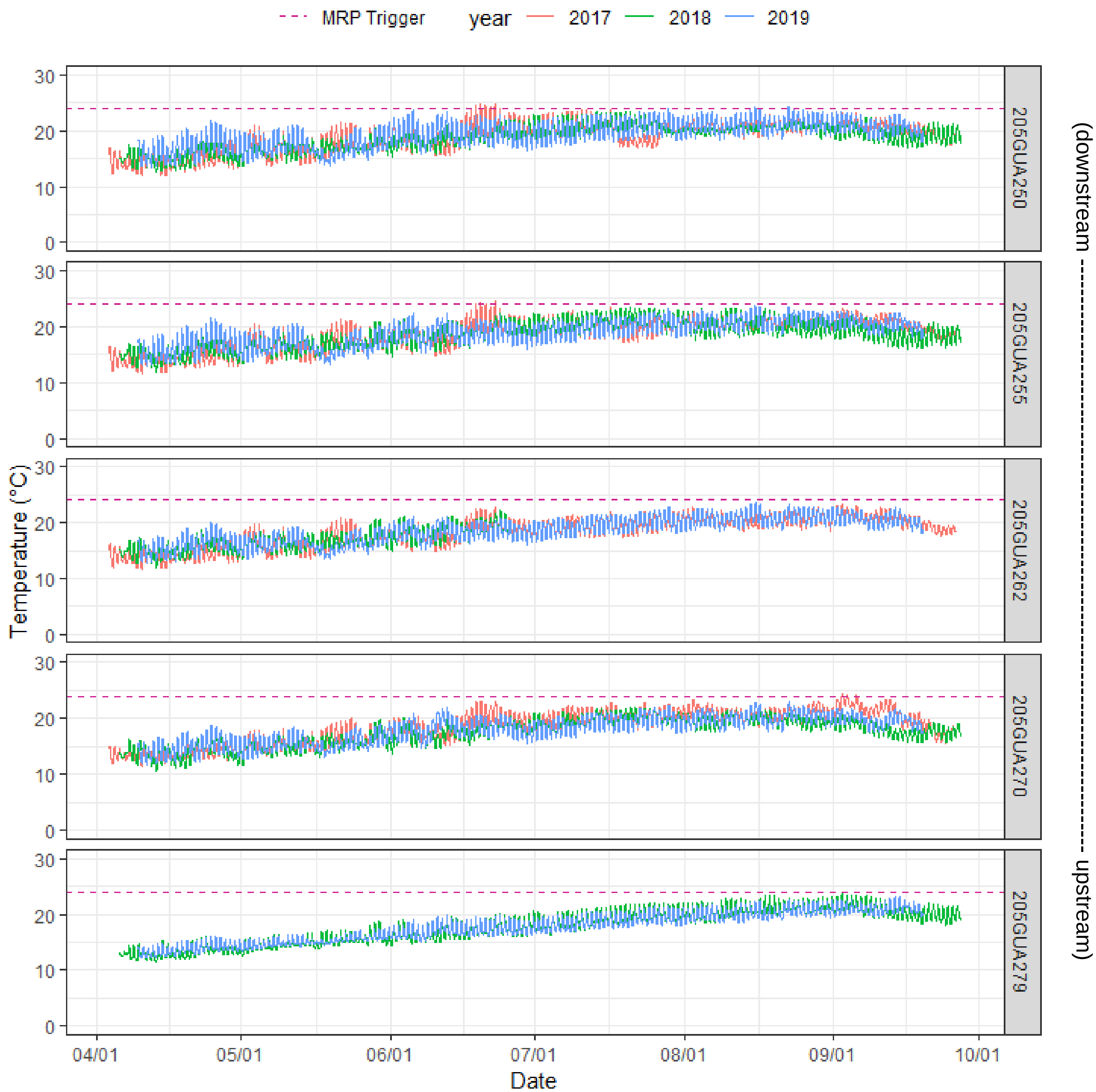

Figure 3.4. Continuous water temperature collected between April and September at five sites in Alamitos Creek during WY 2017, WY 2018 and WY 2019.

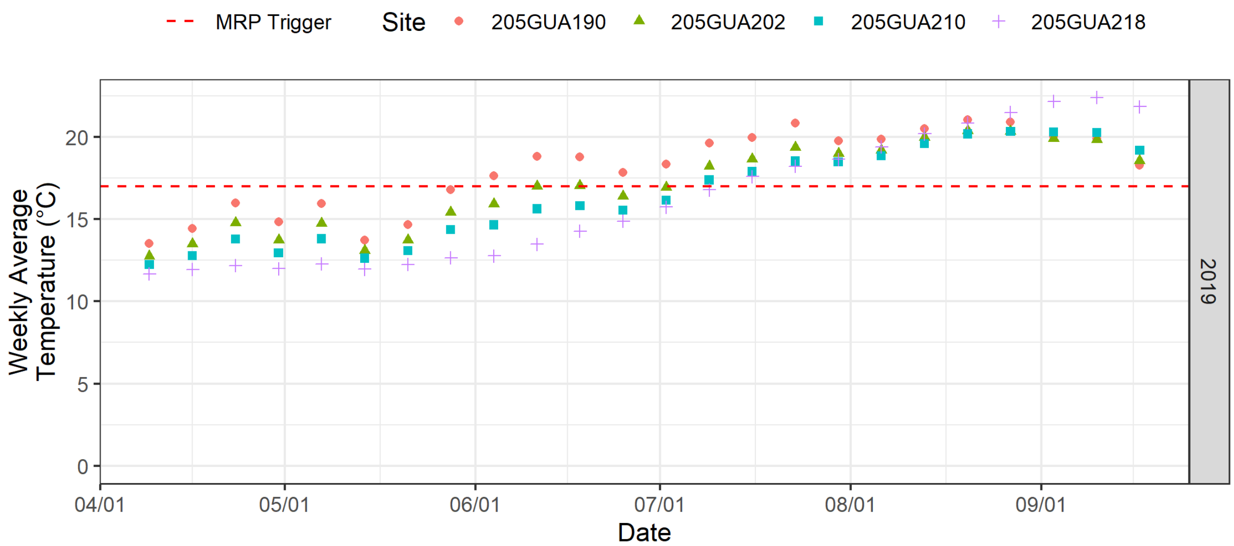

Figure 3.5. Weekly average temperature values calculated for water temperature collected at four sites in Guadalupe Creek over 24 weeks of monitoring in WY 2019. The MRP trigger (17°C) is shown for comparison.

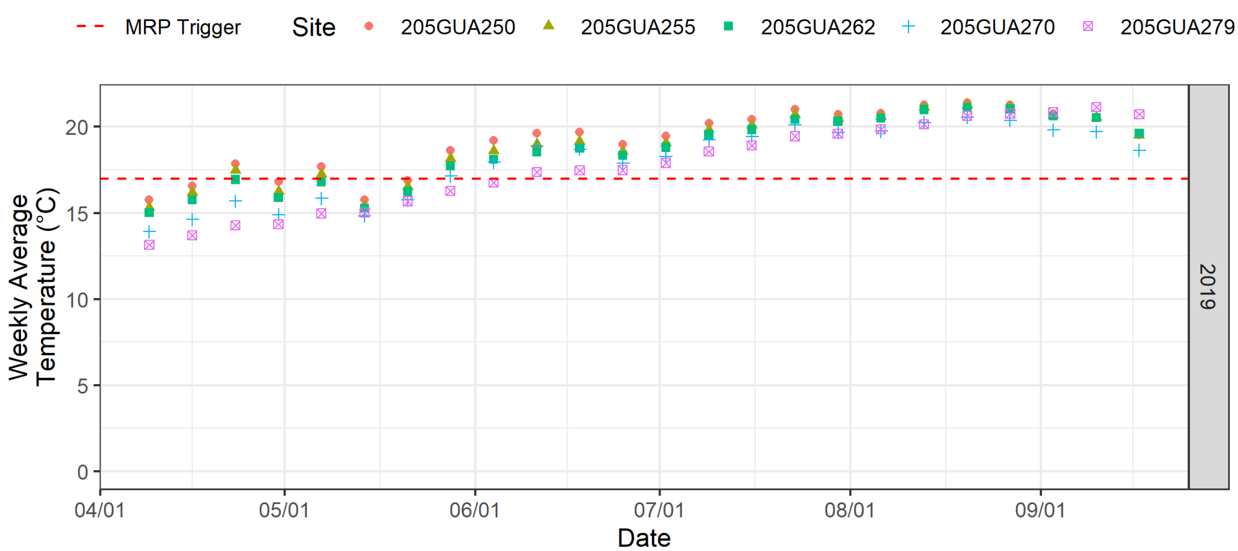

Figure 3.6. Weekly average temperature values calculated for water temperature collected at five sites in Alamitos Creek over 26 weeks of monitoring in WY 2019. The MRP trigger (17°C) is shown for comparison.

Temperature Trigger Considerations

The Basin Plan (SFRWQCB 2017) designates several Beneficial Uses associated with aquatic life uses, including COLD, WARM, MIGR, SPWN and RARE, for Guadalupe Creek and Alamitos Creek (Table 1.5). Spawning and rearing habitat for juvenile steelhead is present in the reaches of Guadalupe Creek and Alamitos Creek below the reservoirs (Becker et al. 2007). The extent and quality of steelhead rearing habitat is dependent on the amount and timing of releases from the reservoirs. Additional limiting factors to the steelhead population in these creeks include passage barriers, water temperature, riparian cover, sediment, mercury contamination, and predatory warm water fish species (FAHCE 2003).

Since WY 2004, Valley Water has conducted temperature and fisheries monitoring in Guadalupe Creek to meet mitigation monitoring requirements for the Downtown-Guadalupe River Flood Control Project. Although most of the temperature monitoring was conducted at stations in the Guadalupe River, limited data available for Guadalupe Creek showed cooler temperatures at stations closest to the dam, which is consistent with monitoring results presented in this report. Portions of Guadalupe Creek and Alamitos Creek presently support small population of steelhead/resident rainbow trout, although fish are generally less abundant in the unshaded, warm section of Guadalupe Creek downstream of Camden Avenue (Smith 2013).

Annual fall monitoring conducted by Valley Water since 2004 indicates juvenile steelhead are typically present in Guadalupe Creek (SCVWD et al. 2016). The only exception is 2015, when no steelhead were encountered due to extreme drought conditions. However, in 2016 two steelhead individuals were documented, which was the lowest count on record but showed recovery after the 2015 drought. Monitoring in 2017 and 2018 recorded 30 and 66 steelhead in Guadalupe Creek, respectively, confirming that Guadalupe Creek continues to provide summer refugia for steelhead (SCVWD 2019). In Alamitos Creek, steelhead were historically found (Leidy et al. 2005, Smith 2013), and 32 individuals were recorded by Valley Water in 2018 (SCVWD 2019). In addition, in 2018, Valley Water recorded 17 individual steelhead in Calero Creek (SCVWD 2019).

Providing continuous flow during the dry season would allow steelhead to migrate to more optimal habitat conditions, including reaches with cooler water temperatures. In addition, longitudinal connectivity to areas where food is available can allow juvenile steelhead to increase feeding behavior and maintain optimal body weight to survive periods of warmer temperatures (Smith 2013). Thus, flow in the lower reaches is critically important for sustaining steelhead populations, as well as other Aquatic Life Beneficial Uses.

Although the MRP trigger for temperature (i.e., MWAT >17°C for two or more weeks) was exceeded at all nine stations in WY 2017 – WY 2019, it is important to keep in mind that different water temperature thresholds exist that may be more relevant to Santa Clara County streams. NOAA's National Marine Fisheries Service (NMFS) has developed recovery plans for Central Coast steelhead (which includes the Guadalupe River watershed) using the Maximum Weekly Maximum Temperature (MWMT) of 20°C to evaluate water quality conditions potentially impacting steelhead. The MWMT is calculated using the maximum, not the average, weekly temperatures of non-overlapping weeks. The MWMT is suggested to better reflect transient water temperature peaks and any acute effects of the single point maximum temperature.[22]

[22] http://krisweb.com/stream/temp_standards.htm

3.4.3 General Water Quality Study Area (Coyote Creek Watershed)

In WY 2017 – WY 2019, continuous (15-minute) general water quality measurements (DO, specific conductance, pH, and temperature) were recorded at three locations on the mainstem of Coyote Creek during two 7 to 14-day sampling events each year (Figure 3.7). The stations include site 205COY235 (Watson Park), site 205COY236 (Julian Street) and site 205COY239 (Williams). The first event of each year (Event 1) began in late-May or early-June and the second event of each year (Event 2) began in late-August or early-September. Table 3.4 shows the start and end dates for all events in the record.

All three monitoring stations were previously sampled for continuous water quality in WY 2013 as part of the Coyote Creek Dissolved Oxygen Stressor/Source Identification (Coyote Creek SSID) Project (SCVURPPP 2014). The Coyote Creek SSID Project evaluated a range of potential stressors and sources that may cause low dissolved oxygen in the section of Coyote Creek between Watson Park and Williams Park. The Coyote Creek SSID Project measured continuous water quality at six locations between June and September 2013.

The WY 2017 monitoring was conducted following an extremely wet winter that resulted in widespread flooding in the urban reaches of Coyote Creek including the reach with the three monitoring stations. One of the objectives for sampling these locations was to assess whether the high flow events in 2017 flushed out the fine sediment and organic matter that was identified as a potentially important factor causing reduced dissolved oxygen levels in the Coyote Creek SSID Project study area. Monitoring results from WY 2017 indicated that dissolved oxygen levels during the September sampling event were generally higher compared to levels measured in WY 2013. To evaluate inter-annual variability, the same sites were monitored in WY 2018 and WY 2019. Data was used to assess overall variability in water quality conditions between a year with high rainfall and flooding (WY 2017), a year with average rainfall (WY 2018), and a year with above average rainfall (WY 2019).

Table 3.4. Start and end dates of continuous general water quality monitoring events, WY 2013 and WY 2017 – WY 2019.

Year	Event 1		Event 2	
	begin	end	begin	end
WY 2013 [a]	Jun 26	Jul 10	Aug 29	Sep 13
WY 2017	Jun 14	Jun 29	Sep 8	Sep 19
WY 2018	May 21	Jun 4	Sep 10	Sep 19
WY 2019	Jun 3	Jun 17	Aug 20	Sep 3

[a] WY 2013 sondes were deployed continuously from June 26 through September 13, 2013 or later. This IMR uses a subset of the 2013 data, as indicated in dates listed above, to compare with the other years.

Figure 3.7. Continuous water quality stations in Coyote Creek, WY 2017 – WY 2019.

3.4.4 General Water Quality Results and Discussion

Summary statistics for general water quality measurements collected at the three sites in Coyote Creek during the two sampling events in WY 2019 are listed in Table 3.5. Monitoring was conducted from June 3 through June 17, 2019 (Event 1) and from August 20 through September 3, 2019 (Event 2). Sampling locations are mapped in Figure 3.7. Plots for all water quality parameters collected during Event 1 are shown in Figure 3.8 and for Event 2 in Figure 3.9. Results discussed below are organized according to parameter (i.e., temperature, dissolved oxygen, specific conductance, and pH).

Table 3.5. Descriptive statistics for continuous water temperature, dissolved oxygen, pH, and specific conductance measured at three Coyote Creek sites in Santa Clara County during WY 2019. Data were collected every 15 minutes over two 2-week time periods during June (Event 1) and September (Event 2).

Parameter	Data Type	205COY235		205COY236		205COY239	
		Event 1	Event 2	Event 1	Event 2	Event 1	Event 2
Temperature (°C)	Minimum	19.2	20.2	19.3	19.7	18.7	19.1
	Median	21.5	21.8	21.2	21.6	21.2	21.4
	Mean	21.6	21.8	21.3	21.6	21.3	21.5
	Maximum	24.9	22.9	24.3	22.8	25.0	23.4
	% > 24	4%	0%	2%	0%	4%	0%
Dissolved Oxygen (mg/L)	Minimum	1.9	2.8	2.4	3.0	4.4	5.3
	Median	3.5	3.7	3.5	3.7	5.6	5.8
	Mean	3.3	3.7	3.4	3.7	5.6	6.0
	Maximum	4.8	4.6	5.3	4.6	6.8	7.2
	% < 7.0	**100%**	**100%**	**100%**	**100%**	**100%**	**98%**
pH [a]	Minimum	NA	7.4	7.1	7.5	7.6	7.6
	Median	NA	8.1	7.8	7.8	7.7	7.7
	Mean	NA	8.1	7.7	7.8	7.7	7.7
	Maximum	NA	8.5	7.8	8.1	7.7	7.8
	% < 6.5 or > 8.5	NA	0%	0%	0%	0%	0%
Specific Conductivity (µS/cm)	Minimum	952	933	948	889	890	880
	Median	1072	970	1063	960	1014	913
	Mean	1054	970	1041	961	990	915
	Maximum	1137	1015	1108	1009	1060	957
	% > 2000	0%	0%	0%	0%	0%	0%
Total number of data points (N)		1338	1345	1340	1343	1341	1341

[a] The pH sensors did not meet data quality objectives at site 205COY235 during Event 1. The data were rejected and not used in the analyses. The sensor was replaced for Event 2.

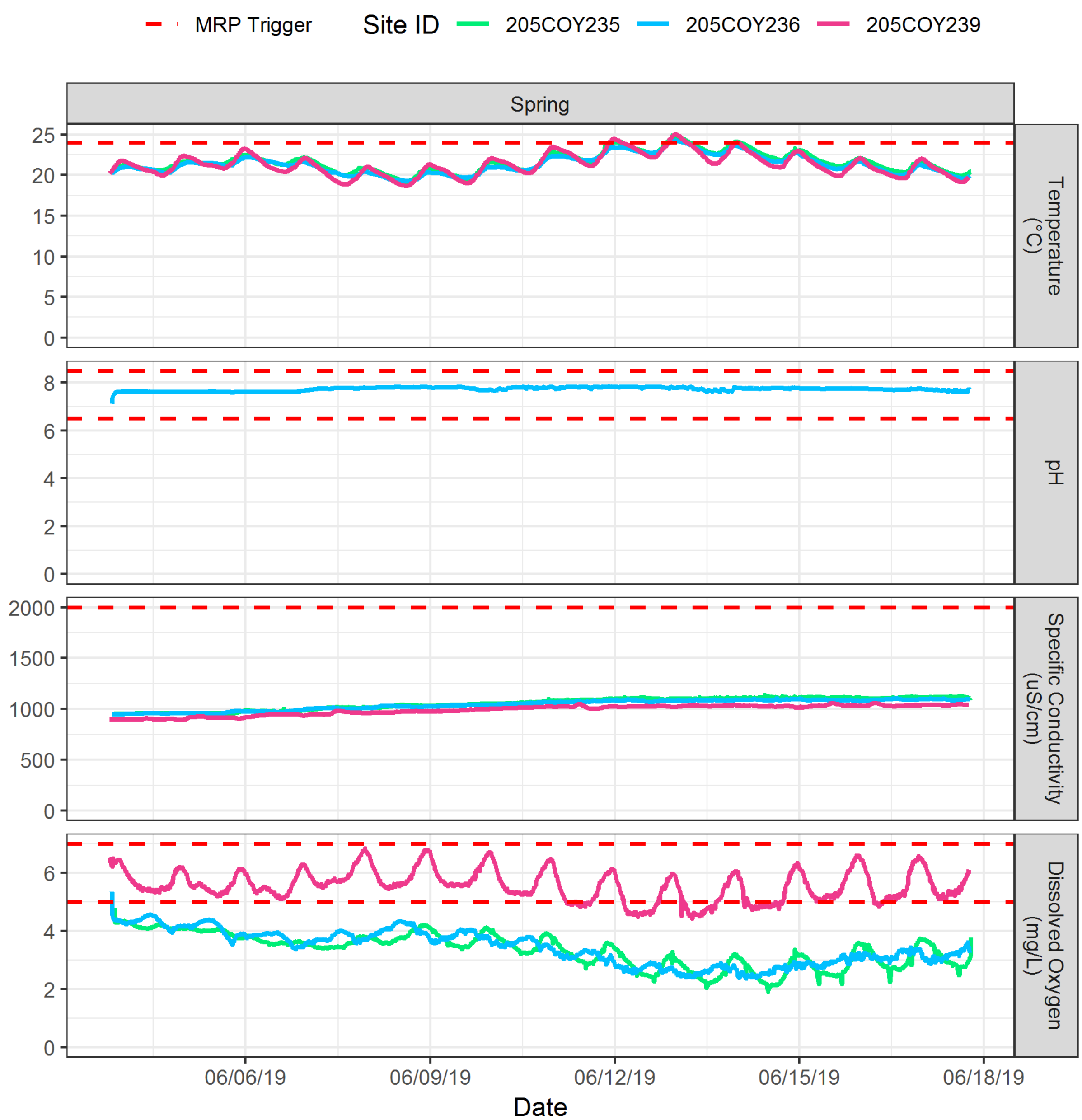

Figure 3.8. Continuous water quality data (temperature, specific conductance, pH[23], and dissolved oxygen) collected at three sites in Coyote Creek in June 2019 (Event 1).

[23] The pH sensor did not meet data quality objectives for pre- and post-calibration for site 205COY235; data were not used for analyses. These pH sensor was replaced for Event 2.

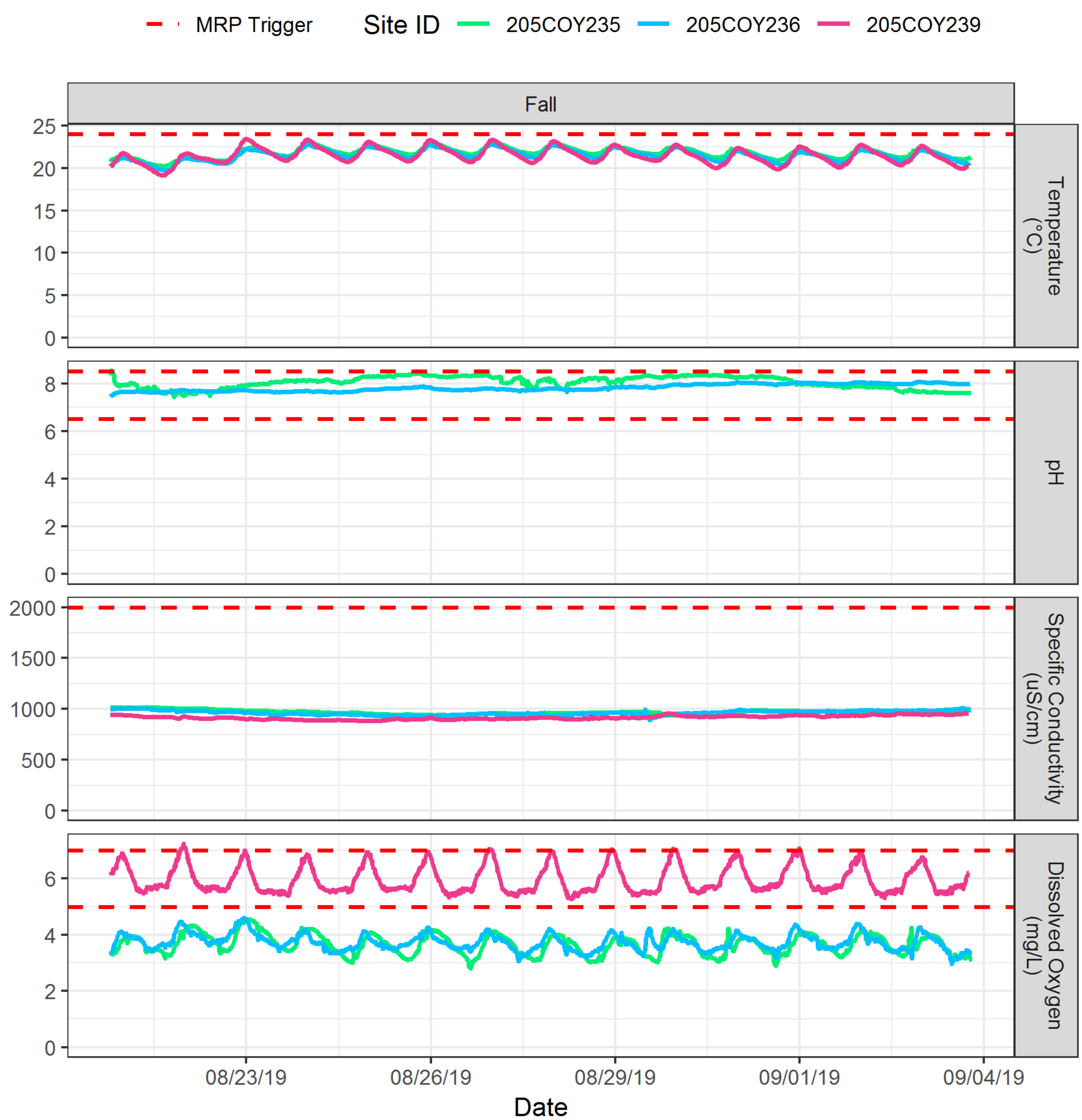

Figure 3.9. Continuous water quality data (temperature, specific conductance, pH, and dissolved oxygen) collected at three sites in Coyote Creek in August/September 2019 (Event 2).

Temperature

The water temperature data collected at the three sites in Coyote Creek show a similar pattern during both events. In general, water temperatures showed little variability between sites during each event (Figures 3.8 and 3.9). Daily patterns are evident in the record with cooler temperatures recorded at night and warmer temperatures in the afternoon. During the June sampling event (Event 1), water temperatures showed both cooling and warming trends (Figure 3.8). During the August-September event (Event 2) water temperatures were more stable (other than diurnal variation) (Figure 3.9). In WY 2018, there were also cooling and warming trends during Event 1 but not during Event 2 (SCVURPPP 2019). The cause of the differences is unknown but is likely related to air temperatures, groundwater inflow, and upstream reservoir operations.

In WY 2019, during Event 1, water temperatures at all stations occasionally exceeded the instantaneous maximum threshold of 24°C; however, this only applies to 2-4% of the record (Table 3.5); therefore, the MRP trigger was not exceeded. The 24°C threshold was not exceeded at any of the three sites during Event 2. In previous water years, the MRP trigger for instantaneous maximum temperature was also not exceeded at any of the sites for either sampling event.

Weekly average temperatures were calculated for both monitoring events (Table 3.6). The MWAT threshold (17°C) was exceeded at all three stations during both weeks of both events. The MWAT trigger was also exceeded during both monitoring events in WY 2017 and WY 2018. Therefore, all three sites were added to the list of candidate SSID projects.

Table 3.6. Weekly average temperature (°C) values for water temperature data collected at three stations monitored in Coyote Creek, WYs 2017, 2018, and 2019.

		Station	205COY235	205COY236	205COY239
Water Year	**Month**	**Week**	**Weekly Average Temperature (°C)**		
2017	May/June	Week 1	21.0	20.7	21.2
		Week 2	22.5	22.2	21.4
	September	Week 1	22.3	22.0	22.2
		Week 2	20.3	20.0	19.9
2018	May/June	Week 1	18.1	18.2	18.5
		Week 2	18.0	18.2	18.1
	September	Week 1	19.3	19.1	19.2
		Week 2	19.1	18.8	18.8
2019	June	Week 1	21.0	20.8	20.9
		Week 2	22.2	21.9	21.9
	August/ September	Week 1	21.8	21.6	21.6
		Week 2	21.8	21.5	21.3

Box and whisker plots are useful in understanding the distribution of data and in comparing data from different years. Each “box” represents the upper quartile, median, and lower quartile of the dataset. The “whiskers” represent the smallest and largest values within 1.5 times the interquartile range and points represent values outside the box and whiskers.

Box and whisker plots comparing temperature and dissolved oxygen data collected during Event 1 and Event 2 of WY 2013, WY 2017, WY 2018, and WY 2019 are shown in Figures 3.10 and 3.11. During the Event 1 time period, temperatures were similar in all years except WY 2018, when they were lower (Figure 3.10). This difference may be explained by differences in timing of Event 1; the WY 2018 deployment was earlier in the season (May 21 – June 4, 2018) compared to the other years when deployments did not start until sometime in June (Table 3.4). During the Event 2 time period, the Coyote Creek sites also had lower water temperatures in 2018 compared to 2019, 2017 and 2013 (Figure 3.11). In this case, the differences cannot be explained by event timing, as the WY 2018 and WY 2017 deployments were nearly identical (Table 3.4).

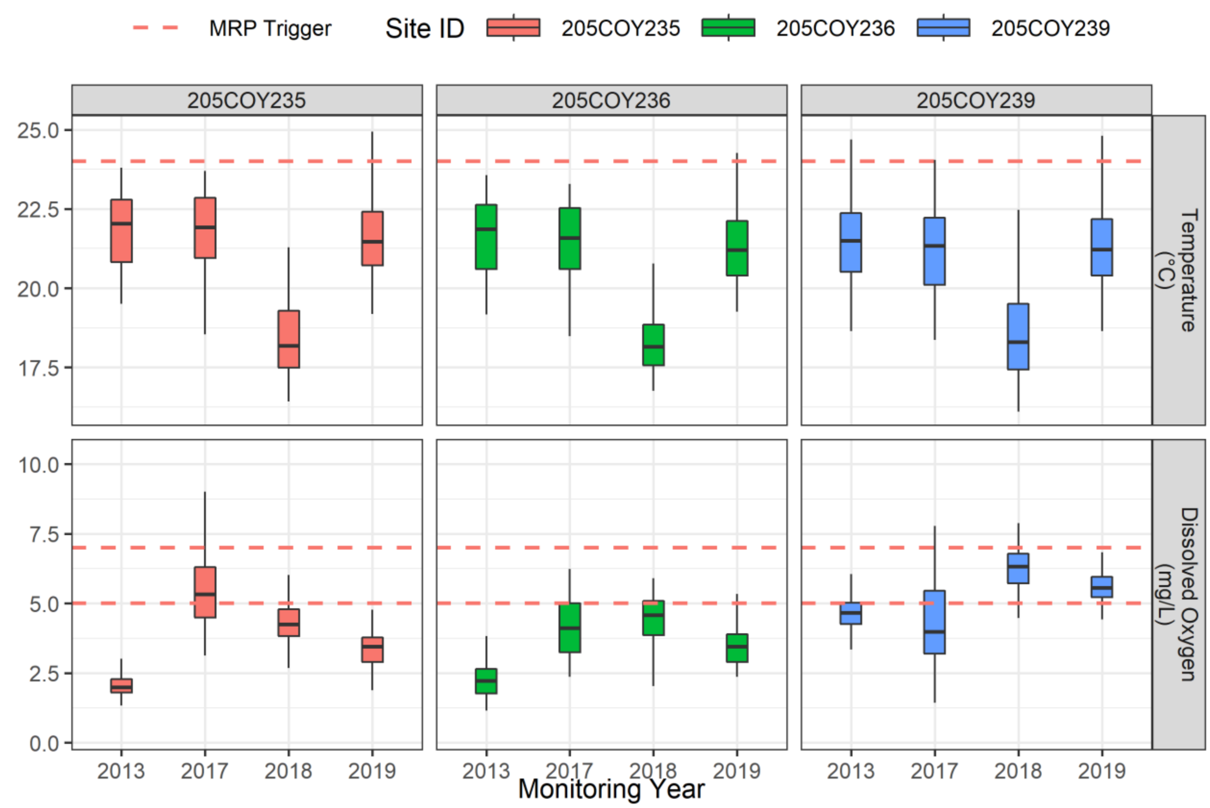

Figure 3.10. Comparison of temperature and dissolved oxygen data collected during Event 1 (May/June) in WYs 2013, 2017, 2018, and 2019 at three stations in Coyote Creek.

Figure 3.11. Comparison of temperature and dissolved oxygen data collected during Event 2 (August/September) in WYs 2013, 2017, 2018, and 2019 at three stations in Coyote Creek.

Dissolved Oxygen

Similar to previous years, the dissolved oxygen data showed a consistent pattern for both sampling events in WY 2019, with median DO levels about 2.0 mg/L lower at the two downstream sites (205COY235, 205COY236) compared to the upstream site (205COY239) (Figures 3.8 and 3.9). The two lower elevation sites also had less diurnal variability compared to the upstream site.

Dissolved oxygen concentrations decreased across all the sites during second week of Event 1 (Figure 3.8). The decrease may be associated with the observed increase in water temperatures that occurred during the same period. In previous years, a similar drop was observed in the Event 1 datasets and attributed to thermal stratification in the water column, which was documented in the WY 2013 Coyote Creek SSID Project (SCVURPPP 2014). In 2019, the drop in dissolved oxygen may also have been associated with above average air temperatures from June 10 to June 12. During these dates, the City of San José experienced three consecutive days of air temperatures reaching 95-100°F, which is 20 °F warmer than average high temperatures for these dates.[24] As water temperatures rise, oxygen solubility decreases. In addition, higher temperatures could lead to a spike in photosynthesis followed by an algae die-off, promoting decomposition and oxygen-consuming processes.

[24] https://www.accuweather.com/en/us/san-jose/95110/june-weather/347630?year=2019

Box and whisker plots of dissolved oxygen and temperature data collected during Event 1 and Event 2 of WYs 2013, 2017, 2018, and 2019 are shown in Figures 3.10 and 3.11. In general, dissolved oxygen concentrations have increased since WY 2013 during both the Event 1 and Event 2 time periods. One hypothesis for the observed increase is the high stream flows that occurred in Coyote Creek during the winter season of WY 2017. These high flows may have caused an overall reduction in the amount of organic material and sediment present in the channel at the sites. One of the conclusions of the Coyote Creek SSID project was that accumulated organic material and sediment coupled with slow velocity and low gradient of the channel are likely important factors in the low DO concentrations and the low potential for re-aeriation of the water column (SCVURPPP 2014). If high flows in WY 2017 reduced the amount of organic material in this reach of Coyote Creek, it is unknown how long the effects will last without subsequent high flow events to scour sediment from the channel.

The dissolved oxygen concentrations in WY 2019, 2018 and 2017 were below 7.0 mg\L (MRP trigger for cold water fishery stream) at all three sites (Table 3.6); therefore, these sites will remain on the list of candidate SSID sites. However, these results should be interpreted cautiously. Although Coyote Creek is designated as having COLD Habitat, Aquatic Life Beneficial Uses associated with a cold water fishery are generally not supported in the reach where water quality sampling was conducted. The sampling reach of Coyote Creek mainstem may support a WARM water fishery; however, existing habitat and water quality conditions currently do not support a cold water fishery beyond serving as a migration corridor to colder, upstream reaches.

<u>Specific Conductance</u>

Specific conductance during WY 2019 was approximately 900 to 1000 µS /cm at all three sites during both sampling events, and thus, never exceeded the MRP trigger threshold (2000 µS/cm). Specific conductance levels followed a similar pattern at all three sites during both events, with very little variability in the record. The same pattern is true of WY 2017 and 2018 monitoring results.

<u>pH</u>

The pH data was generally consistent between sites, ranging between 7.5 and 8.2 for both sampling events, and thus never exceeded the MRP trigger. Calibration checks of the sondes that were deployed at station 205COY235 during Event 1 showed a drift in the pH sensor of over 0.2 units, which was not consistent with Measurement Quality Objectives in the project QAPP (BASMAA 2016b). Thus, those pH data were rejected and not used in the analyses. The pH probe was replaced prior to the September 2019 sampling event.

<u>Continuous Water Quality Trigger Summary</u>

The MRP trigger summary for the continuous water quality data is shown in Table 3.6. All three sites exceeded triggers for temperature MWAT and dissolved oxygen, and therefore these sites were added to the SSID list.

Table 3.6. Exceedances of MRP triggers at three continuous monitoring sites in Coyote Creek, Santa Clara County, WY 2019.

Data Type	MRP Trigger	205COY235	205COY236	205COY239	205COY235	205COY236	205COY239
		Event 1 (June) WY 2019			Event 2 (August/September) WY 2019		
Temperature	20% results > 24°C	No	No	No	No	No	No
MWAT	2 weeks > 17°C	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Dissolved Oxygen	20% results < 7 mg/L	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Specific Conductivity	20% results > 2000 µS/cm	No	No	No	No	No	No
pH	20% results > 6.5, < 8.5	NA	No	No	No	No	No

4.0 PATHOGEN INDICATORS

4.1 Introduction

This section describes the results of pathogen indicator monitoring that was conducted during WY 2014 through WY 2019 in compliance with Creek Status Monitoring Provisions C.8.c of MRP 1.0 and C.8.d.v of MRP 2.0. Monitoring was conducted at selected sites using a targeted design based on the directed principle[25] to address the following management question:

1. *What are the pathogen indicator concentrations at creek sites where there is potential for water contact recreation to occur?*

This management question is addressed primarily through the evaluation of data with respect to trigger thresholds identified in the MRP and WQOs adopted by the State Water Board. Sites where exceedances occur may indicate potential impacts to water contact recreation (REC-1) or other Beneficial Uses and are considered as candidates for future Stressor Source Identification projects.

In compliance with MPR 1.0 and 2.0, five samples were collected each year for a cumulative total of 30 samples for the WY 2014 through WY 2019 IMR reporting period. The sections below summarize methods results from pathogen indicator monitoring conducted during WY 2014 through WY 2019. Conclusion and recommendations for this section are presented in Section 7.0.

4.2 Methods

4.2.1 Sample Collection

Pathogen indicator samples were collected during the dry season in accordance with SWAMP-comparable methods and procedures described in the BASMAA RMC SOPs (BASMAA 2016b) and associated QAPP (BASMAA 2016a). Sampling techniques for pathogen indicators (*E. coli*, enterococci and fecal coliform) include direct filling of sterile containers and transfer of samples to the analytical laboratory within specified holding time requirements. Procedures for sampling and transporting samples are described in RMC SOP FS-2 (BASMAA 2016b).

4.2.2 Data Evaluation

During MRP 1.0 (WY 2014 and WY 2015) *E. coli* and fecal coliform were monitored as pathogen indicators. During MRP 2.0 (WY 2016 – WY 2019), *E. coli* and enterococcus were monitored as pathogen indicators. Pathogen indicator data were evaluated with respect to trigger thresholds identified in the MRP and WQOs adopted by the State Water Board on August 7, 2018 and approved by the USEPA on March 22, 2019. Pathogen indicator trigger thresholds and WQOs are listed in Table 4.1.

The MRP triggers and adopted WQOs are both based on the 2012 USEPA recommended recreational water quality criteria (RWQC). The 2012 RWQC offer two sets of numeric concentration thresholds for *E. coli* and enterococci designed to protect all types of water

[25] Directed Monitoring Design Principle: A deterministic approach in which points are selected deliberately based on knowledge of their attributes of interest as related to the environmental site being monitored. This principle is also known as "judgmental," "authoritative," "targeted," or "knowledge-based."

contact recreation in freshwaters where immersion and ingestion are likely. The two sets of criteria are based on estimated rates of gastrointestinal illness (estimated illness rate of 36 per 1,000 recreators and estimated illness rate of 32 per 1,000 recreators). MPR 2.0 specified the illness rate of 36/1000 as a trigger threshold; whereas, the State Water Board adopted the more conservative set of criteria based on the illness rate of 32/1000 in 2015.

The 2012 RWQC consists of both a geometric mean (GM) and a Statistical Threshold Value (STV). The GM criteria are applied when there are at least five samples distributed over a six-week period. According to the RWQC, the STV criteria should not be exceeded by more than 10 percent of the samples taken in a month, and therefore approximate a single sample maximum. Because pathogen indicator samples collected in compliance with the MRP are not repeated, results are compared to the STV criteria. Also, in this evaluation, the Most Probable Number (MPN) of bacteria colonies given by the analytical method is compared directly with the Colony Forming Units (CFU) of the USEPA recommendations.

The 2012 RWQC do not recommend using fecal coliform as a pathogen indicator. Therefore, fecal coliform data collected during MRP 1.0 were compared to WQOs listed in the Basin Plan (2017).

Table 4.1. Bacteriological trigger thresholds and water quality objectives for water contact recreation in freshwater.

Pathogen Indicator	State Water Board WQO (Estimated Illness Rate 32/1,000)		MRP 2.0 Trigger Threshold (Estimated Illness Rate 36/1,000)		Basin Plan WQO	
	GM	STV	GM	STV	GM	STV
Fecal Coliform (MPN/100 mL)	NA	NA	NA	NA	200	400
E. coli (cfu/100 mL)	100	320	125	410	NA	NA
Enterococci (cfu/100 mL)	30	110	35	130	NA	NA

4.3 Study Area

In compliance with the MRP, five pathogen indicator samples are collected during one sampling event per year at sites located in municipal parks with good public access to creeks and the potential for recreational water contact. In WY 2019, three sites were located on Los Gatos Creek; Novitiate Park (205LGA420), Vasona Park (205LGA400), and along the Los Gatos Creek Trail behind the Pruneyard Shopping Center (205LGAS033). Two sites were located on Coyote Creek; Metcalf Park (205COY392) and Hellyer Park (205COY330). All pathogen indicator monitoring stations sampled from WY 2014 through WY 2019 are mapped in Figure 4.1 with WY 2019 station symbols outlined in black. Figure 4.1 shows that some stations have been sampled more than one time during the WY 2014 through WY 2019 period of record. For example, Alamitos Creek at Singer park has been sampled four times.

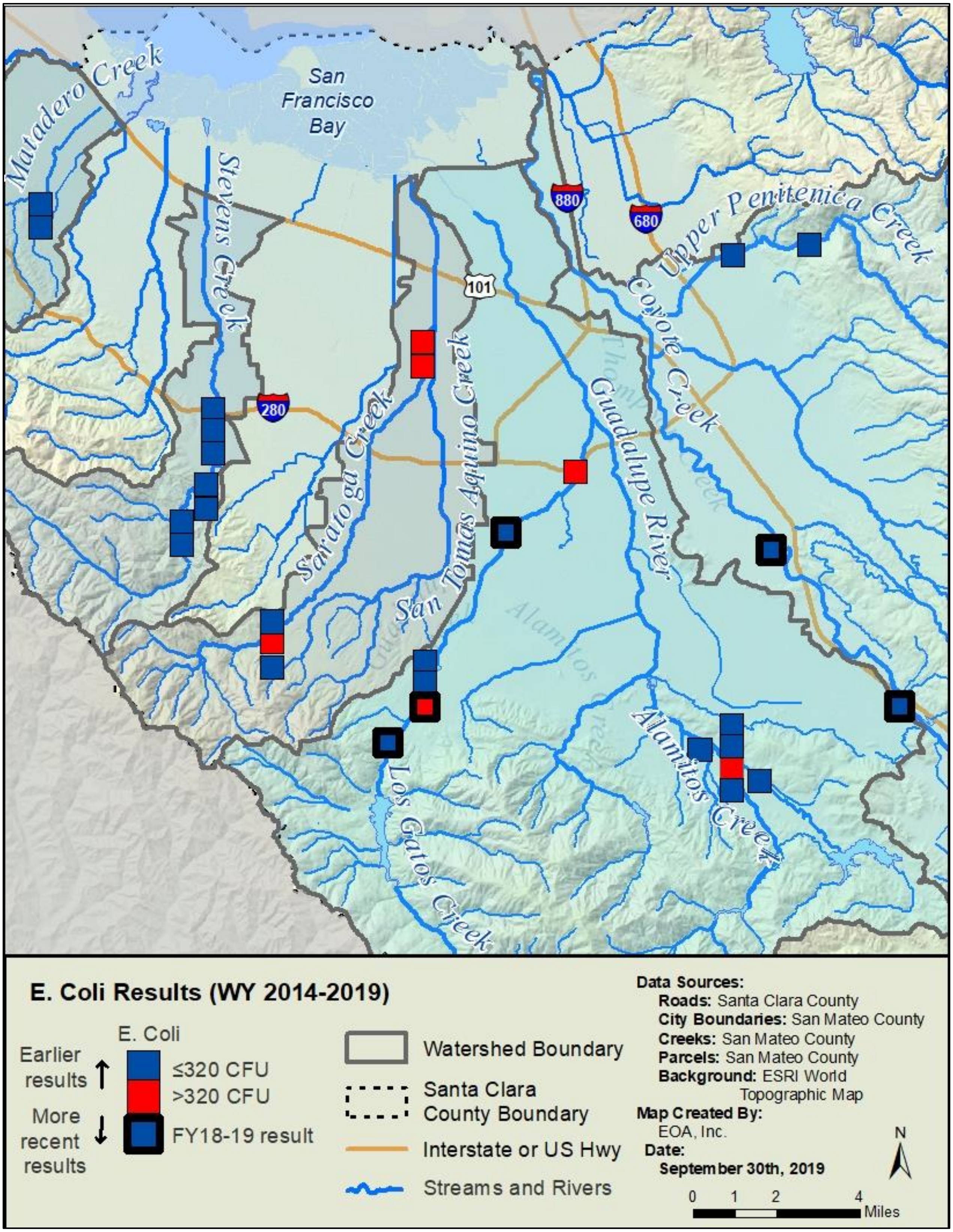

Figure 4.1. Pathogen indicator monitoring sites sampled in Santa Clara County during WY 2014 – WY 2019. Concentrations exceeding the WQO threshold for *E. coli*.

4.4 Results and Discussion

Pathogen indicator (*E. coli* and enterococci) densities measured in grab samples collected in WY 2019 on August 1, 2019 are listed in Table 4.2. Stations are mapped in Figure 4.1. In WY 2019, one sample (205COY330) exceeded the MRP 2.0 trigger and the State Water Board WQO for enterococci. A different sample, 205LGA400, exceeded the WQO for *E. Coli* and did not exceed the MRP 2.0 trigger. Both sites will be considered for future SSID projects.

Table 4.2. Enterococci and *E. coli* levels measured in Santa Clara County during WY 2019 (August 1, 2019). Results exceeding the MRP 2.0 trigger are bold. Results exceeding the WQO are highlighted

Site ID	Creek Name	Site Name	*Enterococci (cfu/100ml) (MPN/100ml)*[1]	*E. Coli (cfu/100ml) (MPN/100ml)*[1]
205LGA420	Los Gatos Creek	Los Gatos Creek at Novitiate Park	15	7.5
205LGA400	Los Gatos Creek	Los Gatos at Vasona Park	17	326
205LGA033	Los Gatos Creek	Los Gatos at Pruneyard	12	102
205COY392	Coyote Creek	Coyote Creek at Metcalf Park	7	27
205COY330	Coyote Creek	Coyote Creek at Hellyer Park	**157**	70
State Water Board WQO (based on 32 per 1000 recreators)			110	320
MRP 2.0 Trigger Threshold (USEPA 2012; 36 per 1000 recreators)			**130**	**410**

All monitoring data collected between WY 2014 and WY 2019 were evaluated for this IMR. The results for *E. coli* from WY 2014 through WY 2109 are shown in Figure 4.1 as compared to the WQO of 320 cfu/100 mL. In WY 2019, there was one *E. coli* exceedance in one of three locations sampled on Los Gatos Creek at site 205LGA400. The reason for this exceedance is unknown, but likely caused by a local source, as this is located between two sites that had results below the threshold. Potential sources of fecal indicator bacteria at 205LGA400 include local wildlife and homeless encampments. The WY 2019 *E. coli* exceedance is the smallest exceedance observed within the WY 2014 – WY 2019 period of record; it was 2% above the WQO compared to the highest result measured at the lower station on Saratoga Creek (205SAR005) in WY 2015 which was 218% above the threshold. Saratoga Creek collectively had the most exceedances with exceedances at both the downstream (205SAR005) and upstream (205SAR045) sites. Between WY 2014 and WY 2019 there were a total of six exceedances in two watersheds: Saratoga Creek watershed and Guadalupe River watershed. The Guadalupe River watershed had exceedances in the Los Gatos Creek tributary (WY 2019 and WY 2014) and the Alamitos Creek tributary (WY 2017). Although WQO exceedances are found in two of the six watersheds targeted, there is no evidence for large scale spatial patterns of bacteria concentrations. The results suggest that pathogen indicator densities at the monitoring stations are highly variable and generally below RWQC and WQOs during dry weather.

It is important to recognize that pathogen indicators do not directly represent actual pathogen concentrations and do not distinguish among sources of bacteria. Testing water samples for specific pathogens is generally not practical for a number of reasons (e.g., concentrations of pathogens from fecal contamination may be small and difficult to detect but still of concern, laboratory analysis is often difficult and expensive, the number of possible pathogens is large).

Therefore, the presence of pathogens is inferred by testing for “pathogen indicator” organisms. The USEPA recommends using *E. coli* and enterococci as indicators of fecal contamination based on historical and recent epidemiological studies (USEPA 2012). The USEPA pathogen indicator thresholds were derived based on human recreation at beaches receiving bacteriological contamination from human wastewater, and may not be applicable to conditions in urban creeks which do not receive wastewater treatment plant discharges. Furthermore, although animal fecal waste contributes to the pathogen indicator load, it is much less likely to contain pathogens of concern to human health than human sources. In most cases, it is the human sources that are associated with REC-1 health risks rather than wildlife or domestic animal sources (USEPA 2012). As a result, the comparison of pathogen indicator results to pathogen indicator thresholds may not be appropriate and should be interpreted cautiously.

5.0 CHLORINE MONITORING

5.1 Introduction

Chlorine is added to potable water supplies and wastewater to kill microorganisms that cause waterborne diseases. However, the same chlorine can be toxic to the aquatic species. Chlorinated water may be inadvertently discharged to the MS4s and/or urban creeks from residential activities, such as pool dewatering, car washing, and over-watering landscaping, or from municipal activities, such as hydrant flushing and water main breaks.

From WY 2012 through WY 2019, in compliance with provision C.8.c of MRP 1.0 and provision C.8.d.ii of MRP 2.0, and to assess whether the chlorine in receiving waters is present at concentrations potentially toxic to the aquatic life living there, SCVURPPP field staff measured free chlorine and total chlorine residual in creeks where bioassessments were conducted. Total chlorine residual is comprised of "combined" chlorine and free chlorine, and should always be greater than or equal to the free chlorine residual. Combined chlorine is the chlorine that has reacted with ammonia or organic nitrogen to form chloramines, while free chlorine is the chlorine that remains unbound. Both can be toxic to aquatic life, but chlorine dissipates into the atmosphere more quickly than chloramine.

5.2 Methods

In accordance with the BASMAA RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012), field testing for free chlorine and total chlorine residual was conducted at twenty sites each year concurrent with spring bioassessment sampling (April - May). From WY 2012 through WY 2018, all sites were selected using the probabilistic design described in Section 2.0. In WY 2019, three of the twenty sites were selected on a targeted basis to address bioassessment management questions Probabilistic and targeted site selection methods are described in Section 2.0.

Field testing for free chlorine and total chlorine residual conformed to methods and procedures described in the BASMAA RMC SOPs (BASMAA 2016a), which are comparable to those specified in the SWAMP QAPP. Per SOP FS-3 (BASMAAS 201ab), water samples were collected and analyzed for free and total chlorine using a Pocket Colorimeter™ II and DPD Powder Pillows, which has a manufacturer reported method detection limit of 0.02 mg/L. If concentrations exceeded the MRP trigger criteria of 0.1 mg/L, the site was immediately resampled. The MRP 1.0 trigger criterion, implemented in WY 2012 through WY 2015, was 0.08 mg/L. The MRP 2.0 trigger criterion, implemented in WY 2016 through WY 2019, was 0.1 mg/L. If the resample also exceeds the trigger, the site is added to the list of candidate SSID projects. Provision C.8.d.ii(4) of the MRP 2.0 also specifies that "Permittees report the observation to the appropriate Permittee central contact point for illicit discharges to that the illicit discharge staff can investigate and abate the associated discharge in accordance with its provision C.5.e – Spill and Dumping Complaint Response Program."

5.3 Results and Discussion

The section below summarizes results from chlorine monitoring conducted during WY 2012 through 2018 and details results from WY 2019. Conclusion and recommendations are presented in Section 7.0.

In WY 2019, SCVURPPP monitored 20 sties for free chlorine and total chlorine residual. The measurements were compared to the MRP 2.0 trigger threshold of 0.1 mg/L.[26] Results are listed in Table 5.1. The trigger thresholds for free chlorine and total chlorine residual were three times; however, in each case, the immediate resample results were lower than the trigger thresholds. These findings illustrate the transient nature of chlorine and/or the unreliability in field measurement equipment at these small quantities. Overall, the results indicate that chlorine levels in the sampled creeks were not of concern during the monitoring time frame.

In WY 2019, the free chlorine result was greater than the total residual chlorine result at two stations (Table 5.1). Inverted results such as these have been occasionally noted through the WY 2012 – WY 2019 monitoring program. Potential causes for these inverted results include matrix interferences, colorimeter user error, and concentrations near the detection limit. According to Hach, the supplier of the equipment and reagents, the free chlorine could have false positive results due to a pH exceedance of 7.6 and/or an alkalinity exceedance of 250 mg/L. The pH was measured concurrently with the chlorine samples, but alkalinity was not measured. At all twenty stations, the pH exceeded 7.6. It is unlikely that the higher free chlorine readings were caused by user error. The field crew is well trained and aware of potential problems with this testing method, such as wait times between adding reagents and taking the readings and keeping the free chlorine and total residual chlorine samples separate. At more than one station, the field crew immediately resampled the creek in response to the inverted readings; with the second set of samples having identical results. The cause of the inverted free chlorine and total chlorine residual results (compared to expected) is unknown. However, it should be noted that colorimetric field instruments are generally not considered capable of providing accurate measurements of free chlorine and total chlorine residual below 0.13 mg/L, regardless of the method detection limit provided by the manufacturer. For this reason, the Statewide General Permit for drinking Water Discharges (Order WQ 2014-0194-DWQ) uses 0.1 mg/L as a reporting limit for field measurements of total chlorine residual.

[26] For reference, the Statewide General Permit for Drinking Water Discharges (Order WQ 2014-0194-DWQ) uses 0.1 mg/L as a reporting limit (minimum level) for field measurements of total residual chlorine.

Table 5.1. Summary of SCVURPPP chlorine testing results compared to MRP trigger of 0.1 mg/L, WY 2019.

Station Code	Date	Creek	Free Chlorine (mg/L) [1,2]	Total Chlorine Residual (mg/L) [1,2]	Exceeds Trigger Threshold (0.1 mg/L) [2]
205COY455	06/04/19	Coyote Creek	0.02	0.03	No
205GUA060	05/08/19	Los Gatos Creek	<0.02	0.04	No
205GUA251	04/29/19	Alamitos Creek	0.03	0.03	No
205R04247	06/05/19	Stevens Creek	0.04	0.04	No
205R04271	06/03/19	Stevens Creek	<0.02	<0.02	No
205R04317	06/04/19	Coyote Creek	<0.02	<0.02	No
205R04359	06/12/19	Adobe Creek	0.03	0.05	No
205R04378	05/08/19	Los Gatos Creek	0.02	0.02	No
205R04383	06/06/19	San Francisquito	0.02	0.05	No
205R04395	05/02/19	Arroyo de Los Coches	0.01	0.01	No
205R04418	04/30/19	Thompson Creek	0.09	0.05	No
205R04479	06/12/19	Saratoga Creek	0.01	0.03	No
205R04530	05/01/19	Upper Silver Creek	0.01	0.02	No
205R04537	04/30/19	Thompson Creek	0.00	0.02	No
205R04591	05/07/19	San Thomas Aquino Creek	0.55 / 0.04	0.07	No
205R04602	05/01/19	Wildcat Creek	0.03	0.02	No
205R04614	05/07/19	San Thomas Aquino	0.21 / 0.08	0.03	No
205R04638	05/06/19	Guadalupe Creek	<0.02	0.11 / 0.01	No
205R04670	05/09/19	Saratoga Creek	<0.02	<0.02	No
205STE070	06/05/19	Stevens Creek	<0.02	0.04	No

[1] The method detection limit is 0.02 mg/L; however, the Statewide General Permit for Drinking Water Discharges (Order WQ 2014-0194-DWQ) uses 0.1 mg/L as a reporting limit (minimum level) for field measurements of total chlorine residual.
[2] The MRP trigger threshold of 0.1 mg/L applies to both free chlorine and total chlorine residual measurements

A total of 144 stations have been monitored by SCVURPPP for free chlorine and total chlorine residual between WY 2012 and WY 2019 in compliance with MRP 1.0 and MRP 2.0. Occasional exceedances were recorded throughout the years and addressed by the appropriate follow-up process. Figure 5.1 maps of all the samples stations with their associated results. Each sample station has two symbols; free chlorine in the left square and total chlorine residual on the right. Larger symbols are used to represent WY 2019 results. The results exceeding the MRP 2.0 trigger threshold of 0.1 mg/L are shown in red. The results exceeding MRP 1.0 trigger threshold of 0.08 mg/L but below the MRP 2.0 trigger are shown in orange. All results equal to or below 0.08 mg/L are shown in green.

Since WY 2012, 17 of the 144 stations had exceedances of either the free chlorine or total chlorine residual trigger. Trigger exceedances tend to occur in high order streams that have traveled through highly populated areas towards the Bay, such as Lower Penitencia Creek. The values range from non-detectable levels of chlorine to 0.4 mg/L with one outlier of 0.91 mg/L (Lower Silver Creek in WY 2016). All stations with exceedances have been included on the SSID table for potential follow up projects.

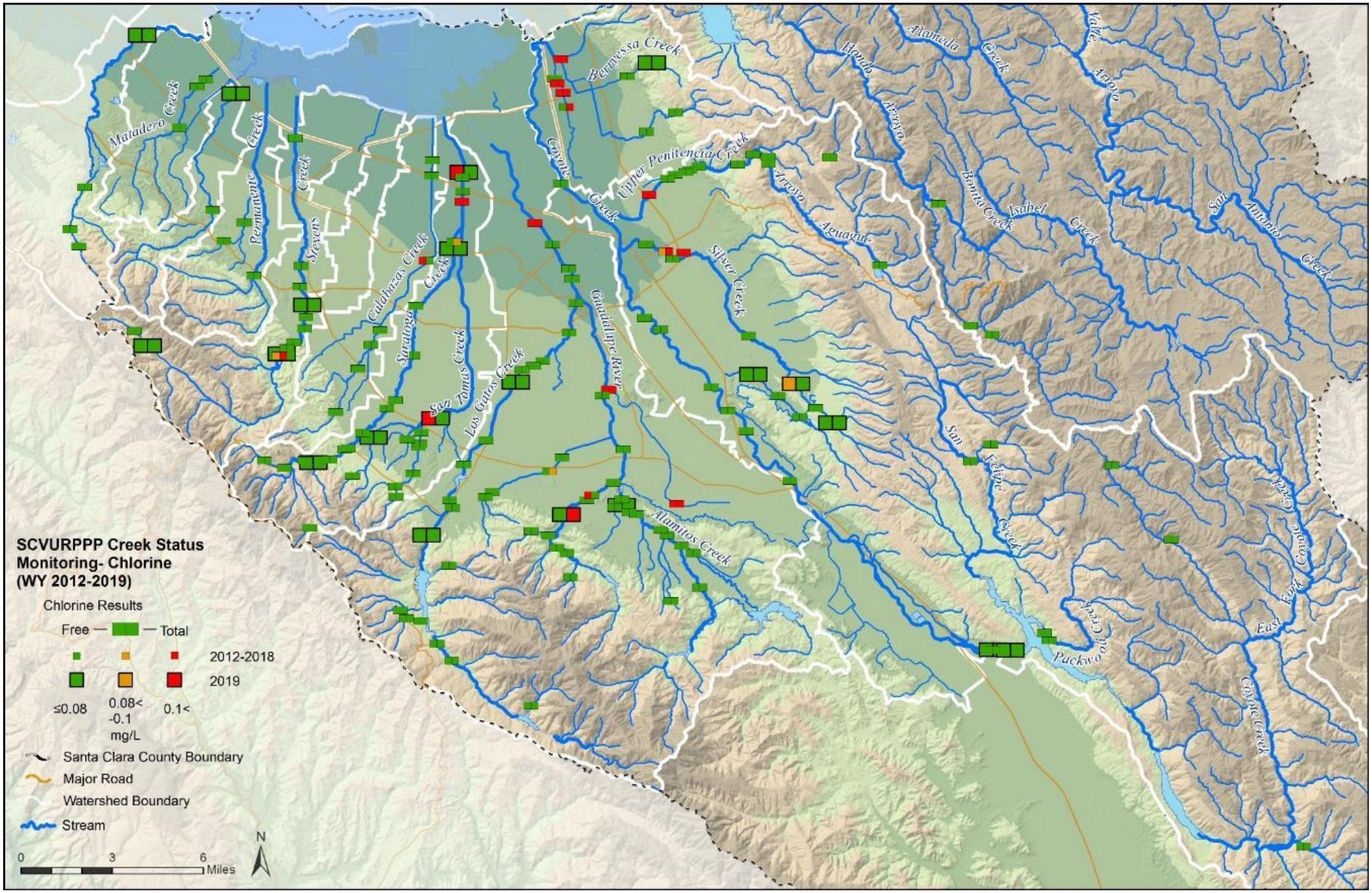

Figure 5.1 Chlorine sample stations and results WY 2012 – WY 2019 in Santa Clara County.

6.0 TOXICITY AND SEDIMENT CHEMISTRY MONITORING

6.1 Introduction

This section describes the results of toxicity testing, sediment chemistry monitoring, and water column pesticides monitoring (collectively referred to as pesticides and toxicity monitoring) conducted during WY 2014 through WY 2019 in compliance with Provisions C.8.c of MRP 1.0 and C.8.g of MRP 2.0. Pesticide and toxicity monitoring results and data from SCVURPPP monitoring and projects external to the RMC are discussed, to inform management efforts for Santa Clara Basin urban creeks with respect to achievement of water quality objectives and support of Beneficial Uses.

Toxicity testing provides a tool for assessing the toxic effects (acute and chronic) of all chemicals in receiving waters or sediments on aquatic organisms, and allows the cumulative effect of these chemicals to be evaluated. Because different test organisms are sensitive to different classes of chemicals and pollutants, several different organisms are used when assessing the toxicity of water or sediment in receiving waters. Sediment and water chemistry monitoring for a variety of potential pollutants is conducted synoptically with toxicity monitoring to provide preliminary insight into the possible causes of toxicity, should it be observed.

Pesticide and toxicity monitoring in urban creeks during wet and dry weather were required by both MRP 1.0 and MRP 2.0. There were slight differences, however, between the requirements included in the two permits, including the required number of samples, types test organisms, and chemical constituents. These differences are outlined in the following sections.

6.1.1 Dry Weather

Provision C.8.c of MRP 1.0 required that three stream sites be sampled during the dry weather period for pesticides and toxicity during WYs 2014 and 2015. The Program selected sites from the list of twenty probabilistic sites where bioassessment was conducted during the same WY. The MRP 1.0 dry weather monitoring included:

- Toxicity testing in water using four species: *Ceriodaphnia dubia* (chronic survival and reproduction), *Pimephales promelas* (larval survival and growth), *Selenastrum capricornutum* (growth), and *Hyalella azteca* (survival);
- Toxicity testing of bedded sediment using one species: *Hyalella azteca* (survival);[27]
- Sediment chemistry analysis for pyrethroids, chlordane, dieldrin, endrin, heptachlor epoxide, lindane, dichlorodiphenyltrichloroethanes (DDT), metals, polycyclic aromatic hydrocarbons (PAHs), total organic carbon (TOC), and sediment grain size.

Provision C.8.g of MRP 2.0 required the Program to sample two stream sites each year during the dry season for pesticides and toxicity during WY 2016 through WY 2019. MRP 2.0 provides examples of possible monitoring location types, including sites with suspected or past toxicity results, existing bioassessment sites, or creek restoration sites. Dry weather pesticides and toxicity monitoring required by MRP 2.0 included:

[27] Although the chronic (growth) endpoint for *Hyalella azteca* was not required by the MRP, it was provided by the laboratory and reported in the UCMRs.

- Toxicity testing in water using five species: *Ceriodaphnia* dubia (chronic survival and reproduction), *Pimephales promelas* (larval survival and growth), *Selenastrum capricornutum* (growth), *Hyalella azteca* (survival) and *Chironomus dilutus* (survival).
- Toxicity testing of bedded sediment using two species: *Hyalella azteca* (survival) and *Chironomus dilutus* (survival).
- Sediment chemistry analysis for pyrethroids, fipronil, carbaryl, polycyclic aromatic hydrocarbons (PAHs), metals, total organic carbon (TOC), and sediment grain size.

6.1.2 Wet Weather

MRP 1.0 required wet weather toxicity testing in WYs 2014 and 2015 at the same three sites where dry weather toxicity and sediment chemistry monitoring was conducted. The wet weather toxicity monitoring was based on the same four species that were used in dry season monitoring. No wet weather water chemistry monitoring for pesticides or other potential pollutants was required during MRP 1.0.

Provision C.8.g.iii.(3) of MRP 2.0, covering WY 2016 through WY 2019, requires MRP Permittees to collectively test a total of 10 wet weather samples for toxicity and water chemistry if the wet weather monitoring is coordinated via the RMC on behalf of all MRP Permittees. MRP 2.0 states that the monitoring locations should be representative of urban watersheds (i.e., at the bottom of watersheds). At the RMC Monitoring Workgroup meeting on January 25, 2016, RMC members agreed to collaborate on implementation of the wet weather monitoring requirements. MRP 2.0 wet weather monitoring requirements include collection of water column samples during storm events for toxicity testing using the same five organisms required for dry weather testing and analysis of pyrethroids, fipronil, imidacloprid, and indoxacarb.[28] All 10 wet weather samples were collected in WY 2018 during a single storm event on January 8, 2018. SCVURPPP and ACCWP each collected three samples, and SMCWPPP and CCCWP each collected two samples.

6.2 Methods

6.2.1 Site Selection

Under MRP 1.0, the three annual pesticides and toxicity monitoring sites were selected from the list of 20 probabilistic sites where bioassessment surveys were conducted. See Section 2.2 of this report for a description of the probabilistic survey design. Sites were identified based on the likelihood that they would be safe to access during storm events and that fine depositional sediments would be present to sample during the dry season.

Under MRP 2.0, water and sediment toxicity and sediment chemistry samples were collected from two sites during dry weather: Stevens Creek and San Tomas Aquino Creek (see Figure 6.1). Sites were selected to represent urban watersheds that were not already being monitored for toxicity or pesticides by other programs, such as the SWAMP Stream Pollution Trends (SPoT) program or the California Department of Pesticide Regulation (DPR) Surface Water Protection Program Monitoring (SWPP). Specific stations within the watersheds were identified based on the likelihood that they would contain fine depositional sediments during dry season sampling and would be safe to access during wet weather sampling. It is anticipated that

[28] Standard analytical methods for indoxacarb are not currently available. Indoxacarb analysis will not be required until the water year following notification by the Executive Officer that a method is available.

SCVURPPP will continue to sample these same two stations throughout the permit term of MRP 2.0, with the goal of building a long-term dataset that complements data being gathered through SWAMP SPoT and DPR SWPP.

In WY 2018, in compliance with Provision C.8.g.iii of MRP 2.0, water toxicity and pesticides samples were collected from three sites during wet weather: Stevens Creek, San Tomas Aquino Creek, and Calabazas Creek (see Figure 6.1). The sites on Stevens Creek and San Tomas Aquino Creek were selected because they were the focus of MRP 2.0 dry weather monitoring. The station on Calabazas Creek was selected because it is located at the bottom of a large urban watershed that may be representative of other urban watersheds in the Santa Clara Basin.

All stations monitored by SCVURPPP for wet and dry weather pesticides and toxicity during WY 2014 through WY 2019 are illustrated in Figure 6.1. SPoT and DPR stations are also included in the figure.

6.2.2 Sample Collection

Water and sediment samples for pesticides and toxicity monitoring were collected in accordance with SWAMP-comparable methods and procedures described in the BASMAA RMC SOPs (BASMAA 2016a) and the associated QAPP (BASMAA 2016b). Before sampling, field personnel conduct a qualitative assessment of the proposed sampling site to identify appropriate sampling locations. This is particularly necessary for sediment sampling, which requires the presence of fine-sediment depositional areas that can support at least five sub-sites within a 100 meter reach.

Water samples were collected using standard grab sampling methods. The required number of labeled amber glass bottles were filled and placed on ice to cool to < 6C. The laboratory was notified of the impending sampling delivery to meet sample hold times. Procedures used for sampling and transporting water samples are described in SOP FS-2 (BASMAA 2016a).

Sediment samples were collected after any water samples were collected. Sediment samples were collected from the top 2 cm at each sub-site beginning at the downstream-most location and continuing upstream. Field staff walk in an upstream direction, carefully avoiding disturbance of sediment at collection sub-sites. Sediment samples were placed in a compositing container, thoroughly homogenized, and then aliquoted into separate jars for chemical or toxicological analysis using standard clean sampling techniques (see SOP FS-6, BASMAA 2016a).

Samples were submitted to respective laboratories under RMC SOP FS-9 Chain of Custody procedures and field data sheets were reviewed per SOP FS-13 (BASMAA 2016a).

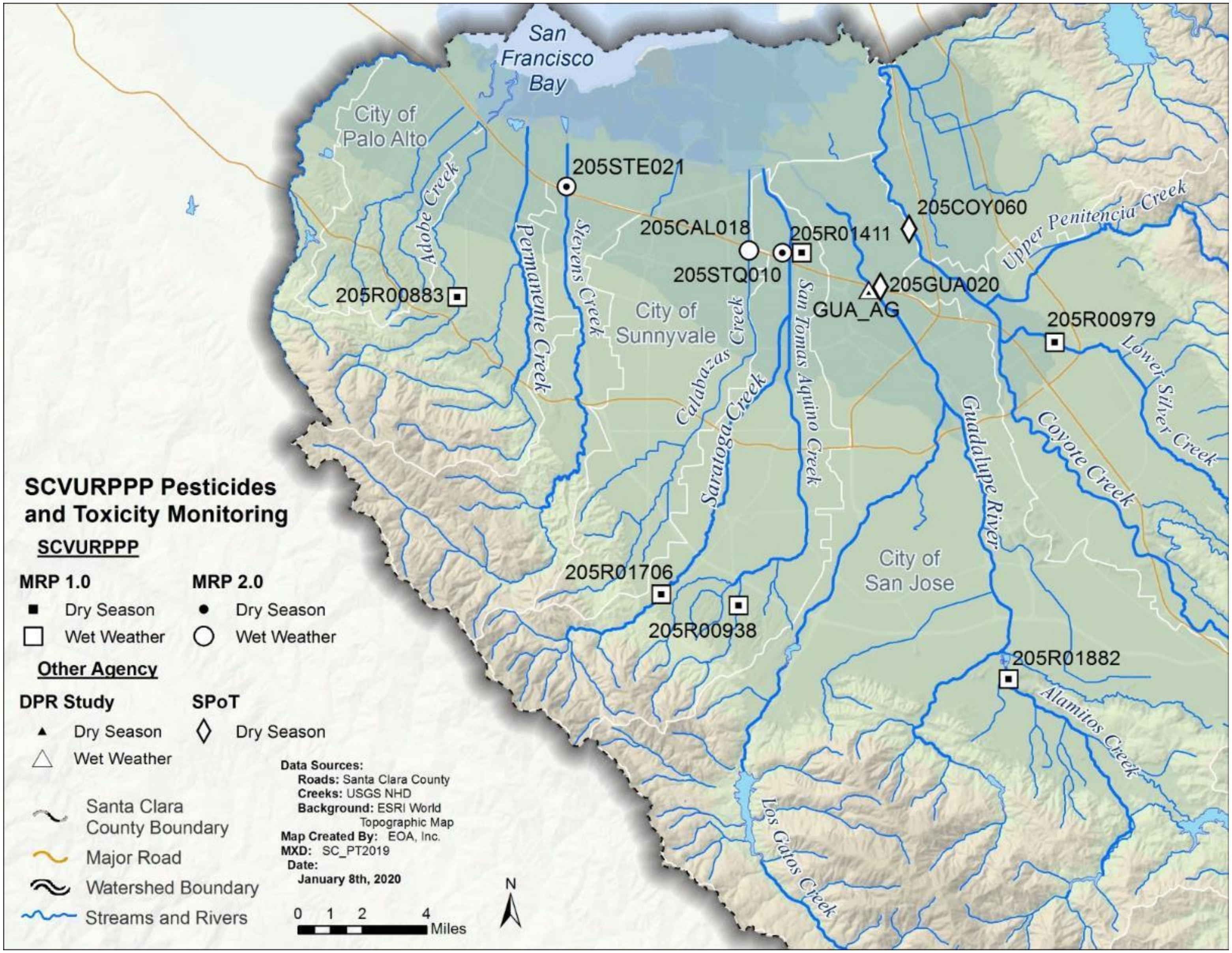

Figure 6.1. Pesticides and toxicity sampling stations in the Santa Clara Basin during WYs 2014 through 2019.

6.2.3 Data Evaluation

Water and Sediment Toxicity

Toxicity data evaluation required by MRP 1.0 and MRP 2.0 involves first assessing whether the samples are toxic to the test organisms relative to the laboratory control treatment via statistical comparison. MRP 2.0 specifies using the Test of Significant Toxicity (TST) statistical approach to compare the sample to the laboratory control. For samples with toxicity (i.e., those that "failed" the TST), the Percent Effect is evaluated. The Percent Effect compares sample endpoints (survival, reproduction, growth) to the laboratory control endpoints. Both the statistical comparison (e.g., TST) and the comparison of the sample results to the laboratory control (e.g., Percent Effect) are determined by the laboratory.

For WY 2014 and WY 2015 data, Table 8.1 of MRP 1.0 identified toxicity results of less than 50% of the laboratory control as requiring follow-up action for water toxicity tests. For sediment toxicity tests conducted during these years, Table H-1 identified toxicity results of greater than 20% less than the control as requiring follow-up action. Follow-up actions for MRP 1.0 include resampling sites where water toxicity tests exceeded the thresholds defined in the MRP. Failure of sediment toxisty tests did not require resampling. Based on the results of initial and/or resampling events, sites with observed toxicity above these thresholds onto a list for consideration of Stressor/Source Identification (SSID) projects, consistent with the MRP.

For WY 2016 through WY 2019 data, Provision C.8.g of MRP 2.0 identified toxicity results reported as "fail" via the TST approach and a Percent Effect of ≥ 50% as requiring follow-up action for water and sediment tests. Follow-up actions include the resampling of a site if any toxicity test result exceeds the threshold defined in MRP 2.0. If both the initial and follow-up sample exceed the threshold, the site is added to the list of candidate SSID projects.

Sediment Chemistry

Sediment chemistry results were evaluated using three criteria: Probable Effects Concentration (PEC) quotients, Treshold Effects Concentration (TEC) quotients and Toxicity Unit (TU) equivalents. PEC and TEC quotients are calculated as the ratio of the measured concentration to the respective PEC and TEC values from MacDonald et al. (2000). TU equivalents are calculated for individual pyrethroid pesticide results based on available LC50[29,] values from the literature. Because organic carbon mitigates the toxicity of pyrethoid pesticides and the LC50 values are derived on the basis of TOC-normalized concentrations, the pyrethroid concentrations as reported by the lab were divided by the measured TOC concentration at each site, and the TOC-normalized concentrations were then used to compute TU equivalents for each pyrethroid.

Under MRP 1.0 (WY 2014 and WY 2015), sites were added to the list of candidate SSID projects if three or more TEC quotients were ≥ 1.0, if the site had a mean PEC quotient ≥ 0.5, or if the sum of TU equivalents for all measured pyrethroids was ≥ 1.0.

MRP 2.0 requires that all sites where a PEC or TEC quotient is ≥ 1.0 are added to the list of candidate SSID projects. MRP 2.0 does not require consideration of pyrethroid, fipronil, or carbaryl[30] sediment chemistry data for follow-up SSID projects, perhaps because pyrethroids

[29] The LC50 is the concentration of a given chemical that is lethal on average to 50% of test organisms.

[30] No LC50 is published for carbaryl in sediment.

are ubiquitous in the urban environment and little is known about fipronil and carbaryl distribution.

Evaluation of sediment chemistry data and calculation of PEC/TEC quotients and TU equivalents is based in several assumptions and considerations, including:

- For PAHs in sediment, the laboratory reports concentrations for 24 individual PAHs; whereas, PECs and TECs are listed in MacDonald et al. (2000) for total PAHs. Total PAH concentrations were calculated by summing the concentrations of 24 individual PAHs.
- Concentrations equal to one-half of the respective laboratory method detection limits were substituted for non-detect data so that calculations and statistics could be computed. Therefore, some of the TEC and PEC quotients and TU equivalents may be artificially elevated (and contribute to trigger exceedances) due to the method used to account for non-detect data.
- The TECs for bedded sediments are very conservative values that do not consider site specific background conditions, and are therefore not very useful in identifying real water quality concerns in receiving waters in Santa Clara County. All sites in the County are likely to have at least one TEC quotient equal to or greater than 1.0. This is due to high levels of naturally-occurring chromium and nickel in geologic formations (i.e., serpentine) and soils that contribute to TEC and PEC quotients.

<u>Water Chemistry</u>

Water chemistry analysis was not part of pesticides and toxicity monitoring under MRP 1.0. Provision C.8.g.iv of MRP 2.0 requires that chemical pollutant data from water and sediment monitoring is compared to the corresponding water quality objectives in the SF Bay Water Quality Control Plan (i.e., Basin Plan) for each analyte sampled. If concentrations in the samples exceed the associated water quality objectives, then the site at which the exceedances were observed will be added to the list of candidate SSID projects. The Basin Plan, however, the does not contain numeric water quality objectives for the chemical analytes that are required to be monitored as part of MRP wet weather pesticide monitoring.

6.3 Results and Discussion

In WY 2014 and WY 2015, a total of six sites (three sites per year) were monitored for water and sediment toxicity and sediment chemistry during the wet and dry seasons within the watersheds of Adobe Creek, San Tomas Aquino Creek, and Lower Silver Creek. Sites were selected at locations where bioassessment surveys were conducted. The results of these monitoring efforts were compared to MRP 1.0 trigger thresholds.

In WY 2016 through WY 2019, dry weather water and sediment toxicity and sediment chemistry monitoring was conducted to satisfy the requirements specified in MRP 2.0. This monitoring took place at the same two sites in Stevens Creek and San Tomas Aquino Creek over all three years. In WY 2018, wet weather toxicity and water chemistry monitoring was conducted at three sites to satisfy Provision C.8.g.iii of MRP 2.0. Two of these sites were the same sites in Stevens Creek and San Tomas Aquino Creek where the dry weather monitoring took place, while the third site was located in Calabasas Creek.

Toxicity and pesticides monitoring results are described in the sections below. Conclusions are provided in Section 7.0.

6.3.1 Toxicity

WY 2019 Results

Table 6.1 provides a summary of toxicity testing results for water and sediment samples collected during dry weather in WY 2019. Due to MRP threshold exceedances associated with the samples taken at station 205STE021 on Stevens Creek, as described below, this site was added to the list of potential SSID project locations.

- **Stevens Creek (205STE021).** The dry weather sediment sample at this sites was not toxic to either of the test organisms utilized. The water sample was significantly toxic to two of the five test organisms (*C. dubia* and *C. dilutus*). The Percent Effect did not exceed the 50% threshold for follow-up for *C. dilutus* (survival), but the threshold for follow-up was exceeded for *C. dubia* (reproduction). The follow-up water sample was significantly toxic, but the 50% threshold for follow-up was not exceeded. The cause of the water toxicity to this test organism that is sensitive to a broad range of aquatic contaminants is unknown. Chronic (reproduction) toxicity to *C. dubia*, however, has been observed in some prior samples collected by SCUVRPPP (Table 6.2) in Stevens Creek. Regional Water Board staff have also observed toxicity in Stevens Creek in previous years. A preliminary study of Stevens Creek toxicity conducted by the Regional Water Board was inconclusive and additional investigation is currently considered a low priority (Jan O'Hara, *personal communication*, Dec. 9, 2019).

- **San Tomas Aquino Creek (205STQ010).** The water sample taken from this site was significantly toxic to one of the five test organisms (*C. dubia*), however, the Percent Effect did not exceed the 50% threshold for follow-up. The cause of the water toxicity is unknown. The sediment sample from this site was significantly toxic to one of the two test organisms (*C. dilutus*) and the Percent Effect exceeded the 50% threshold for follow-up. The follow-up sediment sample was not toxic to *C. dilutus*. The cause of the sediment toxicity is unknown. *C. dilutus* is known to be sensitive to noenicitinoid pesticides, such as fipronil, however, the concentration of fipronil and its degradates at the sites were all below the method detection limit (MDL) in the sediment sample collected concurrently with the initial toxicity sample.

Table 6.1. Summary of SCVURPPP dry weather toxicity results for WY 2019.

Site	Organism	Test Type	Unit	Results		% Effect	TST Value	Follow up needed
				Lab Control	Organism Test			
205STQ010 San Tomas Aquino Creek July 23, 2019	**Water**							
	Ceriodaphnia dubia	Survival	%	100	100	0%	NA[1]	No
		Reproduction	Num/Rep	32	22	31.3%	Fail	No
	Pimephales promelas	Survival	%	100	97.5	2.5%	Pass	No
		Growth	mg/ind	0.767	0.805	-4.99%	Pass	No
	Chironomus dilutus	Survival	%	100	87.5	13%	Pass	No
	Hyalella azteca	Survival	%	100	100	0.00%	Pass	No
	Selenastrum capricornutum	Growth	cells/ml	3560000	5220000	-46.5%	Pass	No
	Sediment							
	Chironomus dilutus	Survival	%	80	35	**56.3%**	**Fail**	**Yes**
	Hyalella azteca	Survival	%	96.2	96.2	0.00%	Pass	No
205STQ010 San Tomas Aquino Creek August 28, 2019	**Sediment – Resample**							
	Chironomus dilutus	Survival	%	92.5	81.2	12.16%	Pass	No
205STE021 Stevens Creek July 23, 2019	**Water**							
	Ceriodaphnia dubia	Survival	%	100	90	10%	NA[1]	No
		Reproduction	Num/Rep	32	8.6	**73.1%**	**Fail**	**Yes**
	Pimephales promelas	Survival	%	100	90	10.0%	Pass	No
		Growth	mg/ind	0.767	0.71	6.85%	Pass	No
	Chironomus dilutus	Survival	%	100	82.5	18%	Fail	No
	Hyalella azteca	Survival	%	100	98	2.00%	Pass	No
	Selenastrum capricornutum	Growth	cells/ml	3560000	3390000	4.7%	Pass	No
	Sediment							
	Chironomus dilutus	Survival	%	80	83.8	-4.69%	Pass	No
	Hyalella azteca	Survival	%	96.2	98.8	-2.60%	Pass	No
205STE021 Stevens Creek September 18, 2019	**Water - Resample**							
	Ceriodaphnia dubia	Survival	%	90	100	0.00%	NA[1]	No
	Ceriodaphnia dubia	Young/female	Num/Rep	32.3	17.2	46.8%	Fail	No

[1] TST analysis is not performed for survival endpoint - a percent effect <25% is considered a "Pass", and a percent effect ≥25% is considered a "Fail"

WY 2014 – WY 2019 Results Summary

Toxicity results for the IMR reporting period (WY 2014 through WY 2019) are summarized in Table 6.2. Details of the WY 2014 to WY 2018 toxicity tests can be found in the Urban Creeks Monitoring Reports for each associated year (SCVURPPP 2019, SCVURPPP 2018, SCVURPPP 2017, SCVURPPP 2016, SCVURPPP 2015).

During WY 2014 through WY 2019, two sediment samples and four water samples had observed toxicity relative to the laboratory control *and* a Percent Effect exceeding the MRP evaluation criteria (see Section 6.2.3 for an explanation of MRP 1.0 and 2.0 triggers). There were an additional 20 test results where significant toxicity was observed, but the Percent Effect did not exceed the MRP trigger threshold. There is no clear pattern to these observations of toxicity. The samples were collected from a variety of creeks under both wet and dry season conditions and a variety of test organisms were affected. In all but one case, the six events with observed toxicity and a Percent Effect over the MRP threshold were resampled for the same test organism within the same season, and the follow-up tests did not exceed the MRP toxicity trigger thresholds. Of the 26 samples where significant toxicity was observed, a majority were water samples and associated with either *C. dubia* reproduction (10 samples) or *H. azteca* survival (7 samples). Six of the seven water samples with toxicity to *H. azteca* survival were collected during wet season sampling events, suggesting that stormwater runoff may be adversely affecting *H. azteca*. The water samples with toxicity to *C. dubia* were more evenly dispersed between wet and dry season sampling events.

With the adoption of MRP 2.0, SCVURPPP initiated annual monitoring of toxicity and pesticides in San Tomas Aquino Creek and Stevens Creek with the goal of building a long-term dataset. A review of the toxicity summary in Table 6.2 suggests that toxicity to *H. azteca*, a test organism known to be sensitive to pyrethroid pesticides is less prevalent in these creeks than toxicity to *C. dilutus*, a test organism known to be sensitive to neonicotinoids (e.g., imidacloprid). This finding is consistent with monitoring results reported by DPR which show that imidacloprid is being detected more frequently throughout Northern California streams (Ensminger 2017). Based on these limited results, it appears plausible that the water quality impacts associated with pyrethroid pesticides may be decreasing, while impacts associated with their replacements (i.e., neonicotinoids) may be increasing as these types of pesitides gain market share.

Table 6.2. Toxicity test result summary, WY 2014 – WY 2019. The Percent Effect is indicated for test results with toxicity relative to the lab control. Test results with toxicity exceeding the MRP 1.0 and MRP 2.0 trigger thresholds are highlighted.

					Sediment			Water						
			Water		*C. dilutus* [2]	*H. azteca*		*C. dubia*		*P. promelas*		*C. dilutus* [2]	*H. azteca*	*S. capricornutum*
Station ID	**Creek**	**Date**	**Year**	**Season**	**Survival**	**Survival**	**Growth** [2]	**Survival**	**Reproduction**	**Survival**	**Growth**	**Survival**	**Survival**	**Growth**
MRP 1.0														
205R00883	Adobe Cr	2/24/2014	WY 2014	Wet	--	--	--	No	No	No	No	--	No	No
205R00883	Adobe Cr	6/4/2014	WY 2014	Dry	--	**Yes** (9%)	No	No	**Yes** (25%)	No	No	--	No	No
205R00938	San Tomas Aquino Cr	2/24/2014	WY 2014	Wet	--	--	--	No	**Yes** (26%)	No	No	--	No	No
205R00938	San Tomas Aquino Cr	6/4/2014	WY 2014	Dry	--	No	No	No	**Yes** (45%) [1]	No	No		No	No
205R00979	Lower Silver Cr	2/24/2014	WY 2014	Wet	--	--	--	No	No	No	No	--	**Yes** (29%)	No
205R00979	Lower Silver Cr	6/4/2014	WY 2014	Dry	--	No	No	No	No	No	No	--	No	No
205R01411	San Tomas Aquino Cr	2/26/2015	WY 2015	Wet	--	--	--	No	**Yes** (17%)	No	No	--	**Yes** (16%)	No
205R01411	San Tomas Aquino Cr	7/7/2015	WY 2015	Dry	--	No	No	No	No	No	No	--	No	No
205R01706	Saratoga Cr	2/26/2015	WY 2015	Wet	--	--	--	No	No	No	No	--	**Yes** (45%)	No
205R01706	Saratoga Cr	7/7/2015	WY 2015	Dry	--	No	No	No	No	No	No	--	No	No
205R01882	Alamitos Cr	2/26/2015	WY 2015	Wet	--	--	--	No	**Yes** (17%)	No	No	--	**Yes** (35%)	No
205R01882	Alamitos Cr	7/7/2015	WY 2015	Dry	--	**Yes** (100%)	**Yes** (100%)	No	No	No	No	--	No	No
MRP 2.0														
205STQ010	San Tomas Aquino Cr	7/11/2016	WY 2016	Dry	**Yes** (18%)	No	--	No	No	No	No	No	No	No
205STQ010	San Tomas Aquino Cr	7/13/2017	WY 2017	Dry	No	No	--	No	**Yes** (30%)	No	No	**Yes** (11%)	No	No
205STQ010	San Tomas Aquino Cr	1/8/2018	WY 2018	Wet	--	--	--	No	No	No	No	No	**Yes** (56%)	No
205STQ010	San Tomas Aquino Cr	3/1/2018	WY 2018	Wet [3]	--	--	--	No	--	--	--	--	No	--
205STQ010	San Tomas Aquino Cr	7/17/2018	WY 2018	Dry	No	No	--	No	No	No	No	No	No	No
205STQ010	San Tomas Aquino Cr	7/23/2019	WY 2019	Dry	**Yes** (56%)	No	--	No	**Yes** (31%)	No	No	No	No	No
205STQ010	San Tomas Aquino Cr	8/28/2019	WY 2019	Dry [3]	No	--	--	No	--	--	--	--	--	--
205STE021	Stevens Cr	7/11/2016	WY 2016	Dry	No	No	--	No	No	**Yes** (27%)	No	No	No	No
205STE021	Stevens Cr	7/13/2017	WY 2017	Dry	No	No	--	No	**Yes** (80%)	No	No	No	No	No
205STE021	Stevens Cr	8/15/2017	WY 2017	Dry [3]	--	--	--	No	No	--	--	--	--	--
205STE021	Stevens Cr	1/8/2018	WY 2018	Wet	--	--	--	No	No	No	No	No	**Yes** (28%)	No
205STE021	Stevens Cr	7/17/2018	WY 2018	Dry	No	No	--	No	No	No	No	**Yes** (24%)	No	No
205STE021	Stevens Cr	7/23/2019	WY 2019	Dry	No	No	--	No	**Yes** (73%)	No	No	**Yes** (18%)	No	No
205STE021	Stevens Cr	9/18/2019	WY 2019	Dry [3]	--	--	--	No	**Yes** (47%)	--	--	--	--	--
205CAL018	Calabazas Cr	1/8/2018	WY 2018	Wet	--	--	--	No	No	No	No	No	**Yes** (60%)	No
205CAL018	Calabazas Cr	3/1/2018	WY 2018	Wet [3]	--	--	--	No	--	--	--	--	**Yes** (12%)	--

1 - The test response in one of the replicates for this test treatment was determined to be a statistical outlier; the results reported above are for the analysis of the data excluding the outlier.
2 - *Chironomus dilutus* testing was not required by MRP 1.0. *Hyalella azteca* growth was not required by either permit but is included here when reported by the lab.
3- Resample.

6.3.2 Sediment Chemistry

Sediment chemistry results are evaluated as potential stressors based on TEC quotients and PEC quotients according to trigger thresholds listed in MRP 1.0 and MRP 2.0 (see Section 6.2.3). Evaluation of TU equivalents was required under MRP 1.0 and, although not required under MRP 2.0, used to inform stormwater management.

<u>WY 2019 Results</u>

Table 6.3 lists concentrations and TEC quotients for sediment chemistry constituents (metals and total PAHs) collected in WY 2019 from Stevens Creek and San Tomas Aquino Creek. TEC quotients are calculated as the measured concentration divided by the highly conservative TEC value, per MacDonald et al. (2000)[31]. TECs are extremely conservative and are intended to identify concentrations below which harmful effects on sediment-dwelling organisms are unlikely to be observed. Both sites exceeded the trigger threshold from MRP 2.0 of having at least one result exceeding the TEC and will be added to the list of potential SSID projects. However, the constituents with TEC quotients ≥ 1.0 were limited to nickel and chromium which are expected in watersheds draining hillsides underlain by serpentine formations.

Table 6.4 lists concentrations and PEC quotients for sediment chemistry constituents (metals and total PAHs) collected in WY 2019. PECs are intended to identify concentrations above which toxicity to benthic-dwelling organisms are predicted to be probable. No PEC quotients were greater than 1.0 in San Tomas Aquino Creek. The PEC quotient for nickel, a serpentine-related metal) in Stevens Creek was equal to 1.2.

Table 6.3. Threshold Effect Concentration (TEC) quotients for WY 2019 sediment chemistry constituents. Bolded and shaded values indicate TEC quotient ≥ 1.0.

Analyte	TEC	205STE021		205STQ010	
		Stevens Creek		San Tomas Aquino Creek	
Metals (mg/kg DW)		**Concentration**	**Quotient**	**Concentration**	**Quotient**
Arsenic	9.79	2.8	0.29	2.1	0.21
Cadmium	0.99	0.19	0.19	0.09	0.09
Chromium	43.4	65	**1.5**	37	0.85
Copper	31.6	27	0.85	18	0.57
Lead	35.8	11	0.31	6.7	0.19
Nickel	22.7	57	**2.5**	36	**1.6**
Zinc	121	84	0.69	58	0.48
PAHs (ug/kg DW)					
Total PAHs	1610	227	0.14[a]	106	0.07[a]

[a] Total calculated using 1/2 MDLs for some individual PAHs.

[31] MacDonald et al. (2000) does not provide TEC or PEC values for pyrethroids, fipronil, or carbaryl. Pesticides are compared to LC50 values in Table 6.5.

Table 6.4. Probable Effect Concentration (PEC) quotients for WY 2019 sediment chemistry constituents. Bolded and shaded values indicate PEC quotient ≥ 1.0.

Analyte	PEC	205STE021		205STQ010	
		Stevens Creek		San Tomas Aquino Creek	
Metals (mg/kg DW)		**Concentration**	**Quotient**	**Concentration**	**Quotient**
Arsenic	33.0	2.8	0.08	2.1	0.06
Cadmium	4.98	0.19	0.04	0.09	0.02
Chromium	111	65	0.59	37	0.33
Copper	149	27	0.18	18	0.12
Lead	128	11	0.09	6.7	0.05
Nickel	48.6	57	**1.2**	36	0.7
Zinc	459	84	0.18	58	0.13
PAHs (ug/kg DW)					
Total PAHs	22,800	227.3	0.01[a]	106.15	0.005[a]

[a] Total calculated using 1/2 MDLs for some individual PAHs.

Table 6.5 lists the concentrations of pesticides measured in sediment samples taken in WY 2019, TOC-normalized concentrations, and TU equivalents for the pesticides for which there are published LC50 values in the literature. Many of the pesticides measured were below MDLs and the TU equivalents were calculated using ½ the MDL concentration. No TU equivalents exceeded 1.0. The highest TU equivalent in the Stevens Creek sample was for fipronil sulfone (0.21), however, this calculation was based on ½ the MDL and therefore is an estimate. The TU equivalent for bifenthrin, which is considered to be the leading cause of pyrethroid-related toxicity in urban areas (Ruby 2013) and the most-commonly detected insecticide monitored by the DPR SWPP (Ensminger 2017), was 0.15. The highest TU equivalent in the WY 2019 San Tomas Aquino Creek sediment sample was for cypermethrin (0.12).

Table 6.5. Pesticide concentrations and calculated toxic unit (TU) equivalents, WY 2019.

Analyte	Unit	LC50 [c]	205STE021 Stevens Creek			205STQ010 San Tomas Aquino Creek		
			Concentration	Normalized to TOC	TU Equivalent	Concentration	Normalized to TOC	TU Equivalent
Total Organic Carbon	%	NA	0.79	NA	NA	0.58	NA	NA
Pyrethroid								
Bifenthrin	µg/g dw	0.52	0.0006 [b]	0.08	0.15	0.0003 [a]	0.04	0.09
Cyfluthrin, total	µg/g dw	1.08	0.0003 [a]	0.04	0.03	0.0003 [a]	0.05	0.05
Cypermethrin, total	µg/g dw	0.38	0.0003 [a]	0.03	0.09	0.0003 [a]	0.04	0.12
Deltamethrin/ Tralomethrin	µg/g dw	0.79	0.0003 [a]	0.04	0.05	0.0003 [a]	0.05	0.07
Esfenvalerate /Fenvalerate, total	µg/g dw	1.54	0.0003 [a]	0.04	0.03	0.0003 [a]	0.06	0.04
Cyhalothrin, Total lambda-	µg/g dw	0.45	0.0002 [a]	0.02	0.04	0.0003 [a]	0.03	0.06
Permethrin, Total	µg/g dw	10.83	0.0003 [a]	0.04	0.003	0.0003 [a]	0.05	0.004
			Sum of TU Equivalents		0.4	Sum of TU Equivalents		0.4
Other MRP Pesticides of Concern								
Carbaryl	mg/Kg dw	NA [d]	0.01 [a]	1.3	NA	0.01 [a]	1.7	NA
Fipronil	ng/g dw	306	0.26 [a]	32.9	0.11	0.26 [a]	44.0	0.14
Fipronil Desulfinyl	ng/g dw	NA [d]	0.26 [a]	32.9	NA	0.26 [a]	44.0	NA
Fipronil Sulfide	ng/g dw	435	0.26 [a]	32.9	0.08	0.26 [a]	44.0	0.10
Fipronil Sulfone	ng/g dw	158	0.26 [a]	32.9	0.21	0.26 [a]	44.0	0.28

a. Concentration was below the method detection limit (MDL). TU equivalents calculated using 1/2 MDL.
b. TU equivalents calculated from concentration below the reporting limit (J-flagged).
c. Sources: Amweg et al. 2005 and Maund et al. 2002 for pyrethroids; Maul et al. for fipronil compounds
d. No available LC50 value for Carbaryl or Fipronil Desulfinyl.

In compliance with the MRP, a grain size analysis was conducted on both of the WY 2019 sediment samples (Table 6.6). The Stevens Creek (205STE021) sample was 10.2% fines (i.e., 3.8% clay and 6.4% silt); and the San Tomas Aquino Creek (205STQ010) sample was 5.2% fines (i.e., 0.7% clay and 4.5% silt).

Table 6.6. Summary of grain size for the two locations sampled in Santa Clara County during WY 2019.

Grain Size (%)		205STE021	205STQ010
		Stevens Creek	San Tomas Aquino Creek
Clay	<0.0039 mm	3.8%	0.7%
Silt	0.0039 to <0.0625 mm	6.4%	4.5%
Sand	V. Fine 0.0625 to <0.125 mm	12.1%	3.4%
	Fine 0.125 to <0.25 mm	8.4%	16.7%
	Medium 0.25 to <0.5 mm	31.9%	45.8%
	Coarse 0.5 to <1.0 mm	10.6%	21.6%
	V. Coarse 1.0 to <2.0 mm	9.2%	7.3%
Granule	2.0 to <4.0 mm	9.6%	2.2%
Pebble	Small 4 to <8 mm	7.5%	2.8%
	Medium 8 to <16 mm	0%	0%
	Large 16 to <32 mm	0%	0%
	V. Large 32 to <64 mm	0%	0%

Note: Sum of grain size values for both sites is greater than 100% due to the laboratory analytical methods used.

<u>WY 2014 – WY 2019 Summary</u>

Between WY 2014 and WY 2019, only one sediment sample had a PEC quotient that exceeded 1.0, for analytes other than chromium and nickel. Chromium and nickel are excluded from this PEC/TEC analysis because they are contributed primarily by serpentine formations present naturally in the watersheds where monitoring occurred. A total mercury PEC quotient of 10 was calculated for the sediment sample collected from Alamitos Creek (site 205R01882) in WY 2015. This sample also had complete mortality to *H. azteca*. This station on Alamitos Creek is within the Guadalupe River watershed downstream of portions of the former New Almaden Mercury Mining District, which is the likely cause of the high concentration. Mercury contamination in the Guadalupe River watershed and throughout the region is being investigated and controlled through implementation of the San Francisco Bay and Guadalupe River Watershed Mercury Total Maximum Daily Load (TMDL) water quality restoration program.

Excluding chromium and nickel, there were 8 samples in the WY 2014 through WY 2019 dataset with TEC quotients ≥ 1.0; the more conservative of the two sediment chemistry evaluation criteria. The constituents and locations with TEC quotients ≥ 1.0 included:

- Total mercury in Alamitos Creek in WY 2015.
- Legacy insecticide DDT compounds were monitored under MRP 1.0 but not under MRP 2.0. Samples with DDT (and daughter product DDE) TEC quotients ≥ 1.0 include: San Tomas Aquino Creek (WY 2014 and WY 2015) and Lower Silver Creek (WY 2014).

- Copper TEC quotients were ≥ 1.0 in sediment samples from Adobe Creek (WY 2014), San Tomas Aquino Creek (WY 2014 and WY 2015), and Stevens Creek (WY 2016 and WY 2018).
- Total PAHs TEC quotients were ≥ 1.0 in samples from Stevens Creek in WY 2017 and WY 2018.

Table 6.7 lists TU equivalents for pesticides with LC50s available in the literature and concentrations for pesticides without LC50s for sediment samples collected in WY 2014 – WY 2019. The sum-of-pyrethroids TU equivalents ranged from 0.11 (Stevens Creek in WY 2017) to 5.36 (Lower Silver Creek in WY 2014). Three samples had sum-of-pyrethroid TU equivalents that exceeded the MRP 1.0 trigger threshold of 1.0: San Tomas Aquino Creek in WY 2014, Lower Silver Creek in WY 2014, and Stevens Creek in WY 2016. Since WY 2016, no samples have had a sum-of-pyrethroids TU equivalent ≥ 1.0 suggesting that pyrethroid concentrations may be decreasing in Santa Clara Basin creek sediments.

Table 6.7. TU equivalent summary for Santa Clara County sediment samples, WY 2014 – WY 2019.

Analyte			Pyrethroids								Other MRP Pesticides of Concern				
			Bifenthrin	Cyfluthrin	Cypermethrin	Deltamethrin	Esfenvalerate	Lambda-cyhalothrin	Permethrin	**Sum Pyrethroids**	Carbaryl	Fipronil	Fipronil desulfinyl	Fipronil sulfide	Fipronil sulfone
LC50 [c]			0.52 µg/g dw	1.08 µg/g dw	0.38 µg/g dw	0.79 µg/g dw	1.54 µg/g dw	0.45 µg/g dw	10.83 µg/g dw	-	NA [d]	306 ng/g dw	NA [d]	435 ng/g dw	158 ng/g dw
Station ID	**Creek**	**Date**													
MRP 1.0															
205R00883	Adobe Creek	6/4/2014	0.33	<MDL	<MDL	<MDL	<MDL	<MDL	0.03 [b]	**0.76** [a]	-	-	-	-	-
205R00938	San Tomas Aquino	6/4/2014	2.88	0.62	<MDL	<MDL	<MDL	<MDL	0.12 [b]	**4.00** [a]	-	-	-	-	-
205R00979	Lower Silver Creek	6/4/2014	3.27	0.44	<MDL	<MDL	<MDL	<MDL	0.16 [b]	**5.36** [a]	-	-	-	-	-
205R01882	Alamitos Creek	7/7/2015	0.26	<MDL	<MDL	<MDL	<MDL	<MDL	0.01 [b]	**0.32** [a]	-	-	-	-	-
205R01411	San Tomas Aquino	7/7/2015	0.54	0.08	0.06 [b]	0.12	<MDL	0.03 [b]	0.01 [b]	**0.85** [a]	-	-	-	-	-
205R01706	Saratoga Creek	7/7/2015	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	**0.16** [a]	-	-	-	-	-
MRP 2.0															
205STQ010	San Tomas Aquino	7/11/2016	0.39	0.15	0.15 [b]	0.11 [b]	<MDL	<MDL	0.03	**0.88** [a]	<MDL	0.01 [b]	-	-	-
205STQ010	San Tomas Aquino	7/13/2017	0.07 [b]	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	**0.22** [a]	<MDL	<MDL	<MDL	<MDL	<MDL
205STQ010	San Tomas Aquino	7/17/2018	0.39	0.15	0.15 [b]	0.11 [b]	<MDL	<MDL	0.03	**0.88** [a]	<MDL	<MDL	<MDL	<MDL	<MDL
205STQ010	San Tomas Aquino	7/23/2019	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	**0.43** [a]	<MDL	<MDL	<MDL	<MDL	<MDL
205STE021	Stevens Creek	7/11/2016	0.78	0.13	0.03 [b]	0.19	0.02 [b]	0.03 [b]	0.03	**1.21** [a]	<MDL	0.01 [b]	-	-	-
205STE021	Stevens Creek	7/13/2017	0.07	<MDL	0.02 [b]	<MDL	<MDL	<MDL	0.002	**0.11** [a]	<MDL	<MDL	<MDL	<MDL	<MDL
205STE021	Stevens Creek	7/17/2018	0.12 [b]	<MDL	0.03 [b]	0.10	<MDL	<MDL	<MDL	**0.29** [a]	<MDL	<MDL	<MDL	<MDL	<MDL
205STE021	Stevens Creek	7/23/2019	0.15 [b]	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	**0.40** [a]	<MDL	<MDL	<MDL	<MDL	<MDL

a. Total calculated using 1/2 MDLs for some individual pyrethroids.
b. TU equivalents calculated from concentration below the reporting limit (J-flagged).
c. Sources: Amweg et al. 2005 and Maund et al. 2002 for pyrethroids; Maul et al. 2008 for fipronil compounds
d. No available LC50 value for Carbaryl or Fipronil Desulfinyl.

6.3.3 Pesticides in Water

During WY 2018, 10 water samples were taken during wet weather events at three sites in Calabasas Creek, San Tomas Aquino Creek, and Stevens Creek to fulfill Provision C.8.g.iii.(3) of MRP 2.0, which requires aquatic toxicity testing and monitoring of water column pesticide concentrations. Results were reported in the WY 2018 UCMR (SCVURPPP 2019). Statistically significant toxicity was observed in the water samples from all three sites (Table 6.2), and the magnitude of toxicity observed at the Calabasas and San Tomas Aquino Creek sites required the collection of follow-up samples. It was not necessary, however, to add any these sites to the list of potential SSID project locations based on the follow-up sample results where toxicity was not observed. The concentrations of most pesticides, with the exception of bifenthrin and fipronil compounds for some samples, were below the MDL, meaning that these analytes were reported as non-detects. There are no water quality objectives specified in the San Francisco Bay Basin Plan for water column pesticide analytes. As a result, no WQO or MRP trigger threshold exceedance analysis was performed on wet weather pesticide data.

6.3.4 Additional Monitoring Efforts

Throughout the monitoring period associated with the results described in this report, several additional programs external to the RMC conducted similar pesticides and toxicity monitoring studies within California. These studies provide valuable data for comparison against RMC findings to view regional water quality in a broader spatial and temporal context, ultimately providing more accurate and complete answers to the management questions set forth by the MRP.

<u>DPR SWPP Monitoring</u>

Mentioned previously in this document, the DPR SWPP is one of the largest pesticide monitoring and management efforts currently being undertaken in California. Pesticide studies conducted by the DPR SWPP evaluate the frequency of pesticide detections at any concentration and make use of USEPA aquatic benchmarks for many pesticide compounds. DPR provides web access to a number of their monitoring reports which contain detailed analyses of USEPA aquatic benchmark exceedance rates. DPR also maintains the Surface Water Database (SURF) to provide public access to quantitative pesticide data from a wide array of surface water monitoring studies. This database could be queried in the future to allow for the leverage of DPR monitoring data in more complex analyses of MRP pesticide data.

In WY 2017, DPR conducted two studies in Northern and Southern California that involved pesticides and toxicity monitoring at urban sites in Alameda, Contra Costa, Placer, Sacramento, Santa Clara (Guadalupe River – see Figure 6.1), Los Angeles, Orange, and San Diego Counties. Both water and sediment samples were collected and analyzed for a wide range of pesticide compounds. In both the Northern and Southern California studies, bifenthrin and fipronil were found to be among the most frequently detected pesticides. Additionally, pyrethroid concentrations were found to be above their USEPA minimum benchmarks for toxicity to aquatic life for the majority of samples with the exception of cyfluthrin. The studies also state that the detection frequencies of most pyrethroids have remained consistent over recent years. (Budd 2018 and Ensminger 2017)

In WY 2018, DPR again conducted two urban monitoring studies in Northern and Southern California that targeted watersheds in the same counties sampled during WY 2017 and involved the collection of water and sediment samples. Similar to WY 2017, bifenthrin was among the most frequently detected insecticides in water samples from both the Northern and Southern

California WY 2018 studies. In the Northern California study, bifenthrin was the most frequently detected insecticide and second most frequently detected compound in water samples with a detection frequency (DF) of 76%. In the Southern California study, bifenthrin was the most frequently detected pyrethroid insecticide and the fifth most frequently detected compound in water samples with a DF of 72%. Fipronil and its degradates were also detected at high rates in water samples from the Northern and Southern California studies. While fipronil itself only had a DF of 48% in the Northern California study, fipronil and its degradates collectively had a DF of 72%. Out of these compounds, fipronil sulfone was found at the highest rate with a DF of 70%. Fipronil was also found at a high rate during the Southern California study with a DF of 76%. Its degradates were also found in a large portion of samples, with fipronil sulfone again being the most found with a DF of 67%. Sediment samples from Northern and Southern California were collected and analyzed for bifenthrin and eight other pyrethroids, but concentrations of fipronil and its degradates were not measured. In both studies, bifenthrin was detected in all samples and was also responsible for the greatest magnitude of TUs. (Budd 2019 and Ensminger 2019)

Findings from the WY 2017 and WY 2018 DPR studies generally corroborate the results garnered from SCVURPPP pesticides monitoring. In particular, bifenthrin has been the most frequently detected pesticide in samples collected by SCVURPPP from WY 2014 through WY 2019 and responsible for the high-magnitude TU equivalents. It is of note, however, that although fipronil and its degradates were frequently detected during the DPR studies, they were seldom found at detectable levels during SCVURPPP monitoring.

<u>SPoT Monitoring Program</u>

The SPoT Monitoring Program conducts annual dry season monitoring (subject to funding constraints) of sediments collected from a statewide network of large rivers. The goal of the SPoT Program is to investigate long-term trends in water quality. Sites are targeted in bottom-of-the-watershed locations with slow water flow and appropriate micromorphology to allow deposition and accumulation of sediments, including stations near the mouth of Coyote Creek and the Guadalupe River (Figure 6.1). In most years, sediments are analyzed for toxicity, pesticides, metals, PCBs, mercury, and organic pollutants (Phillips et al. 2014). The most recent technical report prepared by SPoT program staff was published in 2016 and describes seven-year trends from the initiation of the program in 2008 through 2014 (Phillips et al. 2016). An update to the report is anticipated in the near future.

Toxicity testing was conducted by SPoT in Santa Clara County watersheds using *H. azteca* as the indicator organism and the TST statistical approach, similar to a subset of the toxicity testing completed by SCVURPPP. SPoT samples were characterized as highly toxic if the percent survival was lower than the threshold of 38.6% survival identified as the lower limit survival rate threshold for high toxicity (Anderson et al. 2011). SPoT reported that *H. azteca* toxicity responses have been consistent over the seven-year monitoring period with toxic and highly toxic samples accounting for an average of 18.6% of the samples tested (Phillips et al. 2014). This average aligns relatively closely with the total amount of toxicity exceedances attributed to *H. azteca* survival found during SCVURPPP monitoring from WY 2014 through WY 2019, which was approximately 14%. The SPoT study also calculated five-year rolling averages of toxicity results from 2008 to 2012 and again from 2010 to 2014 to resolve temporal trends in the data. It was found that while the total number of sites exhibiting no toxicity increased from the first averaging period to the second, the number of sites exhibiting moderate to high toxicity also increased during this time (Phillips et al. 2014).

During SPoT sediment chemistry monitoring, the average total pyrethroid concentrations were shown to have doubled from 2010 to 2013. The SPoT analysis identified urban monitoring sites as the exclusive cause of the increase in average pyrethroid concentrations, as pyrethroid concentrations in agricultural and other land use areas remained consistently low throughout the entirety of the monitoring period. The study identified bifenthrin as the primary driver of the increase in average pyrethroid concentrations with a DF of 73% throughout the extent of the monitoring period (Phillips et al. 2014). These findings contrast with the results of the most recent SCVURPPP monitoring period, which have suggested that bifenthrin and other pyrethroid loading within Santa Clara County watersheds may be decreasing. Additionally, results from SPoT testing for fipronil at urban sites in 2013 and 2014 showed that the DF of fipronil and its degradates in addition to their average and maximum concentrations increased between the two years. This trend indicates that, while rarely detected by SCVURPPP at quantifiable levels, monitoring of fipronil and its degradates may be merited in future years.

7.0 CONCLUSIONS AND RECOMMENDATIONS

This section includes conclusions and recommendations from the review of Creek Status and Pesticides & Toxicity Monitoring data collected by SCVURPPP in WYs 2014 through 2019, which were described in the previous sections of this report.

In WY 2019, in compliance with provisions C.8.d and C.8.g of MRP 2.0 and the BASMAA RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012), SCVURPPP continued to implement a two-component monitoring design that was initiated in WY 2012. The strategy includes a regional ambient/"probabilistic" bioassessment monitoring component and a component based on local "targeted" monitoring for general water quality parameters and pesticides/toxicity. The combination of these monitoring designs allows each individual RMC participating program to assess the status of Beneficial Uses in local creeks within its Program (jurisdictional) area, while also contributing data to answering management questions at the regional scale (e.g., differences between aquatic life condition in urban and non-urban creeks).

Conclusions from Creek Status and Pesticides/Toxicity Monitoring conducted during WY 2014 through WY 2019 in the Santa Clara Valley are based on the management questions presented in Section 1.0 of this report:

1) *Are water quality objectives, both numeric and narrative, being met in local receiving waters, including creeks, rivers, and tributaries?*
2) *Are conditions in local receiving water supportive of or likely supportive of Beneficial Uses?*

The first management question is addressed primarily through the evaluation of probabilistic and targeted monitoring data with respect to WQOs and triggers defined in the MRP. A summary of trigger exceedances observed for each site in WY 2019 is presented in Table 7.2. Trigger exceedances from WY 2014 through WY 2018 are listed in prior annual monitoring reports (SCVURPPP 2019, SCVURPPP 2018, SCVURPPP 2017, SCVURPPP 2016, SCVURPPP 2015). In compliance with Provision C.8.e.i of MRP 2.0, SCVURPPP coordinates with the RMC to maintain a comprehensive list of all monitoring results from the region exceeding trigger thresholds. Sites where triggers are exceeded may indicate potential impacts to aquatic life or other Beneficial Uses and are considered for future evaluation of Stressor/Source Identification projects.

The second management question is addressed primarily by assessing indicators of aquatic biological health using benthic macroinvertebrate and algae data. The indices of biological integrity based on BMI and algae data (i.e., CSCI and ASCI) are direct measures of aquatic life Beneficial Uses. Biological condition scores were compared to physical habitat and water quality data collected synoptically with bioassessments to evaluate whether any correlations exist that may explain the variation in biological condition scores. Continuous monitoring data (temperature, dissolved oxygen, pH, and specific conductance) are evaluated with respect to COLD and WARM Beneficial Uses. Pathogen indicator data are used to assess REC-1 (water contact recreation) Beneficial Uses.

All monitoring and data validation was conducted using methods consistent with the BASMAA RMC QAPP (BASMAA 2016a) and SOPs (BASMAA 2016b).

7.1 Conclusions

7.1.1 Biological Condition Assessment

In WYs 2012 through 2019, bioassessment monitoring was conducted in compliance with Provisions C.8.c of MRP 1.0 and C.8.d.i of MRP 2.0. Nearly all bioassessment monitoring (168 of 172 sites) was performed at sites selected randomly using the regional probabilistic monitoring design. The probabilistic monitoring design allows each individual RMC participating program to objectively assess stream ecosystem conditions within its program area (e.g., county boundary) while contributing data to answer regional management questions about water quality and Beneficial Use condition in San Francisco Bay Area creeks. The monitoring design was developed to address the following management questions:

1. *What is the condition of aquatic life in creeks in the RMC area; are water quality objectives met and are Beneficial Uses supported?*
2. *What are major stressors to aquatic life in the RMC area?*
3. *What are the long-term trends in water quality in creeks over time?*

The first question (i.e., *What is the condition of aquatic life in creeks in the RMC area?*) is addressed by assessing indicators of aquatic biological health at probabilistic sampling locations. Over the past eight years (WYs 2012 through 2019), SCVURPPP and the Regional Water Board have sampled 168 probabilistic sites in Santa Clara Valley streams, providing a sufficient sample size to estimate ambient biological condition for urban streams countywide within known estimates of precision. Stream condition was assessed using three different types of indices/tools: 1) the BMI-based CSCI, 2) the draft benthic algae-based ASCI (diatom, soft algae, and hybrid), and 3) the physical habitat-based IPI. Of these three, the CSCI is the only tool with an MRP trigger threshold for follow-up SSID consideration.

The second question (i.e., *What are major stressors to aquatic life in the RMC area?*) is addressed by the evaluation of physical habitat and water chemistry data collected at the probabilistic sites, as potential stressors to biological health. Assessing the extent and relative risk of stressors can help prioritize and inform local management decisions. The stressor levels are compared to biological indicator data (i.e., CSCI and ASCI scores) through correlation and random forest models. The methods were consistent with the approach used in the RMC Five-Year Bioassessment Report (BASMAA 2019) which analyzed the first five years (WY 2012 – WY 2016) of regional bioassessment data. Results from the Program assessment are compared to the regional assessment.

The third question (i.e., *What are the long-term trends in water quality in creeks over time?*) is addressed by assessing the change in biological condition over several years. Changes in biological condition over time can help evaluate the effectiveness of management actions and the effects of changes in factors affecting biological community composition (e.g., climate change).

7.1.1.1 Bioassessment Data (WY 2019)

In WY 2019, 20 sites were sampled for benthic macroinvertebrates, benthic algae, and nutrients. Physical habitat and general water quality parameters were also measured at each site. Sixteen of the twenty sites were randomly selected using the probabilistic monitoring design and four were targeted sites.

CSCI scores and water quality data were compared to applicable WQOs and triggers identified in the MRP. Sites with results that exceed WQOs and triggers are considered as candidates for SSID projects, consistent with Provision C.8.e of MRP 2.0.

- Fourteen of the probabilistic sites and all four targeted sites had CSCI scores below the MRP trigger threshold of 0.795. These seventeen sites were all classified as within urban segments of these streams.
- Four sites had un-unionized ammonia concentrations that exceeded WQOs. No other nutrient or general water quality parameters were measured at concentrations exceeding WQOs or MPR trigger thresholds.

Bioassessment data collected at the four targeted sites during WY 2019 were in creek reaches with planned or recently completed stream restoration work that entailed placement of gravel and wood into the channel for the purpose of increasing the amount of spawning habitat and high flow refugia on the floodplain for salmonid fish populations. Bioassessment data are intended to provide baseline dataset to compare changes in biological conditions at these sites over time.

7.1.1.2 Countywide Bioassessment Data (WY 2012 – WY 2019)

The bioassessment data collected at probabilistic sites (n=168) over the 8-year timeframe were evaluated to assess the current condition of streams in the County and to identify stressors that are likely to pose the greatest risk to stream health. The methods used to evaluate bioassessment data were consistent with the approach used to develop the RMC Five-Year Bioassessment Report (BASMAA 2019).

<u>Biological Condition Assessment</u>

Four biological indicators (CSCI and ASCI-D, ASCI-SB, ASCI-H) were used to assess stream conditions. Results of the analysis indicate that much of the stream length in Santa Clara County is in poor biological condition. Aquatic life uses may not be fully supported at a majority of sites sampled by SCVURPPP. These findings should be interpreted with the understanding that the survey focused on urban segments of streams. Approximately 81% of the assessments (140 of 172) were conducted at urban sites, while only 19% (32 of 172) were conducted at non-urban sites. Although the low number of non-urban sample size precludes making any definitive comparisons, bioassessment scores at non-urban sites were generally higher than scores at urban sites.

- A total of 128 of the 172 (74%) bioassessment sites (including four targeted sites) received CSCI scores that were below the MRP trigger (0.795), corresponding to the two lower condition categories *(likely altered* and *very likely altered)*. Of the 128 low-scoring sites, 113 were classified as urban. The proportion of high-scoring sites varies by watershed. Cumulative distribution frequency functions (CDFs) for CSCI scores indicate there is a 65% probability that a random site in Santa Clara County will have a CSCI score below 0.79 (i.e., *likely altered* or *very likely altered*). There is an 80% probability that a random *urban* site in Santa Clara County will have a CSCI score below 0.79 and there is a 48% probability that a random *non-urban* site will have a CSCI score below 0.79.

- Biological conditions based on algae data (ASCI) differ from those based on BMI data (CSCI). The ASCI-D tool applies diatom data, the ASCI-SB tool applies soft bodied algae data, and the ASCI-H tool applies both. Table 7.1 summarizes the percentages of sites in each condition category for each of the four indices. The percentage of sites in each category based on ASCI-D and ASCI-H was similar to the CSCI results. The ASCI-SB scores do not appear to be associated with urban disturbance gradient. A higher percentage of sites was in the *likely intact* condition category based on ASCI-SB scores and a lower percentage was in the *very likely altered* category, compared to CSCI.

Table 7.1. Percent of stream sites in Santa Clara County within each biological condition category, WY 2012 – WY 2019.

Index [1]	Sites with index score [2]	Likely Intact	Possibly Altered	Likely Altered	Very Likely Altered
Benthic Macroinvertebrates (BMI)					
CSCI	172	19%	7%	23%	52%
Benthic Algae					
ASCI-D	172	20%	18%	30%	32%
ASCI-SB	165	42%	24%	16%	18%
ASCI-H	165	26%	10%	17%	47%

[1] Indices: CSCI = California Stream Condition Index; ASCI-D = Diatom Algae Stream Condition Index; ASCI-SB = Soft Bodied Algae Stream Condition Index; ASCI-H = Hybrid Algae Stream Condition Index.

[2] Index scores for ASCI-SB and ASCI-H were not calculated for 7 bioassessment sites due to insufficient soft algae taxa needed to calculate a score.

<u>Stressor Assessment</u>

Relationships between biological indicators (i.e., CSCI, ASCI-D, ASCI-SB and ASCI-H) and stressor data were evaluated using Spearman's rank correlation, and random forest models utilized only CSCI and ASCI-H indices to evaluate potential relationships. The results indicate that each of the biological indicators respond to different types of stressors.

- The random forest model indicates that watershed, along with physical habitat and several landscape and water-quality stressors, were the best predictors of CSCI scores.

- In the Spearman's rank correlation analysis, nutrients (Total Nitrogen and Total Kjeldahl Nitrogen) correlated more closely with ASCI-H scores than with CSCI scores. Total Nitrogen ranked as an important variable for ASCI-H based on the random forest model results.

- The strength of the correlations between biological indices and stressors was highly variable by watershed. Nutrients did not correlate well with CSCI score for any watershed, however, Stevens Creek exhibited one of the highest correlation coefficients between ASCI score and total nitrogen concentrations.

- The ASCI-D and ASCI-H scores were similarly responsive to environmental-stressor (i.e., urban) gradients, and were particularly aligned with water quality and habitat factors. In contrast, the ASCI-SB index was high scoring at both disturbed and undisturbed sites throughout Santa Clara County, and therefore may not be a good indicator of perturbation.

- Results of the Santa Clara Valley stressor assessment were similar to the RMC regional assessment. Both Santa Clara and regional CSCI scores are strongly influenced by physical habitat variables, such as the level of imperviousness in the contributing watershed area (BASMAA 2019).

It should be acknowledged that despite these apparent relationships to stressors, these analyses do not determine causation, particularly as stressors from habitat/landscape factors are often present at the same sites that exhibit water quality impairment.

7.1.1.3 Trends Assessment

Based on a review of the probabilistic water quality and biological data collected in Santa Clara Valley streams between WYs 2012-2019, it appears that analyses of long-term trends using the probabilistic dataset will require more than eight years of monitoring. The distribution of CSCI scores at urban sites were highly variable across the eight years of monitoring suggesting there are wide range of biological conditions at urban sites, as well as potential variation in conditions due to changes in environmental conditions from year to year (e.g., precipitation, temperature).

A comparison of the probabilistic dataset with targeted data collected prior to MRP adoption (i.e., WYs 2003 -2009) allows for a semi-quantitative trends assessment. SCVURPPP conducted bioassessments in mostSanta Clara Valley watersheds between 2003 and 2009 as part of watershed assessment and monitoring requirements in its municipal stormwater NPDES Permit (Pre-MRP). Biological conditions, based on CSCI scores, during Pre-MRP and MRP time periods were compared for all sites within the six watersheds. For most watersheds, the median CSCI scores were very similar between Pre-MRP and MRP sampling events. Likewise, data collected during Pre-MRP and MRP time periods from nine individual sites in those watersheds were also compared. In general, most sites had similar CSCI scores between the two time periods.

7.1.2 Continuous Monitoring for Temperature and General Water Quality

Continuous water temperature and general water quality monitoring was conducted in WY 2014 through WY 2019 in compliance with Provisions C.8.c of MRP 1.0 and C.8.d.iii – iv of MRP 2.0. Temperature measurements were recorded hourly at a minimum of eight sites each year from April through September. Specific conductance, DO, pH, and temperature were recorded continuously (15 minute interval) at three sites each year during two 2-week periods in spring (Event 1) and summer (Event 2). Monitoring was conducted to address the following management questions:

1. *What is the spatial and temporal variability in water quality conditions during the spring and summer season?*
2. *Do general water quality measurements indicate potential impacts to aquatic life?*

Monitoring sites were selected based on the presence of significant fish and wildlife resources and historical and/or recent indications of water quality concerns. The same sites were often monitored for multiple years to gain a better understanding of the range of water quality conditions that may occur over time. In some years, continuous monitoring data were used to support or follow-up on SSID investigations.

- The Sevens Creek watershed, which supports steelhead rearing and spawning habitat, was targeted for general water quality monitoring in WY 2014 and WY 2015. Monitoring stations were located above and below the reservoir. Overall, water quality conditions were consistent with COLD Beneficial Uses. However, in WY 2014, the number of dissolved oxygen measurements below 7 mg/L in stations below the reservoir exceeded MRP trigger threshold. Furthermore, the MRP maximum weekly average temperature trigger threshold 17°C of was exceeded in both years.

- In WY 2014 and WY 2015, temperature monitoring was conducted at a combined nine stations in the Stevens Creek and Guadalupe Creek watersheds. None of the stations exceeded the maximum instantaneous trigger threshold of 24°C. Seven of the nine stations exceeded the MWAT threshold (17°C). However, it is important to evaluate the temperature data within the context that monitoring was conducted during an extended drought period that resulted in extremely low flow conditions during the dry season.

- The Upper Penitencia Creek watershed was targeted for temperature and general water quality monitoring in WY 2016 to support and SSID study investigating reduced biological condition in a specific stream segment. The MWAT threshold (17°C) was generally not exceeded at the four upper elevation sites that were located in reaches that support juvenile steelhead populations in Alum Rock Park. However, temperatures recorded at the four lower elevation sites did exceed the MWAT threshold and are likely too high to support juvenile steelhead rearing habitat. Triggers for dissolved oxygen and pH were exceeded at the lowest elevations sites; both sites are located downstream of percolation ponds, which may impact water quality conditions in the creek following water releases from the ponds during late spring/summer season.

- The Guadalupe River watershed was targeted for temperature monitoring in WYs 2017 through 2019. Stations were located below Guadalupe Reservoir and Almaden Reservoir. Although the instantaneous maximum temperature trigger threshold was not exceeded, the MWAT trigger was exceeded at every station, each WY. In general, water temperatures were consistent from year to year and increased in the downstream direction.

- The Coyote Creek watershed was targeted for general water quality monitoring in WYs 2017 through 2019. The goal of the monitoring was to follow-up on an SSID study that was completed in 2013 and investigated low dissolved oxygen in a low-gradient reach along the mainstem. Dissolved oxygen concentrations were generally higher in WYs 2017 through 2019, compared to 2013 (but still exceeded the MRP trigger threshold). The improved dissolved oxygen concentraitons were possibly in response to high velocity flows in WY 2017 that flushed out oxygen-demanding bedded sediments that had accumulated in the reach during the WY 2012 through WY 2016 drought.

Overall, continuous monitoring results typically find that temperature and specific conductivity increase in the downstream direction Santa Clara Valley watersheds, which correlates with increased levels of urbanization. In addition, the MRP maximum weekly average temperature (MWAT) trigger threshold of 17°C is often exceeded. These temperature exceedances result in sites being placed on the list of candidate SSID projects, but may not be of concern in Santa Clara County. The MWAT threshold was developed for cooler streams of the Pacific Northwest. Fish in the Santa Clara Basin have likely adapted to warmer conditions. Some locations where the MWAT trigger was exceeded are in reaches through which cold water fish migrate, rather than segments that provide rearing habitat.

7.1.3 Pathogen Indicators

From WY 2014 through WY 2019, in compliance with Provisions C.8.c of MRP 1.0 and C.8.d.v of MRP 2.0, SCVURPPP collected five grab samples per year for pathogen indicator bacteria analyses. Monitoring was conducted at sites that, while generally not considered "bathing beaches," are located within creekside parks or along trails with a potential for public access to water. Some stations were sampled in multiple years. The overall goal of pathogen indicator monitoring is to assess whether WQOs are being met, i.e. supportive of REC-1 Beneficial Uses.

Although WQO exceedances were found in two of the six watersheds targeted, there is no evidence for large-scale spatial patterns of bacteria concentrations. The results suggest that pathogen indicator densities at the monitoring stations are highly variable. It is important to recognize that pathogen indicators do not directly represent actual pathogen concentrations and do not distinguish among sources of bacteria. Sources of pathogen indicator bacteria may include homeless encampments, wildlife, livestock, pets, leaking septic systems/sanitary sewers, and regrowth of bacteria in the environment. It is the human sources of bacteria that are of primary concern for REC-1 health risks. As a result, the comparison of pathogen indicator results to pathogen indicator thresholds may not indicate that a health risk is present, and therefore should be interpreted cautiously.

7.1.4 Chlorine Monitoring

From WY 2012 through WY 2019, in compliance with Provision C.8.c of MRP 1.0 and Provision C.8.d.ii of MRP 2.0, SCVURPPP collected field measurements of total and free chlorine residual in creeks where bioassessments were conducted.

While chlorine residual is generally not a concern in Santa Clara Valley urban creeks, WY 2019 and prior monitoring results suggest there are occasional free chlorine and/or total chlorine residual exceedances in the Santa Clara Basin. Trigger exceedances may be the result of a one-time potable water discharges that are difficult to trace. Furthermore, chlorine in surface waters can dissipate from volatilization and reaction with sediment and organic matter. Over the past eight years of monitoring (WY 2012 – WY 2019), there have been a total of 17 sites with chlorine trigger exceedances (none in WY 2019 after immediate re-sampling).

7.1.5 Pesticides and Toxicity Monitoring

Toxicity testing, sediment chemistry monitoring, and water column pesticides monitoring, collectively referred to as pesticides and toxicity monitoring, was conducted during WY 2014 through WY 2019 in compliance with Provisions C.8.c of MRP 1.0 and C.8.g of MRP 2.0. There were slight differences between the two permit terms with regard to the required number of samples, toxicity test organisms, chemical constituents, and MRP triggers.

<u>Data Evaluation Summary</u>

There are five toxicity test species for water samples and two test species for sediment samples. The test organism *H. azteca*, required for water and sediment is known to be sensitive to pyrethroid pesticides. The test organism *C. dilutus*, added in MRP 2.0, is known to be sensitive to neonicotinoids. A two-tiered approach is applied to assess toxicity. First, organism responses from ambient samples are compared to responses from appropriate laboratory control samples using a statistical comparison. This is followed by a comparison to a "threshold value" or "Percent Effect" that indicates the magnitude of the difference in response. The MRP 2.0 trigger threshold is 50 Percent Effect in the initial sample and a second, follow-up sample for both water and sediment toxicity tests. The MRP 1.0 trigger threshold was 20 Percent Effect in sediment samples with no follow-up required and 50 Percent Effect in the initial and follow-up water samples.

Sediment chemistry data for metals, PAHs, and legacy pesticides (MRP 1.0 only) are compared to Threshold Effect Concentrations (TECs) and Probably Effect Concentrations (PECs) published by MacDonald et al. (2000). Most samples in Santa Clara County have chromium and nickel concentrations that exceed the TEC and PEC. These metals are naturally occurring in the serpentine formations that underly mountains and hills in the region. Sediment chemistry data for pyrethroid and fipronil (MRP 2.0 only) pesticides are compared to TOC-normalized LC50s, calculated at Toxicity Unit equivalents. Water chemistry data would be compared to WQOs, if any existed for the suite of monitored constituents.

Under MRP 1.0 (WY 2014 and WY 2015), pesticides and toxicity monitoring stations were selected from the list of bioassessment stations surveyed those years. Under MRP 2.0 (WY 2016 – WY 2019), bottom-of-the-watershed stations in different creeks were monitored each year with the goal of eventually developing geographically diverse dataset.

<u>WY 2019 Results</u>

In WY 2019, SCVURPPP conducted dry weather pesticides and toxicity monitoring at two stations (Stevens Creek and San Tomas Aquino Creek). Statistically significant toxicity to *C. dubia* (reproduction) and *C. dilutus* (survival) was observed in the water sample collected from Stevens Creek . The magnitude of the toxic effects in this sample did not exceed the MRP trigger criterion of 50 Percent Effect for *C. dilutus*, but this threshold was exceeded for *C. dubia*. Therefore, a follow-up sample was warranted for the latter species. The follow-up sample was found to be significantly toxic, but the follow-up threshold was not exceeded in this case. Due to the toxicity to *C. dubia* observed in the original and follow-up water samples, the Stevens Creek site will be added to a list of potential SSID project locations. The sediment sample taken at the Stevens Creek site was not toxic to either of the test organisms.

Statistically significant toxicity to *C. dubia* (reproduction) was also observed in the water sample collected from San Tomas Aquino during dry season sampling in July 2019. However, the Percent effect did not exceed the 50% threshold for follow-up. The cause of the water toxicity is unknown. The sediment sample from San Tomas Aquino was significantly toxic to one of the test organisms (*C. dilutus*), and the Percent Effect exceeded the 50% threshold for follow-up. The follow-up sediment sample was not found to be toxic to *C. dilutus.* The cause of this sediment toxicity is unknown.

Sediment chemistry results are evaluated as potential stressors based on TEC quotients and PEC quotients according to criteria in provision C.8.g.iv of the MRP. SCVURPPP also evaluated TU equivalents of pyrethroids and fipronil. TEC and PEC quotients were calculated for all metals and total PAHs measured in sediment samples from July 2019. Both sites had at least one TEC or PEC quotient exceeding 1.0. In compliance with the MRP, both stations will therefore be placed on the list of candidate SSID projects. Decisions about which SSID projects to pursue should be informed by the fact that the TEC and PEC quotient exceedances are related to naturally occurring chromium and nickel due to serpentine soils in the watersheds. No TU equivalents exceeded 1.0. The highest TU equivalent for both the Stevens Creek and San Tomas Aquino Creek samples was for fipronil sulfone.

<u>WY 2018 Wet Weather Monitoring</u>

During WY 2018, wet weather samples were taken at three sites in Santa Clara County (Calabasas Creek, San Tomas Aquino Creek, and Stevens Creek) to fulfill Provision C.8.g.iii.(3) of MRP 2.0, in coordination with the RMC partners. Results were reported in the WY 2018 UCMR (SCVURPPP 2019). Statistically significant toxicity was observed in the toxicity samples for all three sites, and the magnitude of toxicity observed at the Calabasas and San Tomas Aquino Creek sites required the collection of follow-up samples. However, it was not necessary to add any sites to the list of potential SSID project locations based on the follow-up sample results. The concentrations of most pesticides analyzed were below the MDL, except for bifenthrin and fipronil compounds.

<u>WY 2014 – WY 2019 Data Summary</u>

The results of pesticides and toxicity monitoring conducted from WYs 2014 through 2019 were analyzed to identify trends at sampling locations in Santa Clara County watersheds. During this period, there were two sediment samples and four water samples with toxicity relative to the laboratory control *and* a Percent Effect exceeding the MRP evaluation criteria. There were an additional 20 test results that had significant toxicity, but with a Percent Effect that did not exceed the MRP trigger thresholds. A majority of these toxicity results were found in water samples and were associated with either *C. dubia* reproduction (ten samples), a chronic toxicity endpoint, or *H. azteca* survival (seven samples), an acute toxicity endpoint. Six of the seven water samples with toxicity to *H. azteca* were collected during wet season sampling events suggesting that stormwater runoff is affecting *H. azteca*. The water samples with toxicity to *C.* dubia were more evenly divided between wet and dry season sampling events.

Between WY 2014 and WY 2019, only one sediment sample that had a PEC quotient ≥ 1.0 for an analyte other than chromium and nickel (mercury in Alamitos Creek downstream of the former New Almaden Mercury Mining District). Excluding the naturally-occurring chromium and nickel, there were eight samples with TEC quotients ≥ 1.0; the more conservative of the two evaluation criteria. These included legacy insecticide DDT compounds in San Tomas Aquino Creek and Lower Silver Creek; copper in Adobe Creek, San Tomas Aquino Creek, and Stevens Creek, and total PAHs in Stevens Creek. Overall, detection frequencies for bifenthrin and fipronil were on par with results from the DPR Northern California study (Ensminger 2019) and *H. azteca* toxicity responses were similar to SPoT monitoring in Coyote Creek and Guadalupe River (Phillips et al. 2014).

The pesticides and toxicity data collected from WYs 2014 through 2019 provide a reference to inform management decisions regarding water quality improvement in Santa Clara County watersheds and guide the planning of future monitoring in the area.

7.2 Trigger Assessment

The MRP requires analysis of the monitoring data to identify candidate sites for SSID projects. Trigger thresholds against which to compare the data are provided for most monitoring parameters in the MRP and are described in the foregoing sections of this report. Stream condition was assessed based on CSCI scores that were calculated using BMI data. Nutrient data were evaluated using applicable water quality standards from the Basin Plan. Water and sediment chemistry and toxicity data were evaluated using numeric trigger thresholds specified in the MRP. In compliance with provision C.8.e.i of the MRP, all monitoring results exceeding trigger thresholds are added to a list of candidate SSID projects that will be maintained throughout the permit term. Follow up SSID projects will be selected from this list. Table 7.2 lists candidate SSID projects based on WY 2019 Creek Status and Pesticides/Toxicity monitoring data. Trigger and WQO exceedances from WY 2014 through WY 2018 were reported in the respective UCMRs (SCVURPPP 2015, 2016, 2017, 2018, and 2019).

Additional data analysis is provided in the previous sections of this report and should be considered prior to selecting and defining SSID projects. The analyses include review of physical habitat and water chemistry data to identify potential stressors that may be contributing to degraded or diminished biological conditions. Analyses in this report also include historical and spatial perspectives that help provide context and deeper understanding of the trigger exceedances.

Table 7.2. Summary of SCVURPPP Trigger Threshold Exceedance Analysis, WY 2019. "No" indicates samples were collected but did not exceed the MRP trigger; "Yes" indicates an exceedance of the MRP trigger.

Station ID	Creek	Bioassessment [1]	Nutrients [2]	Chlorine [3]	Water Toxicity [4]	Sediment Toxicity [4]	Sediment Chemistry [5]	Continuous Temperature [6]	Dissolved Oxygen [7]	pH [8]	Specific Conductance [9]	Pathogen Indicators [10]
205R04247	Stevens Creek	Yes	Yes	No	--	--	--	--	--	--	--	--
205R04271	Stevens Creek	No	Yes	No	--	--	--	--	--	--	--	--
205R04317	Coyote Creek	Yes	No	No	--	--	--	--	--	--	--	--
205R04359	Adobe Creek	Yes	No	No	--	--	--	--	--	--	--	--
205R04378	Los Gatos Creek	Yes	No	No	--	--	--	--	--	--	--	--
205R04383	San Francisquito Cr	Yes	No	No	--	--	--	--	--	--	--	--
205R04395	Arroyo De Los Coches	Yes	Yes	No	--	--	--	--	--	--	--	--
205R04418	Thompson Creek	Yes	No	No	--	--	--	--	--	--	--	--
205R04479	Saratoga Creek	Yes	No	No	--	--	--	--	--	--	--	--
205R04530	Upper Silver Creek	Yes	No	No	--	--	--	--	--	--	--	--
205R04537	Thompson Creek	Yes	No	No	--	--	--	--	--	--	--	--
205R04591	San Tomas Aquino Cr	Yes	Yes	No	--	--	--	--	--	--	--	--
205R04602	Wildcat Creek	Yes	No	No	--	--	--	--	--	--	--	--
205R04614	San Tomas Aquino Cr	Yes	No	No	--	--	--	--	--	--	--	--
205R04638	Guadalupe Creek	No	No	No	--	--	--	--	--	--	--	--
205R04670	Saratoga Creek	No	No	No	--	--	--	--	--	--	--	--
205COY455	Coyote Creek	Yes	No	No	--	--	--	--	--	--	--	--
205GUA060	Los Gatos Creek	Yes	No	No	--	--	--	--	--	--	--	--
205GUA251	Alamitos Creek	Yes	No	No	--	--	--	--	--	--	--	--
205STE070	Stevens Creek	Yes	No	No	--	--	--	--	--	--	--	--
205LGA033	Los Gatos Creek	--	--	--	--	--	--	--	--	--	--	No
205LGA400	Los Gatos Creek	--	--	--	--	--	--	--	--	--	--	Yes
205LGA420	Los Gatos Creek	--	--	--	--	--	--	--	--	--	--	No
205COY330	Coyote Creek	--	--	--	--	--	--	--	--	--	--	Yes
205COY392	Coyote Creek	--	--	--	--	--	--	--	--	--	--	No
205GUA190	Guadalupe Creek	--	--	--	--	--	--	Yes	--	--	--	--
205GUA202	Guadalupe Creek	--	--	--	--	--	--	Yes	--	--	--	--
205GUA210	Guadalupe Creek	--	--	--	--	--	--	Yes	--	--	--	--
205GUA218	Guadalupe Creek	--	--	--	--	--	--	Yes	--	--	--	--
205GUA250	Alamitos Creek	--	--	--	--	--	--	Yes	--	--	--	--
205GUA255	Alamitos Creek	--	--	--	--	--	--	Yes	--	--	--	--
205GUA262	Alamitos Creek	--	--	--	--	--	--	Yes	--	--	--	--
205GUA270	Alamitos Creek	--	--	--	--	--	--	Yes	--	--	--	--
205GUA279	Alamitos Creek	--	--	--	--	--	--	Yes	--	--	--	--
205COY235	Coyote Creek	--	--	--	--	--	--	Yes	Yes	No	No	--
205COY236	Coyote Creek	--	--	--	--	--	--	Yes	Yes	No	No	--
205COY239	Coyote Creek	--	--	--	--	--	--	Yes	Yes	No	No	--
205STE021	Stevens Creek	--	--	--	No	No	Yes	--	--	--	--	--
205STQ010	San Tomas Aquino Cr	--	--	--	No	No	Yes	--	--	--	--	--

Notes:

1. CSCI score ≤ 0.795.
2. Unionized ammonia (as N) ≥ 0.025 mg/L, nitrate (as N) ≥ 10 mg/L, chloride > 250 mg/L.
3. Free chlorine or total chlorine residual ≥ 0.1 mg/L.
4. Test of Significant Toxicity = Fail and Percent Effect ≥ 50 %.
5. TEC or PEC quotient ≥ 1.0 for any constituent.
6. Two or more weekly average temperature values exceed MWAT of 17.0°C or 20% of results ≥ 24°C.
7. Twenty percent of results = DO < 7.0 mg/L in COLD streams or DO < 5.0 mg/L in WARM streams.
8. Twenty percent of results = pH < 6.5 or pH > 8.5.
9. Twenty percent of results = specific conductance > 2000 uS.
10. Enterococcus ≥ 130 cfu/100ml or *E. coli* ≥ 410 cfu/100ml.

7.3 Recommendations

The recommendations presented in this section are directed towards the next iteration of the MRP (MRP 3.0) that is currently under development and will likely become effective in WY 2022. In WY 2020 and WY 2021 the Program will continue to coordinate with RMC partners on implementation of monitoring requirements in Provisions C.8.d and C.8.g of MRP 2.0.

The following recommendations are based on findings from six years (WY 2014 through WY 2019) of Creek Status and Pesticides/Toxicity monitoring conducted by SCVURPPP, as well as reflections on other monitoring, data analysis, and policy development projects being conducted in the region and statewide.

7.3.1 Biological Condition Assessment

The Program is currently working with RMC partners and Regional Water Board staff to evaluate options for revising the monitoring design for Biological Condition Assessments to address Creek Status Monitoring requirements anticipated under MRP 3.0. One of the options under consideration is a targeted monitoring design that would focus on specific watersheds or reaches of interest. A targeted watershed approach would provide stormwater programs more flexibility to evaluate priority areas that stakeholders want to improve, protect, or study. This approach was developed in response to the following findings of the SCVURPPP data analysis:

- Baseline ambient conditions in Santa Clara County urban creeks are described within known estimates of precision using probabilistic data generated through MRP 1.0 and MRP 2.0 monitoring and assessment tools such as the CSCI and ASCI. Continuing to build upon the probabilistic dataset at a countywide scale at this time is unlikely to provide additional benefits to local stormwater management programs.

- The probabilistic sample draw is only likely to provide sufficient new sites through WY 2020. A re-design of the sample draw could provide more sites and address some of the lessons learned about the current sample draw. However, this effort would only be warranted if ambient probabilistic monitoring is desired by SCVURPPP and/or its RMC partners.

- Probablisitc monitoring may inherently exclude stakeholders, such as municipal stormwater programs, land managers, creek groups, and other interested individuals and organizations, from being fully engaged in the SCVURPPP Watershed Monitoring and Assessment Program. Stakeholders may have a preference for the Program to conduct monitoring activities in targeted watersheds or creeks of high interest.

The following objectives could be used to guide future monitoring design:

- Conduct monitoring within a watershed or subwatershed of interest. The watershed could be selected based on known water quality concerns, existing aquatic and riparian resources, planned management activities, or stakeholder interest. Monitoring could be used to develop a high-resolution longitudinal profile of CSCI scores and potential stressors with the goal of identifying sources of stressors and implementing control actions. In addition to bioassessment surveys, monitoring could include creek walks using established protocols and desktop watershed mapping.

- Re-assess sites that have lower or higher biological condition than expected. Use the SCAPE model (discussed in Section 2.2.4.7) to prioritize sites for follow-up assessment. The SCAPE model that provides a context for evaluating stream health by estimating an expectation of biological condition along a given stream reach relative to landscape constraints. Biological condition, based on CSCI scores, can be compared to the reach expectation.

- Evaluate the effectiveness of BMPs or restoration projects. Conduct annual or biannual monitoring in creek reaches where biological condition and/or water quality are likely to improve due to planned management actions such as the implementation of Green Stormwater Infrastrcuture (GSI), flood control, and creek restoration projects. Baseline data generated through Pre-MRP, MRP 1.0, and MRP 2.0 monitoring can be used as baselines for comparison to future (post-implemention) conditions.

- Actively monitor and manage stream segments where monitoring data have indicated that water quality and/or biology is in good condition.

7.3.2 Continuous Monitoring for Temperature and General Water Quality

Continuous monitoring for temperature and general water quality has been an effective tool in supporting SSID studies and evaluating the condition of cold water habitat (COLD) Beneficial Uses. The Program recommends continued implementation of targeted continuous temperature and general water quality monitoring in MRP 3.0.

7.3.3 Pathogen Indicator Monitoring

Pathogen indicator monitoring is a relatively small part of the overall Creek Status and Pesticides & Toxicity monitoring program. Nonetheless, the Program recommends discontinuing this monitoring in MRP 3.0. This recommendation is based on several factors:

- Wildlife, a likely source of pathogen indicator bacteria in creeks, tend to congregate in urban creek corridors. It would be difficult and undesirable to restrict their use of creeks due to exceedances of pathogen indicator WQOs. Furthermore, bacteria from wildlife sources do not generally pose a health risk to REC-1 Beneficial Uses, compared to human sources of fecal pollution.

- Homeless encampments are another common source of bacteria in receiving waters. Although this human source of bacteria likely poses a risk to REC-1 Beneficial Uses, control options are challenging and generally not within the scope of stormwater management programs. The issue of homelessness is being addressed through a patchwork of public and private programs aimed at long-term housing, prevention, law enforcement, and other measures.[32]

- Bacteria densities in freshwater creeks are highly variable and single grab samples are not very useful in identifying problems or making decisions about stormwater management.

Monitoring efforts for pathogen indicators should instead be used to support bacteria Total Maximum Daily Load (TMDL) action plans or site-specific special studies, as applicable.

[32] https://calmatters.org/explainers/californias-homelessness-crisis-explained/

7.3.4 Chlorine Monitoring

Although chlorine monitoring can be an important tool in investigating fish kills, continued chlorine monitoring is not recommended in the next MRP. Based on the chlorine data from WY 2012 – WY 2019, little value is added to the Creek Status Monitoring program by this monitoring.

- The sources of chlorine detected through Creek Status Monitoring are generally transient, episodic, and challenging to trace.

- Discharges of drinking water are the most likely source of free chlorine and total chlorine residual. These discharges are already addressed by MRP Provisions C.5 (IDDE) and C.15 (Exempted and Conditionally Exempted Discharges) and the NPDES General Permit for Drinking Water Systems (Order WQ 2014-0194-DWQ).

- Available field equipment does not provide reliable results below 0.13 mg/L, a concentration higher than the MRP trigger resulting in uncertainty of exceedances. False positives can result in wasted efforts trying to track down non-existent sources.

7.3.5 Pesticides and Toxicity Monitoring

The Strategy to Optimize Resource Management of Storm Water (STORMS), adopted by the State Water Board in January 2016, is developing a statewide framework for urban pesticides reduction (Urban Pesticides Amendments). The primary goal of the statewide Urban Pesticides Amendments is to improve collaboration among regulators, leading to better management of pesticides in urban runoff. The Amendments will also organize coordinated pesticides and toxicity monitoring and data sharing. The Urban Pesticides Amendments team is proposing a statewide monitoring program that will substitute for pesticides and toxicity monitoring requirements in MS4 permits, such as the MRP. The goal is to generate useful data at minimal cost and standardize information at the statewide level. The Draft Amendments will likely be released for public review in early 2021 with adoption anticipated in mid-2021. At this time, the mechanism for implementing the statewide monitoring program is uncertain.

The Program recommends no changes to the current Provision C.8.g Pesticides and Toxicity monitoring requirements until the statewide monitoring program is in place.

7.4 Management Implications

The Program's Creek Status and Pesticides and Toxicity Monitoring programs (consistent with Provisions C.8.d and C.8.g of MRP 2.0, respectively) focus on assessing the water quality condition of urban creeks in the Santa Clara Valley and identifying stressors and sources of impacts observed.

This Integrated Creek Status Monitoring Report presents a comprehensive review of bioassessment and stressor data collected in WY 2012 through WY 2019. Data suggest that most urban streams have *likely altered* or *very likely altered* populations of aquatic life indicators (e.g., benthic macroinvertebrates). These poor stream conditions are likely the result of long-term changes in stream hydrology, channel geomorphology, in-stream habitat complexity, and other modifications to the watershed and riparian areas associated with the urban development that has occurred over the past 60-plus years. Additionally, episodic or site-specific increases in temperature (particularly in lower creek reaches or reaches directly below reservoirs) may not be optimal for aquatic life in some local creeks.

The Program and its Co-permittees are actively implementing many stormwater management programs to address these and other stressors and associated sources of water quality conditions observed in local creeks, with the goal of protecting these natural resources. For example:

- In compliance with provision C.3 of MRP 2.0, new and redevelopment projects in the Bay Area are now designed to more effectively reduce water quality and hydromodification impacts associated with urban development. Low impact development (LID) methods, such as rainwater harvesting and use, infiltration, and biotreatment are required as part of development and redevelopment projects. In addition, Green Infrastructure planning is now part of all municipal projects. These LID measures are expected to reduce the impacts of urban runoff and associated impervious surfaces on stream health.
- In compliance with provision C.7 of MRP 2.0, the Program and its Co-permittees are implementing stormwater outreach activities through the Watershed Watch Campaign (Campaign) that encourage citizens and youth to make watershed-friendly choices. Pollution prevention messages are delivered at eight to ten community events per year, communicating the value and protection of creeks' natural resources to citizens both in plain non-scientific wording and multiple native languages (e.g., Spanish, Vietnamese, Chinese). Media advertising, such as the Earthquakes' and Sharks' collaborations, teach citizens how to dispose properly of litter, hazardous wastes, and car wash water. The Campaign also conducts numerous activities and sessions to educate children about watersheds and urban runoff pollution prevention through the Don Edwards San Francisco Bay National Wildlife Refuge, including watershed-focused field trips, marsh walks, gardening events, bird watching, and wildlife observation. Additionally, the Campaign supports the musical assembly program, ZunZun that engages students through music and theatre while teaching them about stormwater, watersheds, and pollution prevention topics. These efforts are expected to encourage watershed-positive behavior change in Santa Clara Valley residents.
- In compliance with provision C.9 of MRP 2.0, the Program and Co-permittees are implementing pesticide toxicity control programs that focus on source control and pollution prevention measures. The control measures include the implementation of integrated pest management (IPM) policies/ordinances, public education and outreach programs, pesticide disposal programs, and sustainable landscaping requirements for new and redevelopment projects. These efforts will eventually be supplemented by the statewide Urban Pesticides Amendments which will seek to manage pesticide usage via state and federal pesticide regulatory authorities such as DPR and USEPA. The anticipated result is a reduction in pyrethroids and other pesticides in urban stormwater runoff and a reduction in the magnitude and extent of toxicity in local creeks.
- Trash loadings to local creeks have been reduced through implementation of new control measures in compliance with provision C.10 of MRP 2.0 and other efforts by Co-permittees to reduce the impacts of illegal dumping directly into waterways. These actions include the installation and maintenance of trash capture systems, the adoption of ordinances to reduce the impacts of litter prone items, enhanced institutional controls such as street sweeping, and the on-going removal and control of direct dumping. MRP 2.0 establishes a mandatory trash load reduction schedule, minimum areas to be treated

by trash full capture systems, and requires development and implementation of receiving water monitoring programs for trash.

- In compliance with provisions C.2 (Municipal Operations), C.4 (Industrial and Commercial Site Controls), C.5 (Illicit Discharge Detection and Elimination), and C.6 (Construction Site Controls) of MRP 2.0, Co-permittees continue to implement programs that are designed to prevent non-stormwater discharges during dry weather and reduce the exposure of contaminants to stormwater and sediment in runoff during rainfall events.
- In compliance with provision C.13 of MRP 2.0, copper in stormwater runoff is reduced through implementation of controls such as architectural and site design requirements, prohibition of discharges from water features treated with copper, and industrial facility inspections.
- Mercury and polychlorinated biphenyls (PCBs) in stormwater runoff are being reduced through implementation of the respective TMDL water quality restoration plans. In compliance with provisions C.11 (mercury) and C.12 (PCBs) of MRP 2.0, the Program will continue to identify sources of these pollutants and will implement control actions designed to achieve new minimum load reduction goals. Monitoring activities conducted in WY 2014 through WY 2019 that specifically target mercury and PCBs are described in the Integrated Pollutants of Concern Monitoring Data Report that is included as Part D of this IMR.

In addition to the Program and Co-permittee controls implemented in compliance with the MRP, numerous other efforts and programs designed to improve the biological, physical and chemical condition of local creeks are underway. For example, the Valley Water's Integrated Water Resources Master Plan (IWRMP) or "One Water Plan" is an ongoing, multi-year process to develop a framework for long-term management of Santa Clara County water resources. The One Water Plan identifies, prioritizes and implements activities at a watershed scale to meet flood protection, water supply, water quality and environmental stewardship goals and objectives. Additionally, in 2019, SCVURPPP, via a Proposition 1 grant awarded to Valley Water, completed the Santa Clara Basin Stormwater Resource Plan.[33] This Plan supports the development and implementation of MRP-required Green Stormwater Infrastructure Plans and includes a prioritized list of of multi-benefit GSI project opportunities that may be eligible for future State implementation grant funds.

Through the continued implementation of MRP-associated and other watershed stewardship programs, SCVURPPP anticipates that stream conditions and water quality in local creeks will continue to improve over time. In the near term, toxicity observed in creeks should decrease as pesticide regulations better incorporate water quality concerns during the pesticide registration process. In the longer term, control measures implemented to "green" the "gray" infrastructure and disconnect impervious areas constructed over the course of the past 60-plus years will take longer to implement. Consequently, it may take several decades to observe the benefits of these important, large-scale watershed improvements in our local creeks. Long-term creek status monitoring programs designed to detect these changes over time are therefore necessary for our collective understanding of the condition, trends, and health of our local waterways.

[33] https://scvurppp.org/swrp/docs-maps/

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ATTACHMENTS

Attachment 1

QA/QC Report

Integrated Monitoring Report

Creek Status and Pesticides & Toxicity Monitoring

Quality Assurance/Quality Control Report

Water Year 2019

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Prepared for:

Santa Clara Valley
Urban Runoff
Pollution Prevention Program

March 31, 2020

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LIST OF ACRONYMS

BASMAA	Bay Area Stormwater Management Agencies Association
BMI	Benthic Macroinvertebrates
CDFW	California Department of Fish and Wildlife
DPD	Diethyl-p-phenylene Diamine
DQO	Data Quality Objective
EDDs	Electronic data deliverables
EV	Expected Value
KLI	Kinnetic Laboratories, Inc.
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MPN	Most Probably Number
MQO	Measurement Quality Objective
MRP	Municipal Regional Permit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MV	Measured Value
ND	Non-detect
NIST	National Institute of Standards and Technology
NPDES	National Pollution Discharge Elimination System
NV	Native Value
PAH	Polycyclic Aromatic Hydrocarbon
PR	Percent Recovery
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RL	Reporting Limit
RMC	Regional Monitoring Coalition
RPD	Relative Percent Difference
SAFIT	Southwest Association of Freshwater Invertebrate Taxonomists
SCCWRP	Southern California Coastal Water Research Project
SFRWQCB	San Francisco Regional Water Quality Control Board
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SOP	Standard Operating Procedures
STE	Standard Taxonomic Effort
SV	Spike Value
SWAMP	Surface Water Ambient Monitoring Program
TKN	Total Kjeldahl Nitrogen
WY	Water Year

1. INTRODUCTION

In Water Year 2019 (WY 2019; October 1, 2018 through September 30, 2019), the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) conducted Creek Status Monitoring in compliance with provision C.8.d and Pesticide & Toxicity Monitoring in compliance with provision C.8.g of the National Pollutant Discharge Elimination System (NPDES) stormwater permit for Bay Area municipalities, referred to as the Municipal Regional Permit (MRP). The monitoring strategy includes regional ambient/probabilistic monitoring and local "targeted" monitoring as described in the Bay Area Stormwater Management Agencies Association (BASMAA) Regional Monitoring Coalition (RMC) Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012). SCVURPPP implemented a comprehensive data quality assurance and quality control (QA/QC) program, covering all aspects of the probabilistic and targeted monitoring. QA/QC for data collected was performed according to procedures detailed in the BASMAA RMC Quality Assurance Project Plan (QAPP) (BASMAA 2016a) and the BASMAA RMC Standard Operating Procedures (SOP; BASMAA 2016b), SOP FS-13 (Standard Operating Procedures for QA/QC Data Review). The BASMAA RMC QAPP and SOPs are based on the QA program developed by the California Surface Water Ambient Monitoring Program (SWAMP 2017).

Based on the QA/QC review, no WY 2019 data were rejected except for some of the continuous pH data collected in June. These data were rejected due to sensor failure. Additionally, some WY 2019 data were flagged due to issues identified in the QA/QC review. Overall, WY 2019 data met QA/QC objectives. Details are provided in the sections below.

1.1. Data Types Evaluated

During creek status monitoring (MRP Provision C.8.d), several data types were collected and evaluated for quality assurance and quality control. These data types include the following:

1. Bioassessment data
    a. Benthic Macroinvertebrates (BMI)
    b. Algae
2. Physical Habitat Assessment
3. Field Measurements
4. Water Chemistry
5. Pathogen Indicators
6. Continuous Water Quality (2-week deployment; 15-minute interval)
    a. Temperature
    b. Dissolved Oxygen
    c. Conductivity
    d. pH
7. Continuous Temperature Measurements (5-month deployment; 1-hour interval)

During pesticide & toxicity monitoring the following data types were collected and evaluated for quality assurance and quality control:

1. Water Toxicity (dry weather; MRP Provision C.8.g.i)
2. Sediment Toxicity (dry weather; MRP Provision C.8.g.ii)
3. Sediment Chemistry (dry weather; MRP Provision C.8.g.ii)

1.2. Laboratories

Laboratories that provided analytical and taxonomic identification support to SCVURPPP and the RMC were selected based on demonstrated capability to adhere to specified protocols. Laboratories are certified and are as follows:

- Caltest Analytical Laboratory (nutrients, chlorophyll a, ash free dry mass, sediment chemistry)
- Pacific EcoRisk, Inc. (water and sediment toxicity)

- Alpha Analytical Laboratories, Inc. (pathogen indicators)
- BioAsessment Services (benthic macroinvertebrate (BMI) identification)
- Jon Lee Consulting (BMI identification Quality Control)
- EcoAnalysts, Inc. (algae identification)

1.3. QA/QC ATTRIBUTES

The RMC SOP and QAPP identify seven data quality attributes that are used to assess data QA/QC. They include (1) Representativeness, (2) Comparability, (3) Completeness, (4) Sensitivity, (5) Precision, (6) Accuracy, and (7) Contamination. These seven attributes are compared to Data Quality Objectives (DQOs), which were established to ensure that data collected are of adequate quality and sufficient for the intended uses. DQOs address both quantitative and qualitative assessment of the acceptability of data – representativeness and comparability are qualitative while completeness, sensitivity, precision, accuracy, and contamination are quantitative assessments.

Specific DQOs are based on Measurement Quality Objectives (MQOs) for each analyte. Chemical analysis relies on repeatable physical and chemical properties of target constituents to assess accuracy and precision. Biological data are quantified by experienced taxonomists relying on organism morphological features.

1.3.1. Representativeness

Data representativeness assesses whether the data were collected so as to represent actual conditions at each monitoring location. For this project, <u>all samples and field measurements are assumed to be representative</u> if they are performed according to protocols specified in the RMC QAPP and SOPs.

1.3.2. Comparability

The QA/QC officer ensures that the data may be reasonably compared to data from other programs producing similar types of data. For RMC Creek Status monitoring, individual stormwater programs try to maintain comparability within the RMC. The key measure of comparability for all RMC data is the California Surface Water Ambient Monitoring Program.

1.3.3. Completeness

Completeness is the degree to which all data were produced as planned; this covers both sample collection and analysis. For chemical data and field measurements an overall completeness of greater than <u>90%</u> is considered acceptable for RMC chemical data and field measurements. For bioassessment-related parameters – including BMI and algae taxonomy samples/analysis and associated field measurement – a completeness of <u>95%</u> is considered acceptable.

1.3.4. Sensitivity

Sensitivity analysis determines whether the methods can identify and/or quantify results at low enough levels. For the chemical analyses in this project, sensitivity is considered to be adequate if the reporting limits (RLs) comply with the specifications in RMC QAPP Appendix E: RMC Target Method Reporting Limits. For benthic macroinvertebrate data, taxonomic identification sensitivity is acceptable provided taxonomists use standard taxonomic effort (STE) Level I as established by the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT). There is no established level of sensitivity for algae taxonomic identification.

1.3.5. Accuracy

Accuracy is assessed as the percent recovery of samples spiked with a known amount of a specific chemical constituent. Chemistry laboratories routinely analyze a series of spiked samples; the results of these analyses are reported by the laboratories and evaluated using the RMC Database QA/QC Testing Tool. Acceptable levels of accuracy are specified for chemical analytes and toxicity test parameters in

RMC QAPP Appendix A: Measurement Quality Objectives for RMC Analytes, and for biological measurements in Appendix B: Benthic Macroinvertebrate MQOs and Data Production Process.

1.3.6. Precision

Precision is nominally assessed as the degree to which replicate measurements agree, nominally determined by calculation of the relative percent difference (RPD) between duplicate measurements. Chemistry laboratories routinely analyze a series of duplicate samples that are generated internally. The RMC QAPP also requires collection and analysis of field duplicate samples at a rate of 5% of all samples for all parameters[1]. The results of the duplicate analyses are reported by the laboratories and evaluated using RMC Database QA/QC Testing Tool. Results of the Tool are confirmed manually. Acceptable levels of precision are specified for chemical analytes and toxicity test parameters in RMC QAPP Appendix A: Measurement Quality Objectives for RMC Analytes, and for biological measurements in Appendix B: Benthic Macroinvertebrate MQOs and Data Production Process.

1.3.7. Contamination

For chemical data, contamination is assessed as the presence of analytical constituents in blank samples. The RMC QAPP requires collection and analysis of field blank samples at a rate of 5% for orthophosphate.

[1] The QAPP also requires the collection of field duplicate samples for 10% of biological samples (BMI and algae). However, there are no prescribed methods for assessing the precision of these duplicate samples.

2. METHODS

2.1. REPRESENTATIVENESS

To ensure representativeness, each member of the SCVURPPP field crew received and reviewed all applicable SOPs and the QAPP. Most field crew members also attended a two-day bioassessment and field sampling training session from the California Water Boards Training Academy. The course was taught by California Department of Fish and Wildlife, Aquatic Bioassessment Laboratory staff and covered procedures for sampling benthic macroinvertebrates, algae, and measuring physical habitat characteristics using the applicable SWAMP SOPs. As a result, each field crew member was knowledgeable of, and performed data collection according to the protocols in the RMC QAPP and SOPs, ensuring that all samples and field measurements are representative of conditions in Santa Clara County urban creeks.

2.2. COMPARABILITY

In addition to the bioassessment and field sampling training, SCVURPPP field crew members participated in an inter-calibration exercise with other stormwater programs prior to field assessments at least once during the permit term. During the inter-calibration exercise, the field crews also reviewed water chemistry (nutrient) sample collection and water quality field measurement methods. Close communication throughout the field season with other stormwater program field crews also ensured comparability.

Sub-contractors collecting samples and the laboratories performing analyses received copies of the RMC SOP and QAPP and have acknowledged reviewing the documents. Data collection and analysis by these parties adhered to the RMC protocols and was included in their operating contracts.

Following completion of the field and laboratory work, the field data sheets and laboratory reports were reviewed by the SCVURPPP Program Quality Assurance staff and were compared against the methods and protocols specified in the SOPs and QAPP. Specifically, staff checked for conformance with field and laboratory methods as specified in SOPs and QAPP, including sample collection and analytical methods, sample preservation, sample holding times, etc.

Electronic data deliverables (EDDs) were submitted to the San Francisco Regional Water Quality Control Board (SFRWQCB) in Microsoft Excel templates developed by SWAMP, to ensure data comparability with the SWAMP program. In addition, data entry followed SWAMP documentation specific to each data type, including the exclusion of qualitative values that do not appear on SWAMP's look up lists[2] such as field crew member names and site IDs. Completed templates were reviewed using SWAMP's online data checker[3], further ensuring SWAMP-comparability.

2.3. COMPLETENESS

2.3.1. Data Collection

All efforts were made to collect 100% of planned samples. Upon completion of all data collection, the number of samples collected for each data type was compared to the number of samples planned and the number required by the MRP, and reasons for any missed samples were identified. When possible, SCVURPPP staff resampled sites if missing data were identified prior to the close of the monitoring period. Specifically, continuous water quality data were reviewed immediately following deployment for adherence to MQOs. If data were rejected, samplers were redeployed immediately.

[2] Look up lists available online at http://swamp.waterboards.ca.gov/swamp_checker/LookUpLists.php
[3] Checker available online at http://swamp.waterboards.ca.gov/swamp_checker/SWAMPUpload.php

For bioassessments, the SCVURPPP field crew made all efforts to collect the required number of BMI and algae subsamples per site; in the event of a dry transect, the samples were slid to the closest sampleable location to ensure 11 total subsamples in each station's composite sample.

2.3.2. Field Sheets

Following the completion of each sampling event, the field crew leader/local monitoring coordinator reviewed any field generated documents for completion, and any missing values were entered. Once field sheets were returned to the office, a second SCVURPPP staff member reviewed the field sheets again and noted any missing data.

2.3.3. Laboratory Results

SCVURPPP staff assessed laboratory reports and EDDs for the number and type of analysis performed to ensure all sites and samples were included in the laboratory results.

2.4. SENSITIVITY

2.4.1. Biological Data

Benthic macroinvertebrates were identified to SAFIT STE Level I, with the additional effort of identifying chironomids (midges) to subfamily/tribe instead of family (Chironomidae).

2.4.2. Chemical Analysis

The reporting limits for analytical results were compared to the target reporting limits in Appendix E (RMC Target Method Reporting Limits) of the RMC QAPP. Results with reporting limits that exceeded the target reporting limit were flagged.

2.5. ACCURACY

2.5.1. Biological Data

Ten percent of the total number of BMI samples collected was submitted to a separate taxonomic laboratory, Jon Lee Consulting, for independent assessment of taxonomic accuracy, enumeration of organisms, and conformance to standard taxonomic level. For SCVURPPP, two samples were evaluated for QC purposes. Results were compared to MQOs in Appendix B (Benthic macroinvertebrate MQOs and Data Production Process).

2.5.2. Chemical Analysis

Caltest evaluated and reported the percent recovery (PR) of laboratory control samples (LCS; in lieu of reference materials) and matrix spikes (MS), which were recalculated and compared to the applicable MQOs set by Appendix A (Measurement Quality Objectives for RMC Analytes) of the RMC QAPP MQOs. If a QA sample did not meet MQOs, all samples in that batch for that particular analyte were flagged.

For reference materials, percent recovery was calculated as:

$$PR = MV / EV \times 100\%$$

Where: MV = the measured value
EV = the expected (reference) value

For matrix spikes, percent recovery was calculated as:

$$PR = [(MV - NV) / SV] \times 100\%$$

Where: MV = the measured value of the spiked sample
NV = the native, unspiked result
SV = the spike concentration added

2.5.3. Water Quality Data Collection

Accuracy for continuous water quality monitoring sondes was assured via continuing calibration verification for each instrument before and after each two-week deployment. Instrument drift was calculated by comparing the instrument's measurements in standard solutions taken before and after deployment. The drift was compared to measurement quality objectives for drift listed on the SWAMP calibration form, included as an attachment to the RMC SOP FS-3.

Temperature data were checked for accuracy by comparing measurements taken by HOBO temperature loggers with NIST thermometer readings in room temperature water and ice water prior to deployment. The mean difference and standard deviation for each HOBO was calculated, and if a logger had a mean difference exceeding 0.2 ºC, it was replaced.

2.6. PRECISION

2.6.1. Field Duplicates

For creek status monitoring, duplicate biological samples were collected at 10% (two) of the 20 sites and duplicate water chemistry samples were collected at 10% (two) of the sites sampled to evaluate precision of field sampling methods. The RPD for water chemistry field duplicates was calculated and compared to the MQO (RPD < 25%) set by Table 26-1 in Appendix A of the RMC QAPP. If the RPD of the two field duplicates did not meet the MQO, the results were flagged.

The RMC QAPP requires collection and analysis of duplicate sediment chemistry and toxicity samples at a rate of 5% of total samples collected for the project. Responsibility for the collection of the field duplicate rotates each year amongst Alameda County Clean Water Program (ACCWP), Contra Costa Clean Water Program (CCCWP), San Mateo County Water Pollution Prevention Program (SMCWPPP), and SCVURPPP.

The sediment sample and field duplicate were collected together using the Sediment Scoop Method described in the RMC SOP, homogenized, and then distributed to two separate containers. For sediment chemistry field duplicates, the RPD was calculated for each analyte and compared to the MQOs (RPD < 25%) set by Tables 26-7 through 26-11 in Appendix A of the RMC QAPP. For sediment and water toxicity field duplicates, the RPD of the batch mean was calculated and compared to the recommended acceptable RPD (< 20%) set by Tables 26-12 and 26-13 in Appendix A. If the RPD of the field duplicates did not meet the MQO, the results were flagged.

The RPD is calculated as:

RPD = ABS ([X1-X2] / [(X1+X2) / 2])

Where: X1 = the first sample result
X2 = the duplicate sample result

No field duplicate is required for pathogen indicators.

2.6.2. Chemical Analysis

Caltest evaluated and reported the RPD for laboratory duplicates, laboratory control duplicates, and matrix spike duplicates. The RPDs for all duplicate samples were recalculated and compared to the applicable MQO set by Appendix A of the RMC QAPP. If a laboratory duplicate sample did not meet MQOs, all samples in that batch for that particular analyte were flagged.

2.7. CONTAMINATION

Blank samples were analyzed for contamination, and results were compared to MQOs set by Appendix A of the RMC QAPP. For creek status monitoring, the RMC QAPP requires all blanks (laboratory and field) to be less than the analyte reporting limits. If a blank sample did not meet this MQO, all samples in that batch for that particular analyte were flagged.

3. RESULTS

3.1. Overall Project Representativeness

The SCVURPPP staff and field crew members were trained in SWAMP and RMC protocols, and received significant supervision from the local monitoring coordinator and QA officer. As a result, creek status monitoring data were considered to be representative of conditions in Santa Clara County Creeks.

3.2. Overall Project Comparability

SCVURPPP creek status monitoring data were considered to be comparable to both other agencies in the RMC and to SWAMP due to a shared QAPP and SOP, trainings, use of the same electronic data templates, and close communication.

3.3. Bioassessments and Physical Habitat Assessments

In addition to algae and BMI taxonomic samples, the SCVURPPP field crew collected chlorophyll a and ash free dry mass samples during bioassessments. The BMI taxonomic laboratory, BioAssessment Services, confirmed that the laboratory QA/QC procedures aligned with the procedures in Appendices B through D of the RMC QAPP and met the BMI MQOs in Appendix B.

3.3.1. Completeness

SCVURPPP completed bioassessments and physical habitat assessments for 20 of 20 planned/required sites for a 100% sampling completion rate. However, physical habitat assessments could not be taken at several transects due to inaccessibility.

3.3.2. Sensitivity

The BMI taxonomic identification met sensitivity objectives; the taxonomy laboratory, BioAssessment Services, and QC laboratory, Jon Lee Consulting, confirmed that organisms were identified to SAFIT STE Level I, with the exception of Chironomidae which was analyzed to SAFIT level 1a.

The analytical RL for ash free dry mass analysis (8 mg/L) was much higher than the RMC QAPP target RL (2 mg/L) due to high concentrations requiring large dilutions. The results were several orders of magnitude higher than the actual and target reporting limit and were not affected by the higher RL. While the chlorophyll a analyses also required large dilutions due to high concentrations within the samples, the chlorophyll a analytical RL was below that of the RMC QAPP target RL.

Note that the target RLs in the RMC QAPP are set by the SWAMP, but there are currently no appropriate SWAMP targets for either ash free dry mass or chlorophyll a. Limits in the RMC QAPP are meant to reflect current laboratory capabilities. At lower analyte concentrations where a dilution would not be necessary, the analytical RLs would have met the target RLs.

3.3.3. Accuracy

The BMI samples that were submitted to an independent QC taxonomic laboratory had one specimen misidentification and one counting error. The specimen misidentification was speculated to be due to a sorting error or tagalong organism. The QC laboratory calculated sorting and taxonomic identification metrics, which were compared to the measurement quality objectives in Table 27-1 in Appendix B of the RMC QAPP. All MQOs were met. A comparison of the metrics with the MQOs is shown in Table 1. A copy of the QC laboratory report is available upon request.

There is currently no protocol for evaluating the accuracy of algae taxonomic identification.

Table 1. Quality control metrics for taxonomic identification of benthic macroinvertebrates collected in Santa Clara County in WY 2019 compared to measurement quality objectives.

Quality Control Metric	MQO	Sample 1		Sample 2	
		Error Rate	Exceeds MQO?	Error Rate	Exceeds MQO?
Recount Accuracy	> 95%	100%	No	99.84%	No
Taxa ID	≤ 10%	3.45%	No	0%	No
Individual ID	≤ 10%	0.16%	No	0.16%	No
Low Taxonomic Resolution Individual	≤ 10%	0%	No	0%	No
Low Taxonomic Resolution Count	≤ 10%	0%	No	0%	No
High Taxonomic Resolution Individual	≤ 10%	0%	No	0%	No
High Taxonomic Resolution Count	≤ 10%	0%	No	0%	No

3.3.4. Precision

Field blind duplicate chlorophyll a and ash free dry mass samples were collected at two sites in WY 2019 and were sent to the laboratory for analysis.

Duplicate field samples do not provide a valid estimate of precision in the sampling and are of little use to assessing precision, because there is no reasonable expectation that duplicates will produce identical data. Nonetheless, the RPD of the chlorophyll a and ash free dry mass duplicate results were calculated and compared to the MQO (< 25%) for conventional analytes in water (Table 26-1 in Appendix B of the RMC QAPP). Due to the nature of chlorophyll a and ash free dry mass collection, the RPDs for both parameters are expected to exceed the MQO. The field duplicate results and their RPDs are shown in Table 2. The RPD MQO was exceeded for both analytes at one site but was met for both analytes at the other site.

Again, discrepancies were expected due to the potential natural variability in algae production within the reach and the collection of field duplicates at different locations along each transect (as specified in the protocol). As a result, both parameters have frequently exceeded the field duplicate RPD MQOs during past years' monitoring efforts.

Table 2. Field duplicate water chemistry results for site 205R04638, collected on May 6, 2019 and site 205R04247, collected June 5, 2019.

Analyte	Units	205R04638 May 6, 2019				205R04247 June 5, 2019			
		Original Result	Duplicate Result	RPD	Exceeds MQO (>25%)[a]	Original Result	Duplicate Result	RPD	Exceeds MQO (>25%)[a]
Chlorophyll a	**mg/m^3**	2300	320	151%	Yes	2800	2700	4%	No
Ash Free Dry Mass	**mg/L**	300	2000	148%	Yes	1940	1980	2%	No

[a]In accordance with the RMC QAPP, if the native concentration of either sample is less than the reporting limit, the RPD is not applicable

Laboratory duplicates were also collected for chlorophyll a and ash free dry mass samples. The RPD for both analytes were below the MQO limit, so it was not necessary to flag any samples.

3.3.5. Contamination

All field collection equipment was decontaminated between sites in accordance with the RMC SOP FS-8 and CDFW Aquatic Invasive Species Decontamination protocols. As a result, it is assumed that samples were free of biological contamination.

3.4. FIELD MEASUREMENTS

Field measurements of temperature, dissolved oxygen, pH, specific conductivity, and chlorine residual were collected concurrently with bioassessments and water chemistry samples. Chlorine residual was measured using a HACH Pocket Colorimeter™ II, which uses the DPD method. All other parameters were measured with a YSI Professional Plus or YSI 600XLM-V2-S multi-parameter instrument. All data collection was performed according to RMC SOP FS-3 (Performing Manual Field Measurements).

3.4.1. Completeness

Temperature, dissolved oxygen, pH, specific conductivity, free and total chlorine residual were collected at all 20 bioassessment sites for a 100% completeness rate.

3.4.2. Sensitivity

Free and total chlorine residual were measured using a HACH Pocket Colorimeter™ II, which uses the DPD method. For this method, the estimated detection limit for the low range measurements (0.02-2.00 mg/L) was 0.02 mg/L. There is, however, no established reporting limit. Colorimetric field instruments are generally not considered capable of providing accurate measurements of free chlorine and total chlorine residual below 0.13 mg/L (Missouri Department of Natural Resources 2004), due to analytical noise, regardless of the method detection limit provided by the manufacturer. For this reason, the Statewide General Permit for drinking Water Discharges (SWRCB 2014) and other recently issued NPDES permits, use 0.1 mg/L as a reporting limit for field measurements of total chlorine residual.

SCVURPPP also uses this threshold as a reporting limit for MRP chlorine residual monitoring. All measurements between 0.02 and 0.1 mg/L have been flagged as “detected, not quantified”. The adopted SCVURPPP reporting limit is still much lower than the target reporting limit of 0.5 mg/L listed in the RMC QAPP for free and total chlorine residual.

There are no reporting limits for temperature, dissolved oxygen, pH, and conductivity measurements, but the actual measurements are much higher than target reporting limits in the RMC QAPP, so it is assumed that the target reporting limits are met for all field measurements.

3.4.3. Accuracy

Data collection occurred Monday through Thursday, and the multi-parameter instrument was calibrated at most 12 hours prior to the first sample on Monday, with the dissolved oxygen sensor calibrated every morning to ensure accurate measurements. Calibration solutions are certified standards, whose expiration dates were noted prior to use. The chlorine kit is factory-calibrated and is sent into the manufacturer every other year to be calibrated.

Free chlorine was measured to be higher than total chlorine at three of the 20 sites sampled in WY 2019. In past years, free chlorine has also occasionally been measured as higher than total chlorine. Theoretically, the free chlorine measurement should always be less than or equal to the total chlorine measurement, as the total chlorine concentration in water encompasses the free chlorine concentration in addition to any other chlorine species. The reason for free chlorine concentrations exceeding total chlorine concentrations at a sample site has not been definitively established. Potential causes for these inverted results include matrix interferences, colorimeter user error, and uncertainty associated with low concentrations below the reporting limit. According to Hach, the manufacturer of the equipment and reagents, the free chlorine could have false positive results due to a pH exceedance of 7.6 and/or an alkalinity exceedance of 250 mg/L. It is unlikely that the higher free chlorine readings were caused by user error. The field crew is well trained and aware of potential problems with this testing method, such as wait times between adding reagents and taking the readings and separating the free chlorine and total residual chlorine samples. When free chlorine was observed to be higher than total chlorine at a sample site, the free chlorine measurement was retaken with a new water sample and recorded on the field form. It was deemed unnecessary to flag free chlorine measurements that were higher than total chlorine measurements.

3.4.4. Precision

Precision could not be measured as no duplicate field measurements are required or were collected.

3.5. WATER CHEMISTRY

Water chemistry samples were collected by SCVURPPP staff concurrently with bioassessment samples and analyzed by Caltest Analytical Laboratory within their respective holding times. Caltest performed all internal QA/QC requirements as specified in the QAPP and reported their findings to the RMC. Key water chemistry MQOs are listed in RMC QAPP Table 26-2.

3.5.1. Completeness

SCVURPPP collected 100% of planned/required water chemistry samples at the 20 bioassessment sites including two field duplicate samples. Samples were analyzed for all requested analytes, and 100% of results were reported. Water chemistry data were flagged when necessary, but none were rejected.

3.5.2. Sensitivity

Laboratory reporting limits met or were lower than target reporting limits for all nutrients except chloride and nitrate. The reporting limit for all chloride samples exceeded the target reporting limit, but concentrations were much higher than reporting limits, and the elevated reporting limits do not decrease confidence in the measurements.

The reporting limit (0.05 mg/L) and method detection limit (0.02 mg/L) for nitrate samples were higher than the target reporting limit (0.01 mg/L). As a result, two samples were flagged as “detected, not quantified”, but they would have been quantified at the lower reporting limit. Additionally, the nitrate concentration at one other site was measured to be below the method detection limit. SCVURPPP has discussed the reporting limits with Caltest, and due the methodology, lower limits cannot currently be achieved. Target and actual reporting limits are shown in Table 3.

Table 3. Target and actual reporting limits for nutrients analyzed in SCVURPPP creek status monitoring. Data in highlighted rows exceed monitoring quality objectives in RMC QAPP.

Analyte	Target RL mg/L	Actual RL mg/L
Ammonia	0.02	0.02
Chloride	0.25	1-20
Total Kjeldahl Nitrogen	0.5	0.1
Nitrate	0.01	0.05
Nitrite	0.01	0.005
Orthophosphate	0.01	0.01
Silica	1	1
Phosphorus	0.01	0.01

3.5.3. Accuracy

The RMC QAPP lists a target range of 90-110% for nutrient laboratory control samples (LCS), and 80-120% for nutrient matrix spike and matrix spike duplicates (MS/MSD). For other conventional analytes (i.e., silica and chloride), both the LCS and MS/MSD MQO for recovery is 80-120%.

Recoveries on most LCS and MS/MSD samples were within the MQO target range. Two LCS PRs collected for silica and four MS/MSD PRs collected for total Kjeldahl nitrogen (TKN) exceeded their respective MQO ranges listed in the RMC QAPP. The QA samples affected ten sites, whose results have been assigned the appropriate SWAMP flag. Though the results were flagged, none of the analytical data were rejected due to accuracy.

The target PR ranges on laboratory reports differed from the RMC QAPP PR for several LCS and MS/MSD samples. As a result, some QA samples that exceeded RMC MQOs were flagged, but not by the laboratory and vice versa.

3.5.4. Precision

The RPD for all laboratory control sample duplicate and MS/MSD pairs were consistently below the MQO target of < 25%. Please note that the laboratory used a lower threshold of 20% for all analytes. However, all RPDs were much lower than 20% and no samples were flagged by the laboratory or the QA officer for exceeding the RPD MQO.

Water chemistry field duplicates were collected at two sites in Santa Clara County and were compared against the original samples. For WY 2019, one of the total Kjeldahl nitrogen duplicate samples exceeded the RPD MQO. In past years of sampling, total Kjeldahl nitrogen has been common among the analytes that exceed the field duplicate RPD MQOs. Field crews will continue to make an effort in subsequent years to collect the original and duplicate samples in an identical fashion.

The field duplicate water chemistry results and their RPDs are shown in Tables 4 and 5. Because of the variability in reporting limits, values less than the RL were not evaluated for RPD. For those analytes whose RPDs could be calculated and did not meet the RMC MQO, they were assigned the appropriate SWAMP flag.

Table 4. Field duplicate water chemistry results for site 205R04638, collected on May 6, 2019. Data in highlighted rows exceed measurement quality objectives in RMC QAPP.

Analyte Name	Fraction Name	Unit	Original Result	Duplicate Result	RPD	Exceeds MQO (>25%)[a]
Ammonia as N	Total	mg/L	0.41	0.34	19	No
Chloride	None	mg/L	10	10	0%	No
Nitrate as N	None	mg/L	0.095	0.093	2%	No
Nitrite as N	None	mg/L	J 0.002	J 0.002	N/A	N/A
Nitrogen, Total Kjeldahl	None	mg/L	0.14	0.25	56%	N/A
Orthophosphate as P	Dissolved	mg/L	0.018	0.017	6%	No
Phosphorus as P	Total	mg/L	0.028	0.028	0%	No
Silica as SiO2	Total	mg/L	19	20	5%	No

[a]In accordance with the RMC QAPP, if the native concentration of either sample is less than the reporting limit, the RPD is not applicable

Table 5. Field duplicate water chemistry results for site 205R04247, collected on June 5, 2019. Data in highlighted rows exceed measurement quality objectives in RMC QAPP.

Analyte Name	Fraction Name	Unit	Original Result	Duplicate Result	RPD	Exceeds MQO (>25%)[a]
Ammonia as N	Total	mg/L	0.92	0.96	4	No
Chloride	None	mg/L	19	19	0%	No
Nitrate as N	None	mg/L	0.1	0.1	0%	No
Nitrite as N	None	mg/L	J 0.001	ND	N/A	N/A
Nitrogen, Total Kjeldahl	None	mg/L	0.28	0.36	25%	Yes
Orthophosphate as P	Dissolved	mg/L	0.038	0.041	8%	No
Phosphorus as P	Total	mg/L	0.074	0.076	3%	No
Silica as SiO2	Total	mg/L	20	19	5%	No

[a]In accordance with the RMC QAPP, if the native concentration of either sample is less than the reporting limit, the RPD is not applicable

3.5.5. Contamination

None of the target analytes were detected in any of the laboratory blanks at levels above their reporting limit. All analytes were non-detect in the laboratory blanks. The RMC QAPP does not require field blanks to be collected, and possible contamination from sample collection was not assessed. However, the SCVURPPP field crew takes appropriate precautions to avoid contamination, including wearing gloves during sample collection and rinsing sample containers with stream water when preservatives are not needed.

3.6. Pathogen Indicators

Pathogen indicator samples were collected by SCVURPPP staff and were analyzed by Alpha Analytical Laboratories, Inc for *E. coli* and enterococcus. Samples were collected on August 1, 2019.

3.6.1. Completeness

All five required/planned pathogen indicator samples were collected for a 100% completeness rate. These samples and were received and incubated by the laboratory well within the 8-hour hold time.

3.6.2. Sensitivity

The reporting limits for *E. coli* and enterococcus (1 MPN/100mL and 2 MPN/100m, respectively) met the target RL of 2 MPN/100mL listed in the project QAPP.

3.6.3. Accuracy

Negative and positive laboratory controls were run for microbial media. A negative response was observed in the negative control and a positive response was observed in the positive control required by the project QAPP Table 26-4.

3.6.4. Precision

The RMC QAPP requires one laboratory duplicate to be run per 10 samples or per analytical batch, whichever is more frequent. However, determining precision for pathogen indicators requires 15 duplicate sets. Due to the small number of samples collected for this project, there were not enough laboratory duplicates to determine precision. In WY 2019, only one laboratory duplicate was run and is not sufficient to determine precision.

The RMC QAPP does not require a field duplicate to be collected for pathogen indicators. However, one field duplicate was collected in WY 2019 at 205LGA420. The RPD for *E.coli* was 0% and 113% for enterococcus. Since there is no requirement for pathogen field duplicates, there is no corresponding MQO, and the precision could not be assessed. See Table 6 for the field duplicate results.

Table 6. Lab and field duplicate pathogen results collected on August 1, 2019.

Duplicate Type	Analyte	Original Result (MPN/100mL)	Duplicate Result (MPN/100mL)	RPD
Lab Duplicate	E.coli	29.4	27.9	NA
Lab Duplicate	Enterococcus	23.1	16.0	NA
Field Duplicate	E.coli	7.5	7.5	0%
Field Duplicate	Enterococcus	14.8	4.1	113%

3.6.5. Contamination

One method blank (sterility check) was run in the batch for *E. coli* and enterococcus. No growth was observed in the blank.

3.7. Continuous Water Quality

Continuous water quality measurements were recorded at three sites during the spring (June 2019), concurrent with bioassessments, and again in the summer (August/September 2019) in compliance with the MRP. Temperature, pH, dissolved oxygen, and specific conductivity were recorded once every 15 minutes for approximately two-weeks using a multi-parameter water quality sonde (YSI 6600-V2).

3.7.1. Completeness

The MRP requires one to two-week deployments, and both deployments exceeded the one week minimum. Both deployments lasted 14 days. Sondes collected data for 100% of the planned deployments. However, the pH sensor for the sonde deployed at station 205COY235 failed during the spring deployment, and all of the pH data were rejected for that deployment. The sensor was subsequently replaced; however, during the summer deployment, the pH sensor for the sonde deployed at the same site failed periodically, and some data were rejected for this deployment as well.

3.7.2. Sensitivity

There are no method reporting limits for temperature, dissolved oxygen, pH, and conductivity measurements, but the actual measurements are much higher than target reporting limits in the RMC QAPP, so it is assumed that target reporting limits are met for all field measurements.

3.7.3. Accuracy

The SCVURPPP staff conduct pre- and post-deployment sonde calibrations for the three sondes used during monitoring events and calculate the drift during the deployments. During the first monitoring event, the sondes deployed at both 205COY235 and 205COY236 exceeded both the pH 7 and pH 10 MQOs. During the second deployment, sonde at 205COY235 failed the pH 10 drift check and the sonde at 205COY236 failed the pH 7 drift check. The pH results at these sites were subsequently flagged for both deployments. Though some pH data for site 205COY235 were rejected for both deployments due to sensor malfunctions, none were rejected for drift check exceedances. A summary of the drift measurements is shown in Table 7.

Table 7. Drift measurements for two continuous water quality monitoring events in Santa Clara Valley urban creeks during WY 2019. Bold and highlighted values exceeded measurement quality objectives.

Parameter	Measurement Quality Objectives	205COY235		205COY236		205COY239	
		Event 1	Event 2	Event 1	Event 2	Event 1	Event 2
Dissolved Oxygen (mg/l)	± 0.5 mg/L or 10%	-0.09	0.09	-0.07	0.07	-0.29	0.29
pH 7.0	± 0.2	-0.79	0.02	0.18	0.28	0.02	0.02
pH 10.0	± 0.2	-0.22	-0.77	-0.38	0.19	0.02	0.02
Specific Conductance (uS/cm)	± 10%	0.2%	3.4%	0.3%	1.7%	0.0%	0.0%

3.7.4. Precision

There is no protocol listed in the RMC QAPP for measuring the precision of continuous water quality measurements.

3.8. Continuous Temperature Monitoring

Continuous temperature monitoring was conducted from April through September 2019 at nine sites in Santa Clara County. Onset HOBO Water Temperature data loggers recorded one measurement per hour.

3.8.1. Completeness

The MRP requires SCVURPPP to monitor eight stream reaches for temperature each year but anticipating the potential for a HOBO temperature logger to be lost during such a long deployment, SCVURPPP deployed one extra temperature logger, for a total of nine loggers. In the middle of the deployment, SCVURPPP staff checked the loggers to ensure that they were still present and recording. If a logger was missing during the mid-deployment field check, it would be replaced with a new logger. During the field check, staff also downloaded the existing data and redeployed the loggers. All temperature loggers were recovered at the end of the deployment, resulting in a completion rate of over 100%.

3.8.2. Sensitivity

There is no target reporting limit for temperature listed in the RMC QAPP, thus sensitivity could not be evaluated for continuous temperature measurements.

3.8.3. Accuracy

A pre-deployment accuracy check was run on the temperature loggers in March 2019. None of the deployed loggers exceeded the 0.2 ºC mean difference threshold for either the room temperature bath or the ice bath. The loggers were subsequently deployed, and no flagging of the data was necessary.

3.8.4. Precision

There are no precision protocols for continuous temperature monitoring.

3.9. Sediment Chemistry

The dry season sediment chemistry samples were collected by Kinnetic Laboratories, Inc (KLI) concurrently with the dry season toxicity sample on July 23, 2019. Inorganic and synthetic organic compounds were analyzed by Caltest and grain size distribution was analyzed by Soil Control Laboratories, a subcontractor laboratory. Caltest conducted all QA/QC requirements as specified in the

RMC QAPP and reported their findings to the RMC. Key sediment chemistry MQOs are listed in RMC QAPP Tables 26-9 through 26-11. Sediment chemistry data were flagged when necessary, but none were rejected.

3.9.1. Completeness

The MRP requires a sediment chemistry sample to be collected at two locations each year. In WY 2019, SCVURPPP collected the sediment chemistry sample at 205STE021 and 205STQ010. The laboratories analyzed within the one year holding time for analytes in sediment, set by the RMC SOP, and reported 100% of the required analytes.

3.9.2. Sensitivity

A comparison of target and actual reporting limits for those parameters is shown in Table 8. For sediment chemistry analysis conducted in WY 2019, laboratory reporting limits were higher than RMC QAPP target reporting limits for 20 analytes. Since reporting limits for a sample are dependent on the percent solids of that sample, it is likely that the amount of solids in the sample resulted in these exceedances.

Table 8. Comparison of target and actual reporting limits for sediment analytes where reporting limits exceeded target limits. Sediment samples were collected in Santa Clara County creeks in WY 2019.

Analyte	Target RL	Actual RL	Unit
Arsenic	0.3	0.51	mg/Kg
Cadmium	0.01	0.08	mg/Kg
Chromium	0.1	1.0	mg/Kg
Copper	0.01	0.41	mg/Kg
Lead	0.01	0.08	mg/Kg
Nickel	0.02	0.08	mg/Kg
Zinc	0.1	0.8	mg/Kg
Bifenthrin	0.33	1.3	ng/g
Cyfluthrin	0.33	1.3	ng/g
Total Lambda-cyhalothrin	0.33	1.3	ng/g
Total Cypermethrin	0.33	1.3	ng/g
Total Deltamethrin	0.33	1.3	ng/g
Total Esfenvalerate/Fenvalerate	0.33	1.3	ng/g
Permethrin	0.33	1.3	ng/g
Carbaryl	30	31	ng/g
Fipronil	0.33	1.3	ng/g
Fipronil Desulfinyl	0.33	1.3	ng/g
Fipronil Sulfide	0.33	1.3	ng/g
Fipronil Sulfone	0.33	1.3	ng/g
Total Organic Carbon	0.01	0.051	% dw

3.9.3. Accuracy

<u>Inorganic Analytes</u>

No QA samples exceeded the QAPP MQO for LCS percent recovery (PR) for inorganic analytes (75-125%), but the MS samples for arsenic and lead exceeded the PR MQO. These sample were flagged but not rejected.

Synthetic Organic Compounds

The RMC QAPP lists the percent recovery MQO for pyrethroids and other synthetic organic compounds in sediment as 50-150%. However, the PR MQOs listed in the laboratory reports for synthetic organic compounds varied by analyte and were much larger than PR ranges listed in the QAPP. The MQOs ranged from 1 to 275% in certain cases. As a result, several analytes were flagged by the local QA officers, but not by the laboratory.

None of the LCS PRs exceeded the RMC MQO range. However, the MS/MSD PRs exceeded the RMC MQO range for seven PAHs in addition to fipronil, fipronil sulfide, and fipronil sulfone. The PAH MS/MSD samples that exceeded the PR MQO include benzo(a)pyrene, benzo(g,h,i)perylene, fluoranthene, indeno(1,2,3-c,d)pyrene, naphthalene, perylene, and pyrene.

3.9.4. Precision

Inorganic Analytes

The RMC QAPP lists the maximum RPD for inorganic analytes (metals) as 25%. All MS/MSD sets for metals were well below the RMC RPD MQO of 25%.

Synthetic Organic Compounds

The maximum RPD for synthetic organics listed in the sediment laboratory report lists ranges from 30 to 50% for most analytes. However, the RMC QAPP lists the MQO as < 25% RPD for most synthetic organics, < 35% for pyrethroids and fipronil, and < 40% for carbaryl. None of the MS/MSD pairs or LCS duplicates exceeded the RPD MQO.

Field Duplicates

A sediment sample field duplicate was collected in Contra Costa County on July 23, 2019 and evaluated for precision. The field duplicate sample and corresponding RPDs are shown in Table 9. Because of the variability in reporting limits, values less than the RL were not evaluated for RPD. The measured concentrations of a majority of analytes from the original and duplicate samples were below the method detection limit and therefore reported as "ND". As a result, the RPDs were non-calculable. All calculable RPDs were below the MQO limits. Analytes that exceeded the MQO of RPD < 25% were medium sand (0.25 to <0.5 mm); total cyfluthrin; total lambda-cyhalothrin; deltamethrin/tralomethrin.

Given the inherent variability associated with sediment sample field duplicates, the number of analytes with RPDs outside of the MQO limits is acceptable. The method used to collect sediment field duplicates provides more insight to laboratory precision than precision of field methods; however, the results do suggest that field methods are precise.

Table 9. Sediment chemistry duplicate field results for site 544MSH045, collected on July 23, 2019 in Contra Costa County. Data in highlighted rows exceed monitoring quality objectives in RMC QAPP.

	Analyte	Unit	Original	Duplicate	RPD	Exceeds MQO? (<25%)[a]
Grain Size Distribution	Clay: <0.0039 mm	%	25.14	23.22	7.9%	No
	Silt: 0.0039 to <0.0625 mm	%	60.97	60.13	1.4%	No
	Sand: V. Fine 0.0625 to <0.125 mm	%	7.36	8.39	13.1%	No
	Sand: Fine 0.125 to <0.25 mm	%	3.4	4.19	20.8%	No
	Sand: Medium 0.25 to <0.5 mm	%	1.54	2.37	42.5%	Yes
	Sand: Coarse 0.5 to <1.0 mm	%	0.8	1	22.2%	No
	Sand: V. Coarse 1.0 to <2.0 mm	%	0.8	0.7	13.3%	No
	Granule: 2.0 to <4.0 mm	%	0.38	0.36	5.4%	No
	Pebble: Small 4 to <8 mm	%	0.09	ND	N/A	N/A
	Pebble: Medium 8 to <16 mm	%	1.68	ND	N/A	N/A
	Pebble: Large 16 to <32 mm	%	ND	ND	N/A	N/A
	Pebble: V. Large 32 to <64 mm	%	ND	ND	N/A	N/A
Metals	Arsenic	mg/Kg dw	6.4	6.1	4.8%	No
	Cadmium	mg/Kg dw	0.14	0.17	19.4%	No
	Chromium	mg/Kg dw	31	32	3.2%	No
	Copper	mg/Kg dw	34	34	0%	No
	Lead	mg/Kg dw	9.3	10	7.3%	No
	Nickel	mg/Kg dw	43	45	4.5%	No
	Zinc	mg/Kg dw	130	140	7.4%	No
Pyrethroids (MQO <35%)	Bifenthrin	ng/g dw	18	17	5.7%	No
	Cyfluthrin	ng/g dw	2.5	1.7	38.1%	Yes
	Lambda-Cyhalothrin	ng/g dw	1	1.3	26.1%	No
	Cypermethrin	ng/g dw	ND	ND	N/A	ND
	Deltamethrin/Tralomethrin	ng/g dw	6.8	4.8	34.5%	No
	Esfenvalerate/Fenvalerate	ng/g dw	ND	ND	N/A	N/A
	Permethrin	ng/g dw	0.77	0.83	7.5%	No
	Total Organic Carbon	%	2.6	2.4	8.0%	No
	Carbaryl	mg/Kg dw	ND	ND	N/A	N/A
Fipronil	Fipronil	ng/g dw	ND	ND	N/A	N/A
	Fipronil Desulfinyl	ng/g dw	ND	ND	N/A	N/A
	Fipronil Sulfide	ng/g dw	ND	ND	N/A	N/A
	Fipronil Sulfone	ng/g dw	ND	ND	N/A	N/A
Polycyclic Aromatic Hydrocarbons	Acenaphthene	ng/g dw	ND	ND	N/A	N/A
	Acenaphthylene	ng/g dw	ND	ND	N/A	N/A
	Anthracene	ng/g dw	ND	ND	N/A	N/A
	Benz(a)anthracene	ng/g dw	ND	ND	N/A	N/A
	Benzo(a)pyrene	ng/g dw	ND	ND	N/A	N/A
	Benzo(b)fluoranthene	ng/g dw	ND	ND	N/A	N/A
	Benzo(e)pyrene	ng/g dw	ND	ND	N/A	N/A
	Benzo(g,h,i)perylene	ng/g dw	ND	ND	N/A	N/A
	Benzo(k)fluoranthene	ng/g dw	ND	ND	N/A	N/A
	Biphenyl	ng/g dw	ND	ND	N/A	N/A
	Chrysene	ng/g dw	ND	ND	N/A	N/A

Table 9. Sediment chemistry duplicate field results for site 544MSH045, collected on July 23, 2019 in Contra Costa County. Data in highlighted rows exceed monitoring quality objectives in RMC QAPP.

Analyte		Unit	Original	Duplicate	RPD	Exceeds MQO? (<25%)[a]
	Dibenz(a,h)anthracene	ng/g dw	ND	ND	N/A	N/A
	Dibenzothiophene	ng/g dw	ND	ND	N/A	N/A
	Dimethylnaphthalene, 2,6-	ng/g dw	11	11	0%	No
	Fluoranthene	ng/g dw	ND	ND	N/A	N/A
	Fluorene	ng/g dw	ND	ND	N/A	N/A
	Indeno(1,2,3-c,d)pyrene	ng/g dw	ND	ND	N/A	N/A
	Methylnaphthalene, 1-	ng/g dw	ND	ND	N/A	N/A
	Methylnaphthalene, 2-	ng/g dw	ND	ND	N/A	N/A
	Methylphenanthrene, 1-	ng/g dw	ND	ND	N/A	N/A
	Naphthalene	ng/g dw	ND	ND	N/A	N/A
	Perylene	ng/g dw	ND	ND	N/A	N/A
	Phenanthrene	ng/g dw	ND	ND	N/A	N/A
	Pyrene	ng/g dw	ND	ND	N/A	N/A

[a] MQO for pyrethroids is <35%. In accordance with the RMC QAPP, if the native concentration of either sample is less than the reporting limit, the RPD is not applicable

Laboratory Duplicates

Laboratory duplicates were collected and analyzed for grain sizes and total organic carbon. All RPDs were below the MQO limits except for medium (8 to <16 mm) pebbles in addition to granules (2.0 to <4.0 mm). As a result, the associated samples were flagged.

3.9.5. Contamination

All instrument (lab) blanks had concentrations below the reporting limit, and no data were flagged or rejected.

3.10. Toxicity Testing

Dry season water and sediment toxicity samples were collected by KLI concurrently with dry season sediment chemistry samples at two Santa Clara County sites on July 23, 2019. All toxicity tests were performed by Pacific EcoRisk. The water samples were analyzed for toxicity to five organisms (*Selenastrum capricornutum, Ceriodaphnia dubia, Pimephales promelas, Hyalella azteca, and Chronomus dilutus*) and the sediment samples were analyzed for toxicity to *Hyalella azteca* and *Chironomus dilutus.*

3.10.1. Completeness

The MRP requires the collection of dry season water and sediment toxicity samples at two sites per year in Santa Clara County. Pacific EcoRisk tested the required organisms for toxicity, and 100% of results were reported.

3.10.2. Sensitivity and Accuracy

Internal laboratory procedures that align with the RMC QAPP, including water and sediment quality testing and reference toxicant testing, were performed and submitted to SCVURPPP. The laboratory data QC checks found that all conditions and responses were acceptable. A copy of the laboratory QC report is available upon request.

3.10.3. Precision

Field duplicates for sediment toxicity were not taken during the dry weather sampling. This oversight was the result of a misunderstanding of the conflict between the 2016 version of the RMC QAPP (V3.0) and the SWAMP requirements for toxicity sample field duplicates that were revised in 2018. As such, 2019 RMC toxicity data are SWAMP comparable, but were flagged with the “VQCP” qualifier to indicate a discrepancy with the RMC QAPP. The RMC QAPP has been updated to reflect the recent revisions to the SWAMP MQOs.

3.10.4. Contamination

There are no QA/QC procedures for contamination of toxicity samples, but staff followed applicable RMC SOPs to limit possible contamination of samples.

4. CONCLUSIONS

Sample collection and analysis followed MRP and RMC QAPP requirements and data that exceeded measurement quality objectives were flagged. Additionally, all continuous pH data collected in June and several data points in September were rejected due to instrument failure.

5. REFERENCES

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Attachment 2

SCVURPPP Bioassessment Data, WY 2012 – WY 2019

Attachment 2: Eight years of bioassessment data (WY 2012- WY 2019) used for analyses in the Integrated Monitoring Report

Site Information						Water Quality						Water Chemistry (nutrients)																		Biological and Physical Habitat Indicator Scores					Physical Habitat									Land Use Variables		
Station Code	Creek Name	Latitude	Longitude	Land Use	Sample Date	Dissolved Oxygen (mg/L)	Spec Conductance (uS/cm)	Temperature (Deg C)	pH	Chloride (mg/L)	Silica (mg/L)	Ash Free Dry Mass (g/m2)	Chlorophyll a (mg/m2)	QA Flag	Ammonia (mg/L)	QA Flag	UIA (ug/L)	Nitrate as N (mg/L)	QA Flag	Nitrite as N (mg/L)	QA Flag	TKN as N (mg/L)	QA Flag	Ortho Phosphate as P (mg/L)	QA Flag	Total Phosphorus as P (mg/L)	QA Flag	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	CSCI	ASCI_D	ASCI_SB	ASCI_H	IPI	Channel Alteration	Epifaunal Substrate	Sediment Deposition	Human Disturbance Index	Evenness Flow Habitat	% Substrate <2 mm	Shannon Diversity Habitat	Sum Riparian Cover	Shannon Diversity Substrate	% Impervious (wat)	% Urban (wat)	Road Density (wat)
205R00026	Los Gatos Creek	37.23057	-121.97317	U	5/14/12	9.8	439	13.6	7.0	16	14.1	34	28	=	0.077	DNQ	0.2	0.19	=	-0.002	ND	0.34	=	0.016	=	-0.007	ND	0.5	0.004	0.68	0.73	0.62	0.72	NR	15	10	8	1.6	0.8	34	1.7	NR	1.9	6%	11%	2.9
205R00234	San Tomas Aquino	37.26620	-121.99081	U	5/15/12	8.3	632	18.5	8.1	59	24.6	258	18	=	0.055	DNQ	2.0	0.18	=	-0.002	ND	0.33	=	0.018	=	0.023	=	0.5	0.023	0.71	0.66	0.40	0.61	NR	3	5	6	1.9	0.5	30	0.9	NR	1.4	13%	54%	5.6
205R00058	Saratoga Creek	37.25170	-122.08407	NU	5/15/12	10.5	410	10.9	7.1	10	22.3	199	28	=	0.044	DNQ	0.1	0.10	=	-0.002	ND	0.23	=	0.110	=	0.100	=	0.3	0.100	1.15	0.85	NA	NA	NR	20	17	10	0.9	0.8	15	1.6	NR	1.9	3%	3%	0.9
205R00021	MF Coyote Creek	37.25513	-121.57811	NU	5/16/12	6.1	366	12.3	7.4	8	9.2	35	-6	ND	0.088	DNQ	0.4	0.03	DNQ	-0.002	ND	0.13	=	0.010	DNQ	0.012	=	0.2	0.012	0.95	0.87	0.80	0.93	NR	20	15	17	0.0	0.9	5	1.6	NR	1.5	1%	0%	0.4
205R00099	Calabazas Creek	37.30773	-122.02170	U	5/17/12	9.8	456	16.6	7.8	58	11.7	31	-7	ND	-0.040	ND	0.4	0.42	=	-0.002	ND	0.23	=	0.070	=	0.090	=	0.7	0.090	0.61	0.47	0.44	0.56	NR	13	6	6	1.5	0.8	24	1.8	NR	1.4	25%	63%	8.0
205R00042	Coyote Creek	37.24578	-121.77020	U	5/21/12	7.6	510	23.0	8.2	43	12.7	491	-50	ND	0.066	DNQ	4.1	0.81	=	0.003	DNQ	0.76	=	0.012	=	0.032	=	1.6	0.032	0.51	0.83	0.66	0.79	NR	19	8	5	2.0	1.0	64	1.6	NR	1.5	3%	1%	0.8
205R00241	Upper Silver Creek	37.27642	-121.76496	U	5/21/12	7.3	1014	14.1	7.6	87	49.6	743	-50	ND	0.550	=	5.0	0.32	=	-0.002	ND	0.56	=	0.170	=	0.180	=	0.9	0.180	0.30	0.65	0.86	0.68	NR	18	13	3	2.6	0.7	50	1.8	NR	1.6	5%	8%	1.4
205R00154	Canoas Creek	37.23400	-121.83759	U	5/22/12	4.2	1087	20.3	7.6	79	21.3	237	133	=	-0.040	ND	0.3	-0.01	ND	-0.002	ND	0.57	=	0.085	=	0.130	=	0.6	0.130	0.17	0.76	0.38	0.71	NR	3	1	2	4.7	0.0	37	0.6	NR	0.4	36%	61%	8.8
205R00282	Guadalupe Creek	37.23760	-121.88840	U	5/22/12	8.9	403	16.8	7.2	30	16.2	415	-56	ND	-0.040	ND	0.1	0.20	=	-0.002	ND	0.29	=	0.034	=	0.055	=	0.5	0.055	0.74	0.79	0.66	0.64	NR	15	16	10	2.9	0.9	29	1.6	NR	1.8	4%	8%	2.4
205R00090	Canoas Creek	37.28807	-121.87920	U	5/23/12	6.0	952	18.4	8.2	87	29.4	68	40	=	0.120	=	5.8	0.10	=	0.080	=	0.99	=	-0.006	ND	0.024	=	1.2	0.024	0.24	0.88	0.17	0.80	NR	0	1	19	5.4	0.0	0	0.3	NR	0.0	46%	76%	11.8
205R00218	Coyote Creek	37.29000	-121.81804	U	5/23/12	6.4	490	19.1	7.2	42	12.4	271	-52	ND	0.150	=	0.7	0.20	=	-0.002	ND	0.43	=	0.034	=	0.055	=	0.6	0.055	0.54	0.87	0.63	0.71	NR	19	14	7	2.9	0.9	35	1.7	NR	1.6	4%	3%	0.9
205R00035	Upper Penitencia Cr	37.38105	-121.85735	U	5/24/12	9.3	361	18.0	7.7	46	10.9	213	69	=	0.120	=	2.1	0.33	=	-0.002	ND	0.44	=	0.072	=	0.087	=	0.8	0.087	0.59	0.52	0.42	0.55	NR	14	12	14	4.1	1.0	30	1.8	NR	1.7	4%	9%	1.1
205R00131	Lower Penitencia Cr	37.43404	-121.91280	U	6/3/12	4.8	1253	18.1	8.0	100	13.8	1555	65	DNQ	0.330	=	8.8	0.14	=	0.014	DNQ	0.65	=	0.020	=	0.038	=	0.8	0.038	0.31	0.49	0.68	0.45	NR	1	1	1	4.1	0.0	96	1.4	NR	0.9	69%	96%	12.4
205R00067	San Tomas Aquino	37.37693	-121.96857	U	6/3/12	16.1	1093	25.0	8.2	71	10.4	141	112	=	0.150	=	10.0	0.25	=	0.012	DNQ	0.36	=	0.008	DNQ	-0.007	ND	0.6	0.004	0.39	0.83	0.31	0.85	NR	1	2	2	4.6	1.0	15	0.7	NR	1.3	37%	70%	9.1
205R00227	Matadero Creek	37.40990	-122.15831	U	6/5/12	5.0	977	13.8	7.2	100	20.7	89	133	=	0.430	=	1.4	0.58	=	0.073	=	3.20	=	0.150	=	0.230	=	3.9	0.230	0.59	0.33	0.76	0.57	NR	2	7	9	3.4	0.3	15	1.3	NR	1.3	17%	51%	4.9
205R00115	Stevens Creek	37.40586	-122.06906	U	6/5/12	5.8	789	16.6	6.8	27	19.2	60	61	=	0.120	=	0.2	0.55	=	0.035	=	0.72	=	0.018	=	0.055	=	1.3	0.055	0.24	0.89	0.55	0.70	NR	11	8	9	2.9	0.5	37	1.9	NR	1.5	20%	34%	5.5
205R00066	Trib to Arroyo Aguague	37.37189	-121.73289	NU	6/5/12	9.4	471	11.6	8.0	16	NR	20	15	=	0.105	=	1.8	0.18	=	-0.001	ND	0.40	=	0.075	=	0.019	=	0.6	0.019	0.66	0.82	1.02	1.05	NR	19	15	15	0.0	0.5	13	1.7	NR	1.7	1%	0%	0.2
205R00291	Coyote Creek	37.31718	-121.84857	U	6/13/12	4.8	748	18.5	7.0	69	17.5	358	11	DNQ	0.120	=	0.4	0.26	=	0.003	DNQ	0.47	=	0.091	=	0.120	=	0.7	0.120	0.50	0.52	1.11	0.48	NR	19	10	10	2.4	1.0	31	1.7	NR	1.5	5%	5%	1.2
205R00355	Saratoga Creek	37.32668	-121.99539	U	6/13/12	9.0	438	20.7	8.1	56	10.9	24	-52	ND	0.099	DNQ	4.6	0.27	=	-0.002	ND	0.22	=	0.074	=	0.088	=	0.5	0.088	0.64	0.51	0.65	0.90	NR	5	7	5	3.5	0.5	22	1.5	NR	1.5	20%	39%	5.8
205R00259	Guadalupe River	37.36723	-121.92477	U	6/14/12	9.8	894	20.1	7.5	56	20.2	71	19	=	-0.040	ND	0.2	2.60	=	0.010	DNQ	0.33	=	0.046	=	0.062	=	2.9	0.062	0.44	0.64	1.09	0.67	NR	10	13	15	2.9	0.6	31	1.8	NR	1.5	25%	43%	6.8
205R00346	Guadalupe River	37.25973	-121.87010	U	6/14/12	6.1	531	19.7	7.8	42	14.2	42	14	DNQ	0.055	DNQ	1.1	0.02	DNQ	0.005	DNQ	0.32	=	0.017	=	0.040	=	0.3	0.040	0.48	0.67	0.91	0.73	NR	16	14	12	3.0	0.8	31	1.7	NR	1.6	10%	19%	3.3
204R00189	Smith Creek	37.32117	-121.66358	NU	5/6/13	9.4	306	12.6	8.2	7	15	35	65	=	-0.040	ND	0.6	-0.10	ND	-0.002	ND	0.22	=	0.011	=	0.012	=	0.3	0.012	0.93	1.09	1.12	0.90	NR	19	16	17	0.3	0.8	10	1.7	NR	1.7	1%	0%	0.5
205R00337	EF Coyote Creek	37.18975	-121.46888	NU	5/7/13	11.3	582	21.7	8.2	12	NR	15	14	=	0.030	DNQ	1.7	0.00	ND	-0.001	ND	0.48	=	-0.004	ND	0.014	=	0.5	0.014	0.59	1.03	1.15	1.09	NR	19	7	5	0.1	0.0	9	1.4	NR	1.4	3%	0%	0.1
205R00182	Randol Creek	37.18947	-121.84108	NU	5/7/13	9.2	1131	13.3	8.6	16	21	65	9	=	0.055	DNQ	3.9	0.05	=	-0.002	ND	0.35	=	0.058	=	0.051	=	0.4	0.051	0.74	0.91	0.65	0.84	NR	20	18	13	0.7	0.7	12	1.0	NR	1.7	1%	0%	1.5
205R00538	Shannon Creek	37.21801	-121.91376	U	5/8/13	6.8	855	14.5	7.5	61	26	130	13	=	-0.040	ND	0.1	-0.01	ND	-0.002	ND	0.37	=	0.062	=	0.060	=	0.4	0.060	0.50	0.84	0.91	0.93	NR	16	8	10	2.3	0.6	17	1.5	NR	1.5	4%	21%	4.5
205R00666	Coyote Creek	37.26930	-121.79683	U	5/9/13	6.6	474	18.3	8.4	62	8.2	81	256	=	0.066	DNQ	4.5	0.48	=	-0.002	ND	0.68	=	0.007	DNQ	0.020	=	1.2	0.020	0.69	0.80	0.90	0.75	NR	15	6	8	2.1	0.8	34	1.8	NR	1.6	4%	2%	0.8
205R00474	Coyote Creek	37.27891	-121.80733	U	5/9/13	7.8	486	18.0	8.1	64	9	90	27	=	0.055	DNQ	1.9	0.36	=	0.002	DNQ	0.53	=	0.018	=	0.026	=	0.9	0.026	0.68	0.77	1.04	0.60	NR	16	8	13	2.8	0.7	29	1.4	NR	1.7	4%	2%	0.9
205R00289	Coyote Creek	37.09003	-121.46985	NU	5/28/13	10.1	571	20.7	7.7	22	NR	18	30	=	-0.003	ND	-0.1	0.00	ND	-0.001	ND	0.40	=	-0.004	ND	*0.007*	DNQ	0.4	*0.007*	0.82	1.14	1.07	1.13	NR	15	13	13	0.5	0.2	23	1.6	NR	1.7	2%	0%	0.2
205R00554	San Tomas Aquino	37.24656	-121.99543	U	5/29/13	11.2	527	14.3	7.6	13	29	216	71	=	0.055	DNQ	0.5	0.03	DNQ	-0.002	ND	0.20	=	0.089	=	0.010	=	0.2	0.010	0.68	0.81	0.87	0.63	NR	13	10	18	2.2	0.6	18	1.7	NR	1.5	7%	38%	4.2
205R00170	Saratoga Creek	37.24845	-122.07081	NU	5/29/13	10.4	477	12.8	7.8	33	21	8	5	=	0.044	DNQ	0.6	0.57	=	-0.002	ND	0.31	=	0.016	=	0.082	=	0.9	0.082	1.03	0.66	1.04	0.97	NR	19	16	19	1.3	0.6	7	1.4	NR	1.6	3%	4%	0.8
205R00602	Alamitos Creek	37.23019	-121.86591	U	6/3/13	11.8	513	19.0	8.4	36	21	198	107	=	0.066	DNQ	5.5	0.16	=	-0.002	ND	0.57	=	0.039	=	0.041	=	0.7	0.041	0.55	0.79	1.08	0.75	NR	14	12	7	2.5	0.9	47	1.6	NR	1.6	7%	15%	2.6
205R00374	Alamitos Creek	37.19420	-121.82315	U	6/3/13	9.9	444	15.5	8.2	9	19	152	83	=	0.066	DNQ	2.3	0.05	=	-0.002	ND	0.40	=	0.065	=	0.062	=	0.5	0.062	0.67	0.85	0.86	0.86	NR	15	11	13	3.0	0.9	33	1.9	NR	1.8	3%	2%	1.2
205R00627	Calabazas Creek	37.39597	-121.98683	U	6/4/13	18.7	952	25.0	8.7	66	23	355	354	=	0.044	DNQ	8.6	0.56	=	0.010	DNQ	1.00	=	0.010	=	0.120	=	1.6	0.120	0.51	0.66	0.39	0.58	NR	19	16	16	2.7	0.8	61	1.0	NR	1.3	49%	84%	10.5
205R00547	Calabazas Creek	37.34769	-121.98985	U	6/4/13	16.3	578	25.2	9.0	66	23	43	41	=	-0.040	ND	7.1	-0.01	ND	0.002	DNQ	0.46	=	-0.006	ND	-0.007	ND	0.5	0.004	0.46	0.50	0.67	0.90	NR	0	0	19	3.5	1.0	3	0.0	NR	0.6	40%	78%	9.9
205R00451	Coyote Creek	37.38717	-121.90979	U	6/5/13	7.8	1203	19.0	8.0	94	19	396	22	=	0.190	=	5.9	1.70	=	0.009	DNQ	1.50	=	0.086	=	0.150	=	3.2	0.150	0.44	0.62	1.28	0.67	NR	15	12	3	3.2	0.8	68	1.4	NR	1.5	10%	15%	2.5
205R00707	Upper Penitencia Cr	37.38984	-121.84495	U	6/5/13	8.8	439	22.4	8.3	54	9.8	127	70	=	0.120	=	8.7	0.37	=	0.002	DNQ	0.59	=	0.100	=	0.110	=	1.0	0.110	0.64	0.57	1.03	0.71	NR	15	16	18	2.7	0.5	22	1.5	NR	1.9	3%	8%	1.0
205R00387	Calera Creek	37.44631	-121.90844	U	6/6/13	12.6	1113	31.6	8.2	47	25	2526	65	=	-0.040	ND	2.2	-0.01	ND	0.003	DNQ	1.10	=	0.015	=	0.052	=	1.1	0.052	0.27	0.63	0.72	0.52	NR	1	12	3	5.5	0.0	99	0.7	NR	0.2	10%	18%	3.1
205R00771	Guadalupe River	37.34260	-121.90206	U	6/6/13	8.6	805	18.4	7.8	61	19	140	193	=	-0.040	ND	0.4	3.00	=	0.004	DNQ	0.46	=	0.032	=	0.045	=	3.5	0.045	0.51	0.68	0.98	0.77	NR	10	11	11	3.3	0.8	27	1.9	NR	1.7	23%	40%	6.5
205R00714	Los Gatos Creek	37.23407	-121.97355	U	6/10/13	10.4	396	16.2	8.1	14	13	109	97	=	-0.040	ND	0.6	0.07	=	-0.002	ND	0.57	=	0.028	=	0.036	=	0.6	0.036	0.71	0.75	1.02	0.87	NR	13	12	16	1.9	0.6	25	1.9	NR	1.8	6%	11%	2.9
205R00586	Los Gatos Creek	37.16565	-121.97938	U	6/10/13	9.8	410	14.2	8.0	9	19	332	29	=	-0.040	ND	0.5	-0.01	ND	-0.002	ND	0.26	=	0.039	=	0.034	=	0.3	0.034	0.96	0.73	1.00	0.77	NR	18	18	14	0.6	0.7	23	1.7	NR	1.6	5%	7%	2.3
205R00739	Matadero Creek	37.42984	-122.12799	U	6/11/13	13.6	1020	19.2	8.5	78	28	538	39	=	0.044	DNQ	4.0	1.50	=	0.003	DNQ	0.77	=	0.044	=	0.078	=	2.3	0.078	0.27	0.68	0.52	0.77	NR	0	3	14	4.6	0.8	3	0.2	NR	0.6	30%	65%	7.0
205R00419	Stevens Creek	37.31979	-122.06175	U	6/11/13	9.9	537	17.5	8.1	22	18	202	126	=	-0.040	ND	0.7	0.21	=	-0.002	ND	0.53	=	0.027	=	0.048	=	0.7	0.048	0.75	0.70	0.75	0.68	NR	15	13	8	1.9	0.8	25	1.8	NR	1.5	3%	4%	1.4
205R00275	Arroyo Aguague	37.39043	-121.78352	NU	6/12/13	8.9	760	14.7	8.1	19	NR	17	12	=	-0.003	ND	-0.1	0.09	=	-0.001	ND	0.27	=	0.040	=	0.047	=	0.4	0.047	0.89	0.90	0.83	0.81	NR	20	18	19	0.0	0.1	7	1.3	NR	1.6	1%	0%	0.4
205R00787	Upper Penitencia Cr	37.40139	-121.79528	U	6/12/13	9.8	569	15.1	8.0	16	15	40	6	=	0.044	DNQ	1.1	0.10	=	-0.002	ND	0.13	=	0.034	=	0.027	=	0.2	0.027	1.26	0.94	0.88	0.89	NR	18	18	15	1.3	0.7	4	0.9	NR	1.6	1%	2%	0.4
205R00851	Arroyo de las Coches	37.43828	-121.87107	U	4/21/14	9.2	750	14.9	8.0	94	31	1387	54	=	-0.040	ND	0.5	-0.01	ND	-0.005	ND	0.40	=	0.170	=	0.180	=	0.4	0.180	0.60	0.50	0.89	0.68	NR	10	7	5	2.6	1.0	61	1.3	NR	1.4	2%	3%	2.2
205R01578	San Tomas Aquino	37.24047	-122.00595	U	4/22/14	7.0	657	14.8	6.8	49	26	88	51	=	-0.040	ND	0.0	1.20	=	-0.005	ND	0.22	=	-0.006	ND	0.014	=	1.4	0.014	0.55	0.93	1.12	0.95	NR	10	10	12	2.8	1.0	16	1.7	NR	1.6	5%	25%	3.0
205R00938	San Tomas Aquino	37.26078	-121.99184	U	4/22/14	9.5	303	14.6	7.7	90	26	87	49	=	-0.040	ND	0.2	0.37	=	-0.005	ND	0.62	=	0.044	=	0.046	=	1.0	0.046	0.76	0.69	0.83	0.62	NR	8	12	10	2.8	0.7	31	1.5	NR	1.7	11%	51%	5.1
205R00266	Limekiln Creek	37.20320	-121.97296	NU	4/23/14	6.6	689	12.5	7.1	34	22	4	19	=	0.055	DNQ	0.1	-0.01	ND	-0.005	ND	0.31	=	-0.006	ND	-0.007	ND	0.3	0.004	0.43	0.56	1.01	0.80	NR	16	14	15	1.2	0.8	3	1.4	NR	1.4	2%	2%	1.5
205R01306	Ross Creek	37.24887	-121.91393	U	4/23/14	8.6	959	14.0	8.9	150	12	85	119	=	-0.040	ND	2.8	-0.01	ND	-0.005	ND	0.62	=	0.140	=	0.180	=	0.6	0.180	0.38	0.50	0.57	0.67	NR	2	2	1	3.3	0.1	22	1.2	NR	1.4	31%	73%	8.9
205R00979	Lower Silver Creek	37.35432	-121.84674	U	4/24/14	13.3	950	18.3	8.1	130	16	1034	137	=	0.088	DNQ	3.2	2.90	=	0.052	=	0.97	=	0.013	=	0.091	=	3.9	0.091	0.46	0.17	1.05	0.58	NR	4	2	16	3.2	0.5	7	1.7	NR	1.1	24%	47%	6.8
205R00915	Thompson Creek	37.31470	-121.79623	U	4/24/14	7.2	2	14.9	8.1	340	26	224	47	=	0.077	DNQ	2.4	1.70	=	-0.005	ND	0.53	=	0.200	=	0.200	=	2.2	0.200	0.43	0.27	0.86	0.53	NR	9	4	3	2.8	0.4	26	1.9	NR	1.5	16%	30%	4.5
205R01098	Guadalupe Creek	37.20961	-121.90311	U	4/30/14	9.6	675	16.0	8.0	18	13	405	49	=	0.055	DNQ	1.5	0.19	=	-0.005	ND	0.70	=	0.023	=	0.033	=	0.9	0.033	0.89	0.80	0.91	0.95	NR	2	2	2	3.0	0.4	20	1.8	NR	1.5	1%	0%	1.3
205R00330	Hicks Creek	37.19830	-121.90095	NU	4/30/14	9.7	437	13.2	8.0	9	17	35	27	=	-0.040	ND	0.4	0.06	=	-0.005	ND	0.40	=	0.022	=	0.026	=	0.5	0.026	1.21	1.00	1.14	1.20	NR	15	16	15	0.7	1.0	1	1.4	NR	1.4	1%	0%	0.5
205R00362	Lyndon Canyon Creek	37.21976	-122.05622	NU	5/1/14	9.7	356	12.2	7.6	10	25	37	14	=	-0.040	ND	0.2	0.09	=	-0.005	ND	0.31	=	0.160	=	0.180	=	0.4	0.180	1.15	1.22	1.20	0.99	NR	20	19	16	0.3	0.8	7	1.1	NR	1.7	12%	2%	1.1
205R01027	Guadalupe River	37.35694	-121.91432	U	5/5/14	6.4	907	17.7	7.2	58	21	59	-3	ND	0.130	=	0.7	2.30	=	-0.005	ND	0.62	=	0.038	=	0.051	=	2.9	0.051	0.52	0.64	0.97	0.57	NR	10	10	10	2.1	0.8	46	1.8	NR	1.3	25%	42%	6.7
205R01091	Saratoga Creek	37.35755	-121.97317	U	5/5/14	19.4	123	19.9	7.8	85	15	440	170	=	0.055	DNQ	1.2	0.08	=	-0.005	ND	0.48	=	0.008	DNQ	0.021	=	0.6	0.021	0.31	0.73	0.52	0.94	NR	9	3	2	3.0	0.0	33	0.9	NR	1.4	25%	47%	6.6
205R00394	Austrian Gulch	37.13670	-121.92300	NU	5/12/14	10.4	286	10.9	7.8	5	20	191	20	=	-0.040	ND	0.2	-0.01	ND	-0.005	ND	0.22	=	0.010	=	0.007	DNQ	0.2	0.007	1.23	1.13	1.00	0.98	NR	20	18	11	0.7	0.7	10	1.1	NR	1.9	1%	0%	2.0
205R00883	Adobe Creek	37.37074	-122.11770	U	5/13/14	9.3	601	17.7	7.9	72	25	95	32	=	-0.040	ND	0.4	0.44	=	-0.005	ND	0.44	=	0.066	=	0.074	=	0.9	0.074	0.72	0.67	1.00	0.64	NR	16	8	5	2.5	0.4	31	1.8	NR	1.4	8%	29%	3.1
205R00322	Arroyo Aguague	37.36018	-121.73720	NU	5/14/14	8.5	508	16.6	7.9	19	15.6	19	14	=	-0.002	ND	-0.1	-0.01	ND	-0.002	ND	0.18	=	0.028	=	0.020	=	0.2	0.020	0.53	1.00	0.97	1.09	NR	19	14	15	0.3	0.3	12	1.8	NR	1.7	1%	0%	0.2
205R01187	Stevens Creek	37.30299	-122.07446	U	5/14/14	7.7	756	13.8	7.4	25	18	183	32	=	0.190	=	1.1	0.62	=	0.019	DNQ	0.57	=	0.020	=	0.073	=	1.2	0.073	0.43	0.41	1.28	0.56	NR	19	12	1	0.9	0.8	38	2.1	NR	1.8	2%	2%	1.2
205R01443	Stevens Creek	37.31477	-122.06168	U	5/14/14	8.8	752	17.8	7.8	27	13	439	98	=	-0.040	ND	0.3	0.12	=	-0.005	ND	0.26	=	0.032	=	0.044	=	0.4	0.044	0.68	0.80	1.20	0.89	NR	15	12	4	2.9	0.7	40	1.8	NR	1.8	2%	4%	1.3
205R01299	Arroyo Aguague	37.39816	-121.78614	U	5/15/14	8.6	779	13.3	7.7	18	11	115	156	=	-0.040	ND	0.2	0.05	DNQ	-0.005	ND	-0.07	ND	0.051	=	0.058	=	0.1	0.058	0.96	1.32	0.98	1.01	NR	20	18	13	0.6	0.6	6	1.6	NR	1.7	1%	1%	0.3
204R00221	Valpe Creek	37.47092	-121.66640	NU	5/19/14	10.2	343	11.0	8.1	9	15.2	25	15	=	-0.002	ND	-0.1	0.01	DNQ	-0.002	ND	0.17	=	0.022	=	0.023	=	0.2	0.023	0.96	1.13	0.95	1.00	NR	19	17	16	0.0	0.6	10	1.7	NR	1.7	2%	0%	0.4
205R01539	Los Gatos Creek	37.31488	-121.90380	U	5/20/14	9.4	392	19.2	7.9	16	11	483	43	=	-0.040	ND	0.5	0.01	DNQ	-0.005	ND	0.48	=	0.016	=	0.033	=	0.5	0.033	0.58	0.60	1.13	0.64	NR	10	10	8	3.0	0.5	17	1.7	NR	1.4	17%	29%	5.1
205R01226	Los Gatos Creek	37.29782	-121.92913	U	5/20/14	8.7	505	19.2	8.1	15	11	121	101	=	-0.040	ND	0.8	-0.01	ND	-0.005	ND	0.48	=	0.015	=	0.037	=	0.5	0.037	0.54	0.85	0.91	0.79	NR	10	12	14	3.5	0.8	35	1.7	NR	1.7	13%	22%	4.2
205R01434	Arroyo Calero	37.21412	-121.83444	U	5/21/14	8.7	439	15.4	7.7	59	38	427	75	=	-0.040	ND	0.3	0.57	=	-0.005	ND	0.18	=	0.059	=	0.057	=	0.8	0.057	0.75	1.04	1.17	0.83	NR	15	14	6	1.6	0.6	31	1.9	NR	1.9	3%	7%	2.2
205R00401	MF Coyote Creek	37.17775	-121.49713	NU	5/29/14	6.5	444	18.3	7.6	13	14.6	22	21	=	-0.002	ND	0.0	-0.01	ND	-0.002	ND	0.08	DNQ	0.018	=	*0.005*	DNQ	0.1	*0.005*	0.77	1.10	0.74	1.01	NR	19	14	17	0.3	0.5	16	1.4	NR	1.6	1%	0%	0.2
204R00365	Arroyo Hondo	37.45117	-121.75464	NU	6/2/14	9.2	466	15.2	8.2	10	14.6	27	39	=	0.003	DNQ	0.1	0.01	DNQ	-0.002	ND	0.09	DNQ	0.037	=	0.017	=	0.1	0.017	1.09	1.14	0.80	1.00	NR	20	19	19	0.1	0.8	8	1.2	NR	1.8	1%	0%	0.4
205R00097	Coyote Creek	37.12126	-121.48027	NU	6/3/14	7.2	631	19.0	8.1	16	11.5	24	39	=	0.005	DNQ	0.2	-0.01	ND	-0.002	ND	0.50	=	0.017	=	*0.009*	DNQ	0.5	*0.009*	0.54	0.96	0.71	0.86	NR	13	17	17	0.5	0.7	17	1.6	NR	1.7	2%	0%	0.2

Site Information						Water Quality						Water Chemistry (nutrients)																		Biological and Physical Habitat Indicator Scores					Physical Habitat									Land Use Variables		
Station Code	Creek Name	Latitude	Longitude	Land Use	Sample Date	Dissolved Oxygen (mg/L)	Spec Conductance (uS/cm)	Temperature (Deg C)	pH	Chloride (mg/L)	Silica (mg/L)	Ash Free Dry Mass (g/m2)	Chlorophyll a (mg/m2)	QA Flag	Ammonia (mg/L)	QA Flag	UIA (ug/L)	Nitrate as N (mg/L)	QA Flag	Nitrite as N (mg/L)	QA Flag	TKN as N (mg/L)	QA Flag	Ortho Phosphate as P (mg/L)	QA Flag	Total Phosphorus as P (mg/L)	QA Flag	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	CSCI	ASCI_D	ASCI_SB	ASCI_H	IPI	Channel Alteration	Epifaunal Substrate	Sediment Deposition	Human Disturbance Index	Evenness Flow Habitat	% Substrate <2 mm	Shannon Diversity Habitat	Sum Riparian Cover	Shannon Diversity Substrate	% Impervious (wat)	% Urban (wat)	Road Density (wat)
205R01562	Shannon Creek	37.21995	-121.92418	U	4/16/15	7.6	793	12.9	7.6	45	26	229	11	=	-0.040	ND	0.2	-0.01	ND	-0.005	ND	0.88	=	0.024	=	0.023	=	0.9	0.023	0.45	0.88	1.08	0.77	NR	16	12	13	2.4	1.0	21	1.6	NR	1.4	3%	14%	4.0
205R02154	Wildcat Creek	37.24502	-122.03136	U	4/16/15	9.4	520	13.3	8.2	15	24	148	5	=	-0.040	ND	0.6	-0.01	ND	-0.005	ND	0.40	=	0.022	=	0.016	=	0.4	0.016	0.71	0.77	1.12	1.04	NR	15	15	9	1.3	0.7	29	1.6	NR	1.9	2%	7%	1.3
204R00253	Isabel Creek	37.37893	-121.68361	NU	4/20/15	9.6	430	16.8	8.1	9	12	16	6	=	0.130	=	4.3	-0.01	ND	-0.005	ND	0.62	=	-0.006	ND	0.018	=	0.6	0.018	0.68	1.15	1.06	1.12	NR	20	17	18	0.4	0.8	14	1.7	NR	1.8	1%	0%	0.4
205R02074	Golf Creek	37.23195	-121.87455	U	4/21/15	14.8	1434	23.2	8.8	150	24	99	26	=	0.140	=	27.2	0.43	=	-0.005	ND	1.00	=	0.058	=	0.084	=	1.4	0.084	0.43	0.33	0.81	0.54	NR	3	3	6	5.0	0.1	17	1.1	NR	1.2	26%	54%	7.9
205R01962	Sobey Creek	37.26295	-121.99919	U	4/21/15	8.6	1240	13.8	8.0	210	35	61	7	=	0.140	=	2.8	0.36	=	-0.005	ND	0.62	=	0.071	=	0.085	=	1.0	0.085	0.38	0.70	1.15	0.73	NR	11	7	9	3.5	0.8	33	1.8	NR	1.5	16%	100%	6.6
205R01882	Alamitos Creek	37.23577	-121.87047	U	4/27/15	5.9	867	16.6	7.3	78	26	38	183	=	0.044	DNQ	0.2	1.70	=	-0.005	ND	0.57	=	0.012	=	0.013	=	2.3	0.013	0.60	0.69	0.62	0.73	NR	12	13	11	2.1	0.8	23	1.2	NR	1.9	9%	19%	3.2
205R01738	Ross Creek	37.23844	-121.94789	U	4/27/15	8.5	1162	16.7	8.1	85	36	17	40	=	-0.040	ND	0.6	0.95	=	0.006	DNQ	1.10	=	0.230	=	0.230	=	2.1	0.230	0.44	0.43	0.83	0.74	NR	6	15	6	4.9	0.8	20	1.8	NR	1.8	22%	62%	7.5
205R01610	Los Gatos Creek	37.15754	-121.97052	U	4/28/15	10.2	403	12.3	8.0	8	17	150	9	=	0.055	DNQ	1.0	0.05	DNQ	-0.005	ND	0.53	=	0.016	=	0.017	=	0.6	0.017	1.05	0.94	1.28	0.85	NR	18	17	8	0.8	0.6	31	1.5	NR	1.9	3%	4%	1.5
205R01706	Saratoga Creek	37.26485	-122.02638	U	4/28/15	10.2	597	16.6	8.2	32	23	48	84	=	0.044	DNQ	1.7	0.12	=	-0.005	ND	0.44	=	0.043	=	0.040	=	0.6	0.040	0.72	0.80	0.98	0.87	NR	12	13	14	2.9	0.9	20	1.7	NR	1.7	6%	13%	2.2
205R01715	Hale Creek	37.35606	-122.11071	U	4/29/15	7.0	1406	14.1	7.8	110	30	672	101	=	0.150	=	1.9	-0.01	ND	-0.005	ND	0.97	=	0.061	=	0.064	=	1.0	0.064	0.46	0.56	0.74	0.64	NR	18	6	3	1.9	0.0	49	1.8	NR	1.2	11%	59%	5.5
205R02119	Los Trancos Creek	37.36044	-122.20276	U	4/29/15	8.0	590	16.4	8.0	29	18	63	7	=	-0.040	ND	0.5	-0.01	ND	-0.005	ND	0.20	=	0.009	DNQ	0.012	=	0.2	0.012	0.68	0.37	1.07	0.81	NR	14	11	7	2.4	0.7	9	1.1	NR	1.7	4%	13%	1.5
205R02211	Stevens Creek	37.30555	-122.07191	U	5/14/15	10.3	481	12.7	7.9	17	18	762	73	=	0.160	=	2.5	0.33	=	-0.005	ND	0.66	=	0.029	=	0.052	=	1.0	0.052	0.41	0.76	1.16	0.65	NR	16	11	5	1.9	0.9	36	1.7	NR	1.5	2%	2%	1.2
205R01315	Coyote Creek	37.32263	-121.85837	U	5/18/15	3.3	1236	15.7	7.6	83	19	302	15	=	0.200	=	1.9	0.29	=	0.025	DNQ	1.00	=	0.210	=	0.230	=	1.3	0.230	0.30	0.36	0.87	0.34	NR	13	7	8	2.4	0.4	20	1.9	NR	1.6	6%	6%	1.4
205R01747	Lower Silver Creek	37.35223	-121.84211	U	5/18/15	9.9	1320	17.1	8.2	110	27	350	-7	ND	0.220	=	8.3	2.80	=	0.045	=	0.57	=	0.050	=	0.130	=	3.4	0.130	0.37	0.39	1.02	0.54	NR	11	9	13	3.6	0.6	66	1.9	NR	1.4	23%	46%	6.7
205R02051	Guadalupe River	37.34548	-121.90422	U	5/19/15	3.1	1360	16.2	7.8	180	20	217	16	=	0.220	=	3.2	0.67	=	0.016	DNQ	0.62	=	0.200	=	0.220	=	1.3	0.220	0.32	0.71	0.72	0.56	NR	8	9	12	2.3	0.6	16	1.9	NR	1.7	24%	41%	6.5
205R01411	San Tomas Aquino	37.38842	-121.96863	U	5/19/15	11.7	967	18.6	8.3	59	15	87	108	=	0.180	=	11.2	0.17	=	-0.005	ND	0.44	=	0.046	=	0.056	=	0.6	0.056	0.42	0.55	0.42	0.63	NR	5	3	1	4.6	0.4	23	1.1	NR	1.5	39%	72%	9.2
205R01669	Coyote Creek	37.16628	-121.64787	U	5/20/15	9.6	643	15.2	8.1	100	16	175	56	=	0.044	DNQ	1.2	0.64	=	-0.005	ND	0.40	=	0.088	=	0.096	=	1.0	0.096	0.63	0.84	0.85	0.80	NR	13	16	13	3.1	0.8	28	1.9	NR	1.8	3%	0%	0.5
205R01923	Lower Penitencia Cr	37.42266	-121.90707	U	5/21/15	10.4	1467	18.7	8.2	110	14	199	50	=	0.099	DNQ	5.1	0.15	=	-0.005	ND	0.53	=	0.015	=	0.021	=	0.7	0.021	0.29	0.44	0.88	0.65	NR	2	1	1	4.0	0.1	40	1.4	NR	1.4	69%	96%	12.5
205R01930	Los Gatos Creek	37.26308	-121.95209	U	5/26/15	8.2	479	18.3	7.8	21	12	63	45	=	0.044	DNQ	1.0	0.04	DNQ	-0.005	ND	0.88	=	0.020	=	0.035	=	0.9	0.035	0.34	0.69	0.69	0.72	NR	14	16	9	1.7	0.9	33	1.8	NR	1.6	8%	15%	3.4
205R02307	Los Gatos Creek	37.29904	-121.92683	U	5/26/15	10.2	495	20.7	8.2	20	7.5	44	87	=	-0.040	ND	1.2	-0.01	ND	-0.005	ND	0.53	=	0.026	=	0.051	=	0.5	0.051	0.56	0.82	1.03	1.05	NR	13	17	11	3.1	0.6	17	1.6	NR	1.7	13%	22%	4.2
205R00593	Soda Springs Canyon	37.16919	-121.50815	NU	5/28/15	9.0	922	13.4	7.9	19	20.4	46	12	=	-0.002	ND	0.0	-0.01	ND	-0.002	ND	0.11	=	0.046	=	0.026	=	0.1	0.026	0.52	0.78	1.03	1.04	NR	17	16	15	0.9	0.6	8	1.8	NR	1.8	1%	0%	1.1
205R00657	MF Coyote Creek	37.17992	-121.50095	NU	6/2/15	8.3	502	20.7	7.7	11	12.9	15	17	=	0.005	DNQ	0.1	-0.01	ND	0.003	DNQ	0.20	=	0.011	=	0.007	DNQ	0.2	0.007	0.51	1.04	0.79	1.00	NR	16	13	15	0.9	0.5	19	1.8	NR	1.8	1%	0%	0.2
204R00893	Smith Creek	37.32471	-121.67017	NU	6/10/15	9.2	386	16.6	8.0	7	19.6	26	101	=	0.012	DNQ	0.4	0.05	=	-0.002	ND	0.18	=	0.028	=	0.024	=	0.2	0.024	0.97	0.73	0.92	1.06	NR	15	16	17	1.3	0.8	5	1.9	NR	1.3	1%	0%	0.5
205R00578	Arroyo Aguague	37.34925	-121.71812	NU	4/26/16	7.9	305	13.9	7.6	13	13	72	9	=	-0.015	ND	0.1	-0.02	ND	-0.001	ND	0.40	=	0.030	=	0.044	=	0.4	0.044	0.74	0.87	1.28	0.92	1.03	17	10	10	1.0	0.4	17	1.7	172	1.5	1%	0%	0.0
205R00213	Cow Creek	37.26445	-121.65039	NU	4/27/16	10.5	492	10.7	8.2	16	16	14	1	=	-0.015	ND	0.2	-0.02	ND	-0.001	ND	-0.07	ND	0.006	DNQ	0.018	=	0.0	0.018	0.66	0.94	1.28	1.10	1.06	20	17	16	0.0	0.6	6	1.5	139	1.6	1%	0%	0.8
205R00305	San Felipe Creek	37.25626	-121.66266	NU	4/27/16	10.7	555	13.4	8.4	18	14	83	87	=	-0.015	ND	0.4	1.20	=	0.002	DNQ	0.26	=	0.024	=	0.040	=	1.5	0.040	0.89	0.68	0.98	0.91	1.19	16	7	5	0.2	0.7	18	1.9	166	1.6	1%	0%	0.9
205R02618	Aldercroft Creek	37.17623	-121.98942	U	5/2/16	10.9	575	11.7	8.0	15	23	10	4	=	0.015	DNQ	0.3	0.54	=	0.001	DNQ	0.48	=	0.081	=	0.087	=	1.0	0.087	0.83	0.93	NA	NA	1	17	15	10	1.3	0.7	16	1.7	138	1.7	4%	11%	2.5
205R01114	Guadalupe River	37.28534	-121.88298	U	5/3/16	9.4	547	18.9	8.3	41	8.8	224	47	=	0.022	=	1.3	0.03	DNQ	0.002	DNQ	0.48	=	0.016	=	0.086	=	0.5	0.086	0.39	0.72	0.66	0.68	0.92	6	12	15	2.9	0.8	29	1.1	106	1.5	17%	34%	5.2
205R02330	Ross Creek	37.25520	-121.90656	U	5/3/16	16.0	2848	25.2	9.1	670	16	22	66	=	0.025	=	9.3	0.15	=	0.001	DNQ	0.79	=	0.060	=	0.084	=	0.9	0.084	0.49	0.44	0.80	0.78	0.47	2	4	15	6.2	0.1	3	0.9	30	1.3	37%	79%	10.2
205R02422	Arroyo Calero	37.21059	-121.82717	U	5/4/16	8.8	489	15.8	7.7	37	17	421	75	=	0.024	=	0.3	0.26	=	0.004	DNQ	0.88	=	0.039	=	0.049	=	1.1	0.049	0.72	1.03	0.71	0.55	1	14	13	9	2.7	0.8	51	1.7	152	1.5	3%	5%	1.9
205R02458	Alamitos Creek	37.21897	-121.84321	U	5/4/16	10.4	472	16.7	8.1	28	18	34	35	=	0.033	=	1.2	0.14	=	0.003	DNQ	0.57	=	0.030	=	0.037	=	0.7	0.037	0.61	0.92	0.91	0.91	1.05	14	10	7	3.1	0.7	38	1.9	128	1.7	4%	8%	1.9
205R01731	Upper Penitencia Cr	37.39265	-121.83477	U	5/5/16	10.3	876	15.7	8.7	50	15	55	-4	ND	0.027	=	2.8	0.19	=	0.004	DNQ	1.10	=	0.020	=	0.026	=	1.3	0.026	0.63	0.60	0.64	0.79	0.91	11	10	15	3.9	0.7	17	1.7	72	1.5	2%	4%	0.9
205R02835	Upper Penitencia Cr	37.39658	-121.80390	U	5/5/16	10.0	794	13.8	8.2	37	15	248	74	=	0.170	=	6.2	0.30	=	0.035	=	0.97	=	0.030	=	0.042	=	1.3	0.042	0.79	0.76	1.01	0.79	0.98	7	17	13	2.8	0.9	27	1.5	95	1.9	2%	2%	0.7
205R02474	Saratoga Creek	37.25819	-122.03437	U	5/18/16	9.9	526	14.6	8.0	20	20	30	14	=	-0.015	ND	0.2	0.06	=	0.002	DNQ	0.57	=	0.042	=	0.044	=	0.6	0.044	0.82	0.77	0.81	1.10	1.07	15	16	14	3.6	0.6	16	1.9	149	1.7	5%	10%	2.0
205R02538	Calabazas Creek	37.27538	-122.04225	U	5/18/16	8.7	1108	20.1	8.0	96	16	63	13	=	-0.015	ND	0.2	-0.02	ND	0.001	DNQ	0.53	=	0.032	=	0.019	=	0.5	0.019	0.57	0.61	0.81	0.87	0.88	13	7	8	2.4	0.6	19	1.5	120	1.4	6%	33%	4.2
205R02563	Los Gatos Creek	37.32924	-121.89960	U	5/19/16	12.1	498	21.4	8.8	43	10	39	145	=	-0.015	ND	1.4	0.66	=	0.003	DNQ	0.62	=	0.021	=	0.033	=	1.3	0.033	0.52	0.80	0.86	0.93	0.9	13	12	9	3.7	0.9	26	1.1	87	1.7	18%	30%	5.3
205R02659	Stevens Creek	37.34474	-122.06417	U	5/19/16	9.6	467	15.7	8.4	17	18	72	10	=	0.390	=	21.8	0.09	=	0.014	=	0.62	=	0.028	=	0.072	=	0.7	0.072	0.62	0.43	0.81	0.60	1.03	12	10	9	1.8	0.8	22	1.8	125	1.6	8%	13%	2.5
205R02650	Alamitos Creek	37.22150	-121.84700	U	5/31/16	9.0	492	16.4	7.9	38	18	186	71	=	0.021	=	0.5	0.18	=	0.002	DNQ	0.62	=	0.034	=	0.037	=	0.8	0.037	0.73	0.78	1.15	0.87	1.1	15	15	12	2.7	0.8	35	1.8	136	1.8	5%	10%	2.1
205R02547	Stevens Creek	37.31243	-122.16309	U	6/1/16	10.2	534	12.6	8.2	12	18	14	15	=	0.029	=	0.8	-0.02	ND	-0.001	ND	0.70	=	0.025	=	0.024	=	0.7	0.024	0.96	0.98	1.12	0.98	1.18	20	17	6	0.1	0.8	7	1.7	171	1.7	2%	1%	1.0
205R02730	Saratoga Creek	37.28141	-122.00642	U	6/1/16	10.3	501	20.1	8.4	71	10	158	96	=	0.069	=	5.2	0.22	=	-0.001	ND	0.79	=	0.098	=	0.110	=	1.0	0.110	0.29	0.76	0.52	0.77	1	11	11	10	3.1	0.8	23	1.7	124	1.5	11%	22%	3.4
205R02602	Unnamned Tributary	37.23547	-122.00528	U	6/2/16	8.9	468	15.8	7.6	18	23	195	12	=	0.028	=	0.3	0.41	=	-0.001	ND	0.40	=	0.200	=	0.017	=	0.8	0.017	0.93	1.09	1.28	1.09	0.95	13	15	11	3.4	0.7	8	1.9	103	1.4	4%	20%	3.1
205R02762	Ross Creek	37.23593	-121.95184	U	6/2/16	11.7	1013	18.7	8.3	96	35	63	223	=	0.036	=	2.1	1.60	=	0.009	=	1.10	=	0.036	=	0.200	=	2.7	0.200	0.30	0.20	0.85	0.65	0.64	11	8	11	4.1	0.1	32	1.6	73	1.6	23%	64%	7.6
205R02771	Lower Silver Creek	37.35228	-121.83543	U	6/3/16	9.0	1364	20.9	8.1	120	24	736	123	=	0.098	=	4.1	3.40	=	0.031	=	1.10	=	0.200	=	0.082	=	4.5	0.082	0.49	0.50	1.12	0.57	0.68	5	9	10	4.0	0.6	39	1.6	25	1.9	21%	43%	6.2
205R02755	Berryessa Creek	37.42093	-121.84015	U	5/8/17	11.1	590	10.9	8.5	25	31	290	16	=	0.220	=	11.7	0.71	=	0.007	=	0.62	=	0.180	=	0.210	=	1.3	0.210	0.93	0.41	NA	NA	0.98	20	12	13	0.5	1.0	28	1.4	112	1.9	1%	3%	0.7
205R03011	Berryessa Creek	37.41123	-121.85857	U	5/8/17	8.1	614	20.4	8.7	27	30	260	5	=	0.270	=	42.9	0.43	=	0.005	=	0.62	=	0.130	=	0.180	=	1.1	0.180	0.80	0.86	NA	NA	0.89	11	8	10	3.0	1.0	41	1.7	110	1.5	4%	8%	1.5
205R03306	Saratoga Creek	37.27739	-122.01172	U	5/9/17	11.5	458	12.6	8.3	21	24	90	17	=	0.049	=	1.8	0.18	=	0.001	DNQ	0.48	=	0.047	=	0.065	=	0.7	0.065	0.87	0.65	NA	NA	1.04	14	14	10	3.1	1.0	49	1.7	134	1.6	8%	17%	2.7
205R00609	Hunting Hollow	37.07372	-121.46027	NU	5/10/17	9.1	618	15.1	8.0	28	17	21	12	=	0.058	=	1.4	-0.02	ND	-0.001	ND	0.97	=	0.010	=	0.015	=	1.0	0.015	0.66	0.83	0.81	1.04	0.87	20	16	9	0.8	0.5	33	1.2	108	1.8	2%	0%	0.3
205R02947	Lower Penitencia Cr	37.42918	-121.90895	U	5/11/17	1.9	1386	23.3	8.4	120	16	218	52	=	0.047	=	4.4	0.22	=	0.013	=	0.66	=	0.013	=	0.012	=	0.9	0.012	0.27	0.42	0.58	0.59	0.23	4	3	2	3.5	0.0	94	0.8	36	0.9	69%	96%	12.3
205R03523	Upper Penitencia Cr	37.39339	-121.83237	U	5/11/17	7.2	788	13.8	8.5	41	17	44	42	=	0.038	=	2.5	0.19	=	0.007	=	0.66	=	0.036	=	0.043	=	0.9	0.043	0.91	0.40	0.78	0.71	0.99	12	14	15	2.5	1.0	42	1.9	104	1.7	3%	6%	0.8
205R00645	Packwood Creek	37.17072	-121.61339	NU	5/15/17	10.8	576	11.7	8.4	19	17	173	21	=	-0.015	ND	0.4	1.80	=	0.002	DNQ	0.44	=	0.015	=	0.019	=	2.2	0.019	0.75	0.77	0.78	0.57	1.12	20	16	13	0.1	1.0	22	1.4	141	1.7	1%	0%	0.4
205R02693	Packwood Creek	37.17479	-121.61669	U	5/15/17	4.9	579	15.6	8.5	19	17	62	12	=	-0.015	ND	0.5	1.70	=	0.003	DNQ	0.31	=	0.015	=	0.024	=	2.0	0.024	0.62	0.46	1.07	0.64	0.76	20	9	4	1.3	0.8	49	1.3	60	1.5	1%	0%	0.4
205R03386	Aldercroft Creek	37.17676	-121.99588	U	5/16/17	3.6	320	11.4	8.1	16	26	49	4	=	0.068	=	1.4	0.10	=	0.003	DNQ	0.22	=	0.110	=	0.140	=	0.3	0.140	1.00	0.71	NA	NA	0.99	19	14	10	1.4	0.9	24	1.7	126	1.6	4%	5%	0.8
205R00570	Trib to Aldercroft Creek	37.18146	-122.00217	NU	5/16/17	5.7	738	10.6	8.0	14	27	278	9	=	0.054	=	1.0	0.06	=	0.003	DNQ	0.13	=	0.120	=	0.140	=	0.2	0.140	0.95	0.99	1.28	1.00	0.83	14	13	4	2.7	0.7	43	1.9	103	1.5	1%	0%	3.3
205R03091	Arroyo Aguague	37.39925	-121.78563	U	5/18/17	10.7	670	10.5	8.5	22	16	2	5	=	0.017	DNQ	0.8	-0.02	ND	0.001	DNQ	0.31	=	0.033	=	0.033	=	0.3	0.033	1.01	0.88	NA	NA	0.91	19	17	14	0.1	0.6	14	0.8	119	1.8	1%	1%	0.3
205R03443	Calabazas Creek	37.38864	-121.98684	U	6/1/17	19.6	703	30.4	9.0	83	20	136	196	=	0.110	=	45.9	1.40	=	0.035	=	1.70	=	-0.006	ND	0.014	=	3.1	0.014	0.45	0.86	0.39	0.96	0.44	0	2	14	6.0	1.0	21	0.2	22	0.8	49%	84%	10.4
205R02787	Matedero Creek	37.43220	-122.12484	U	6/1/17	12.9	1218	19.9	8.5	110	31	253	140	=	0.082	=	7.2	2.10	=	0.025	=	0.92	=	0.064	=	0.070	=	3.0	0.070	0.49	0.37	0.52	0.52	0.28	0	2	14	5.2	1.0	34	0.2	27	0.5	30%	65%	7.0
205R02915	Stevens Creek	37.30693	-122.06925	U	6/5/17	9.7	504	15.3	8.0	22	18	47	79	=	0.081	=	2.1	0.03	DNQ	-0.001	ND	0.57	=	0.024	=	0.066	=	0.6	0.066	0.58	0.79	0.63	0.95	1.02	20	17	14	0.9	0.8	41	2.0	136	1.5	2%	2%	1.2
205R03235	Stevens Creek	37.33467	-122.06433	U	6/5/17	11.5	519	16.6	8.5	24	17	42	117	=	0.061	=	4.5	0.08	=	0.010	=	0.44	=	0.022	=	0.052	=	0.5	0.052	0.86	0.88	0.62	0.91	0.9	4	6	14	3.0	0.9	31	1.5	122	1.4	4%	7%	1.7
205R03354	Guadalupe Creek	37.21237	-121.90860	U	6/6/17	10.1	346	13.7	8.2	7	16	30	19	=	0.056	=	1.9	0.04	DNQ	0.002	DNQ	0.88	=	0.011	=	0.015	=	0.9	0.015	1.03	0.89	1.28	0.86	0.96	14	17	16	2.8	0.6	23	1.7	110	1.7	1%	0%	1.3
205R03098	Guadalupe Creek	37.24366	-121.87407	U	6/6/17	10.5	393	17.8	8.3	17	16	371	54	=	0.073	=	3.8	0.09	=	0.002	DNQ	0.53	=	0.011	=	0.025	=	0.6	0.025	0.70	0.74	0.65	0.63	0.98	16	15	11	1.9	1.0	25	1.5	110	1.5	6%	11%	2.7
205R03530	Los Gatos Creek	37.25194	-121.96387	U	6/7/17	9.4	331	18.5	8.2	9	17	209	152	=	0.140	=	6.5	0.03	DNQ	0.006	=	0.18	=	0.012	=	0.027	=	0.2	0.027	0.56	0.74	0.65	0.77	1.13	16	15	11	2.5	1.0	45	1.8	134	1.7	8%	14%	3.2
205R03331	Los Gatos Creek	37.30089	-121.91970	U	6/7/17	9.9	332	21.0	8.4	11	14	41	163	=	0.120	=	10.8	-0.02	ND	0.003	DNQ	0.18	=	0.016	=	0.029	=	0.2	0.029	0.59	0.81	0.67	0.93	1.03	14	15	16	3.3	0.7	15	1.4	124	1.6	14%	23%	4.4
205R03418	Alamitos Creek	37.22855	-121.86176	U	6/8/17	10.2	461	16.5	8.3	19	20	74	219	=	0.110	=	5.2	0.09	=	0.002	DNQ	0.57	=	0.022	=	0.033	=	0.7	0.033	0.70	0.73	0.75	0.67	0.91	11	14	9	3.8	0.8	28	1.0	90	1.8	7%	14%	2.6
205R03699	Hale Creek	37.36503	-122.09869	U	4/30/18	9.0	1959	12.0	8.1	200	32	74	18	=	0.099	DNQ	2.3	2.00	=	0.012	=	1.10	=	0.210	=	0.220	=	3.1	0.220	0.46	0.59	0.96	0.53	1	13	9	9	3.7	0.5	52	1.7	159	1.7	26%	83%	8.8
205R03683	Permanente Creek	37.33985	-122.09227	U	4/30/18	9.2	1143	14.5	8.0	200	16	81	189	=	-0.040	ND	0.5	0.13	=	-0.001	ND	0.40	=	0.190	=	0.035	=	0.5	0.035	0.91	0.60	0.96	0.71	1.08	9	14	11	2.2	0.6	38	1.9	157	1.7	11%	12%	1.3
205R03825	Thompson Creek	37.28066	-121.75540	U	5/1/18	8.5	746	14.0	8.1	100	27	135	96	=	-0.040	ND	0.6	1.30	=	-0.001	ND	0.48	=	0.056	=	0.053	=	1.8	0.053	0.43	0.19	0.78	0.54	1.03	18	10	13	1.6	1.0	50	1.6	153	1.3	6%	13%	2.4
205R03738	Upper Silver Creek	37.28625	-121.77794	U	5/1/18	8.4	1443	13.9	8.1	170	39	165	159	=	-0.040	ND	0.6	0.71	=	0.002	DNQ	0.57	=	0.150	=	0.170	=	1.3	0.170	0.47	0.56	0.96	0.47	1.15	17	14	12	1.5	0.9	34	1.9	153	1.8	9%	18%	3.4
205R04266	Calabazas Creek	37.29627	-122.02920	U	5/2/18	9.5	321	16.5	7.9	42	9.5	48	11	=	-0.040	ND	0.5	0.26	=	0.001	DNQ	0.44	=	0.093	=	0.092	=	0.7	0.092	0.51	0.80	1.28	0.69	1.04	14	6	10	3.1	0.8	24	1.8	125	1.5	12%	43%	5.0
205R03875	Calabazas Creek	37.31482	-122.01633	U	5/2/18	9.4	335	19.9	8.3	43	8.6	23	8	=	0.055	DNQ	4.1	0.22	=	-0.001	ND	0.13	=	0.076	=	0.062	=	0.4	0.062	0.46	0.58	0.81	0.81	0.65	12	5	5	3.4	0.1	39	1.7	70	1.3	27%	66%	8.4
205R04217	Upper Penitencia Cr	37.40062	-121.74909	U	5/3/18	9.7	376	12.6	7.6	12	13	102	24	=	0.055	DNQ	0.2	-0.02	ND	0.001	DNQ	0.13	=	0.035	=	0.034	=	0.1	0.034	1.04	0.81	1.28	1.01	0.97	NR	NR	NR	1.1	0.2	18	1.4	160	1.3	1%	0%	0.0
205R03591	Los Trancos Creek	37.35237	-122.19712	U	5/7/18	11.1	515	11.0	7.8	18	17	100	15	=	-0.040	ND	0.2	0.11	=	-0.001	ND	0.35	=	0.017	=	0.034	=	0.5	0.034	1.06	0.78	1.28	0.86	1.08	16	16	13	1.3	0.7	24	1.6	150	1.8	5%	13%	1.6

Site Information						Water Quality						Water Chemistry (nutrients)																		Biological and Physical Habitat Indicator Scores					Physical Habitat									Land Use Variables		
Station Code	Creek Name	Latitude	Longitude	Land Use	Sample Date	Dissolved Oxygen (mg/L)	Spec Conductance (uS/cm)	Temperature (Deg C)	pH	Chloride (mg/L)	Silica (mg/L)	Ash Free Dry Mass (g/m2)	Chlorophyll a (mg/m2)	QA Flag	Ammonia (mg/L)	QA Flag	UIA (ug/L)	Nitrate as N (mg/L)	QA Flag	Nitrite as N (mg/L)	QA Flag	TKN as N (mg/L)	QA Flag	Ortho Phosphate as P (mg/L)	QA Flag	Total Phosphorus as P (mg/L)	QA Flag	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	CSCI	ASCI_D	ASCI_SB	ASCI_H	IPI	Channel Alteration	Epifaunal Substrate	Sediment Deposition	Human Disturbance Index	Evenness Flow Habitat	% Substrate <2 mm	Shannon Diversity Habitat	Sum Riparian Cover	Shannon Diversity Substrate	% Impervious (wat)	% Urban (wat)	Road Density (wat)
205R03847	Los Trancos Creek	37.38067	-122.19440	U	5/7/18	10.3	718	14.5	8.2	45	24	61	14	=	-0.040	ND	0.6	0.08	=	-0.001	ND	-0.07	ND	0.017	=	0.034	=	0.1	0.034	1.20	0.91	0.81	0.77	1.12	12	12	8	3.9	0.6	21	1.6	182	1.6	6%	20%	2.7
205R03754	San Tomas Aquino	37.25953	-121.99220	U	5/8/18	9.3	626	16.5	7.6	59	28	13	7	=	-0.040	ND	0.2	0.32	=	-0.001	ND	0.31	=	0.019	=	0.020	=	0.6	0.020	0.92	0.70	1.00	0.87	1.06	NR	NR	NR	3.3	0.7	18	1.6	150	1.4	11%	51%	5.1
205R03619	Saratoga Creek	37.30297	-121.99652	U	5/8/18	11.1	447	13.8	7.8	65	14	84	14	=	-0.040	ND	0.3	0.31	=	-0.001	ND	0.18	=	0.071	=	0.077	=	0.5	0.077	0.63	0.90	0.96	0.96	0.99	9	9	10	3.5	0.4	23	1.8	126	1.5	16%	32%	4.6
204R00749	Smith Creek	37.31672	-121.65056	NU	5/9/18	10.1	310	13.1	7.8	7	13	11	54	=	0.044	DNQ	0.6	0.06	=	-0.001	ND	0.09	DNQ	0.007	DNQ	0.007	DNQ	0.2	0.007	1.23	0.90	0.69	1.09	1.14	20	18	16	0.1	0.9	7	1.7	113	1.8	1%	0%	0.4
205R00769	MF Coyote Creek	37.21997	-121.54205	NU	5/10/18	9.0	328	12.9	7.6	8	13	9			-0.040	ND	0.2	0.07	=	-0.001	ND	0.13	=	-0.006	ND	-0.007	ND	0.2	0.004	0.74	1.20	0.91	1.10	1.15	20	18	18	0.2	0.8	16	1.6	139	1.8	1%	0%	0.2
205R03562	Saratoga Creek	37.25257	-122.04499	U	5/23/18	11.9	502	12.7	8.0	21	20	61	47	=	-0.040	ND	0.4	0.17	=	-0.001	ND	0.40	=	0.066	=	0.046	=	0.6	0.046	1.08	0.93	0.81	0.97	1.14	7	16	10	5.7	0.7	20	1.6	172	1.8	2%	5%	1.3
205R03498	Saratoga Creek	37.25746	-122.03630	U	5/23/18	11.3	507	13.9	8.3	22	20	106	46	=	-0.040	ND	0.9	0.14	=	-0.001	ND	0.40	=	0.060	=	0.064	=	0.5	0.064	1.14	0.92	0.78	0.89	1.19	15	12	9	3.1	1.0	28	1.9	142	1.8	3%	9%	1.8
205R00746	Saratoga Creek	37.25201	-122.06014	NU	5/24/18	11.4	462	12.2	8.0	16	23	38	89	=	-0.040	ND	0.4	0.21	=	-0.001	ND	0.40	=	0.072	=	0.046	=	0.6	0.046	1.12	0.78	1.07	0.98	1.05	19	15	13	1.6	0.6	19	1.6	119	1.9	2%	2%	1.1
205R04190	Guadalupe Creek	37.23516	-121.89115	U	5/29/18	11.7	750	17.6	7.2	34	16	36	266	=	1.000	=	4.8	0.10	=	0.001	DNQ	0.70	=	0.020	=	-0.007	ND	0.8	0.004	0.88	1.14	1.07	0.90	1.2	17	12	8	2.9	0.9	35	1.9	169	1.6	4%	8%	2.3
205R03843	San Tomas Aquino	37.38185	-121.96842	U	5/29/18	7.2	1020	19.7	7.8	34	18	228	261	=	1.200	=	23.6	0.10	=	0.006	=	0.75	=	0.013	=	0.046	=	0.9	0.046	0.39	0.51	0.26	0.44	0.93	3	7	6	3.3	0.8	27	1.1	100	1.4	37%	71%	9.1
205R03907	Lower Penitencia Cr	37.43624	-121.91423	U	5/30/18	8.3	1342	22.6	8.0	120	20	533	62	=	1.100	=	45.6	0.77	=	0.027	=	0.62	=	0.028	=	0.043	=	1.4	0.043	0.19	0.49	0.50	0.43	0.34	3	2	1	4.6	0.1	98	1.1	86	0.1	69%	96%	12.5
205R03795	Lower Silver Creek	37.35770	-121.85819	U	5/30/18	7.7	1540	19.9	7.5	140	27	305	89	=	0.920	=	8.7	8.00	=	0.017	=	0.13	=	0.032	=	-0.007	ND	8.1	0.004	0.40	0.40	0.34	0.44	0.8	4	7	4	4.5	0.9	77	1.4	118	1.1	25%	49%	7.1
205GUA251	Alamitos Creek	37.23306	-121.87054	U	4/29/19	9.8	509	14.8	8.1	28	21	133	184	=	0.330	=	8.9	0.32	=	0.003	DNQ	0.77	=	0.017	=	0.026	=	1.1	0.026	0.62	0.69	0.81	0.86	1	13	13	12	3.3	0.9	37	1.4	119	1.7	7%	15%	2.7
205R04537	Thompson Creek	37.27378	-121.74535	U	4/30/19	8.4	977	14.0	7.8	65	31	78	9	=	0.330	=	8.1	1.00	=	0.008	=	0.77	=	0.110	=	0.110	=	1.8	0.110	0.51	0.46	1.28	0.90	0.92	16	8	8	2.8	0.9	31	1.4	126	1.4	3%	5%	1.9
205R04418	Thompson Creek	37.29217	-121.76741	U	4/30/19	10.3	750	15.1	8.3	130	25	133	17	=	0.330	=	24.4	0.07	=	0.001	DNQ	0.77	=	0.095	=	0.097	=	0.8	0.097	0.38	0.62	0.86	0.62	0.88	14	10	8	1.1	0.4	31	1.7	125	1.7	11%	20%	3.3
205R04530	Upper Silver Creek	37.29639	-121.79295	U	5/1/19	11.5	1252	12.9	8.3	150	47	133	14	=	0.330	=	14.6	1.40	=	0.004	DNQ	0.61	=	0.150	=	0.150	=	2.0	0.150	0.53	0.72	0.37	0.65	0.99	15	9	7	3.0	0.9	35	1.7	145	1.5	18%	37%	5.9
205R04602	Wildcat Creek	37.26359	-122.01925	U	5/1/19	9.7	604	17.4	7.8	73	30	133	2	=	0.330	=	6.2	0.65	=	0.004	DNQ	0.25	=	0.150	=	0.029	=	0.9	0.029	0.50	0.73	0.96	0.83	0.9	8	10	8	3.1	0.7	35	1.7	130	1.5	16%	59%	5.3
205R04395	Arroyo De Los Coches	37.44464	-121.85645	U	5/2/19	11.0	908	11.9	8.3	71	47	427	20	=	0.330	=	32.5	2.10	=	0.006	=	0.83	=	0.230	=	0.360	=	2.9	0.360	0.67	0.91	1.28	0.72	0.85	17	18	5	1.9	0.6	47	1.6	123	1.7	2%	5%	2.5
205R04638	Guadalupe Creek	37.22823	-121.90335	U	5/6/19	10.8	370	12.2	8.2	10	19	13	184	=	0.410	=	12.3	0.10	=	0.002	DNQ	0.14	=	0.018	=	0.028	=	0.2	0.028	0.97	0.96	0.87	0.95	1.02	16	15	12	2.3	0.9	36	1.7	119	1.6	3%	5%	1.9
205R04591	San Tomas Aquino	37.39086	-121.96797	U	5/7/19	20.5	1064	25.4	8.4	81	21	224	184	=	0.340	=	39.3	0.45	=	0.028	=	0.80	=	0.007	DNQ	0.043	=	1.3	0.043	0.50	0.62	0.24	0.52	0.77	7	2	1	3.3	0.3	50	1.5	105	1.3	38%	71%	9.1
205R04614	San Tomas Aquino	37.27327	-121.98247	U	5/7/19	10.0	607	13.8	8.3	56	21	25	184	=	0.140	=	6.1	0.11	=	0.002	DNQ	0.25	=	0.015	=	0.020	=	0.4	0.020	0.63	0.62	0.81	0.72	0.91	7	7	10	3.6	0.4	13	1.5	138	1.4	21%	69%	6.3
205R04378	Los Gatos Creek	37.21733	-121.98670	U	5/8/19	10.7	753	11.9	8.1	7	21	10	93	=	0.250	=	6.1	0.19	=	0.003	DNQ	0.11	=	0.018	=	0.027	=	0.3	0.027	0.64	0.48	0.96	0.96	1.18	16	16	16	3.2	0.8	25	1.9	203	1.5	3%	7%	2.4
205GUA060	Los Gatos Creek	37.29109	-121.93488	U	5/8/19	8.5	367	20.0	8.2	7	21	57	62	=	0.270	=	14.8	0.07	=	0.003	DNQ	0.11	=	0.018	=	0.034	=	0.2	0.034	0.57	0.77	0.82	0.97	1.12	11	10	12	3.9	0.8	22	1.9	137	1.6	12%	21%	4.1
205R04670	Saratoga Creek	37.25116	-122.05508	U	5/9/19	11.1	415	12.5	8.4	13	21	113	184	=	0.280	=	14.3	0.16	=	0.001	DNQ	-0.07	ND	0.064	=	0.078	=	0.2	0.078	0.99	0.94	0.69	1.13	1.04	20	18	17	1.2	0.6	20	1.4	156	1.7	2%	3%	1.1
205R04271	Stevens Creek	37.30551	-122.15517	NU	6/3/19	10.0	547	12.6	8.3	14	16	200	8	=	0.780	=	29.8	0.03	DNQ	-0.001	ND	-0.07	ND	0.029	=	0.029	=	0.1	0.029	1.08	1.09	1.28	1.10	1.17	20	18	12	0.1	0.9	20	1.9	176	1.5	3%	2%	0.9
205COY455	Coyote Creek	37.16631	-121.64776	U	6/4/19	10.7	314	13.7	7.9	15	12	16	74	=	0.760	=	13.7	0.30	=	0.001	DNQ	0.33	=	0.019	=	0.041	=	0.6	0.041	0.58	0.84	0.95	1.00	1.1	15	15	16	3.4	0.9	22	1.9	100	1.7	1%	0%	0.5
205R04317	Coyote Creek	37.16628	-121.63747	U	6/4/19	9.2	315	11.6	7.7	15	12	48	92	=	0.830	=	7.6	0.33	=	0.001	DNQ	0.22	=	0.017	=	0.042	=	0.6	0.042	0.54	0.95	1.10	1.13	1.06	12	13	15	3.8	0.9	20	1.7	126	1.3	1%	0%	0.5
205R04247	Stevens Creek	37.32635	-122.06019	U	6/5/19	12.0	495	17.2	8.3	19	20	106	154	=	0.920	=	55.7	0.10	=	0.001	DNQ	0.28	=	0.038	=	0.074	=	0.4	0.074	0.65	0.97	0.87	1.01	1.1	11	12	7	3.3	0.8	14	1.8	140	1.4	3%	6%	1.6
205STE070	Stevens Creek	37.30275	-122.07486	U	6/5/19	8.3	471	15.2	7.8	15	20	38	153	=	0.790	=	13.1	0.03	DNQ	-0.001	ND	0.19	=	0.040	=	0.082	=	0.2	0.082	0.44	0.66	1.02	1.11	1.13	18	7	13	0.5	0.8	18	1.8	157	1.5	2%	2%	1.2
205R04383	San Francisquito Cr	37.45383	-122.16170	U	6/6/19	6.3	796	18.1	8.3	56	11	47	110	=	0.058	=	3.7	0.30	=	0.006	=	0.28	=	0.018	=	0.026	=	0.6	0.026	0.47	0.79	0.90	0.86	0.79	2	6	2	3.6	0.0	23	1.4	140	1.4	13%	34%	3.8
205R04359	Adobe Creek	37.42669	-122.10509	U	6/12/19	8.2	989	21.2	8.1	73	25	135	64	=	0.200	=	8.9	2.20	=	0.072	=	0.63	=	0.030	=	0.061	=	2.9	0.061	0.32	0.61	0.53	0.68	0.13	0	1	2	7.2	0.1	95	1.0	25	0.1	25%	56%	6.6
205R04479	Saratoga Creek	37.35436	-121.97327	U	6/12/19	10.8	1093	23.0	7.9	95	19	42	36	=	0.061	=	2.1	1.60	=	0.019	=	0.19	=	0.016	=	0.026	=	1.8	0.026	0.58	0.53	0.53	0.80	0.75	4	4	11	5.0	0.1	25	1.1	111	1.4	25%	47%	6.6

Land Use: U - Urban, NU - Non-urban
QA Flag: ND - Non-detect (used ½ value of the method detection limit), DNQ - Detected Not Quantifiable (used measured value)
NR - Not Recorded
UIA- Un-ionized Ammonia
TKN - Total Kjeldahl Nitrogen
CSCI - California Stream Index
ASCI_D - Algae Stream Condition Index (Diatoms)
ASCI_H - Algae Stream Condition Index (Hybrid)
ASCI_SB - Algae Stream Condition Index (Soft Body)
IPI - Index Physical Habitat Integrity