Santa Clara Valley
Urban Runoff
Pollution Prevention Program

Watershed Monitoring and Assessment Program

Urban Creeks Monitoring Report
Part A: Creek Status and Pesticides & Toxicity Monitoring

Water Year 2020 (October 2019 – September 2020)

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

March 31, 2021

EOA inc.

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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
CCCWP	Contra Costa Clean Water Program
CDC	Center for Disease Control
CDFW	California Department of Fish and Wildlife
CEDEN	California Environmental Data Exchange Network
COLD	Cold Freshwater Habitat
CSCI	California Stream Condition Index
D_ASCI	Diatom Algae 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
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
MPC	Monitoring and Pollutants of Concern Committee
MPN	Most Probable Number
MQO	Measurement Quality Objective
MRP	Municipal Regional Permit
MS4	Municipal Separate Storm Sewer System
MUN	Municipal and Domestic Water Supply Beneficial Use
MWAT	Maximum Weekly Average Temperature
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
REC-1	Water Contact Recreation
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
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

1.0 INTRODUCTION

This *Urban Creeks Monitoring Report (UCMR) Part A: Creek Status and Pesticides & Toxicity Monitoring*, *Water Year*[1] *(WY) 2020* 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). The next iteration of the MRP (i.e., MRP 3.0) is currently being drafted and is anticipated to become effective July 1, 2022.

This report fulfills the requirements of provision C.8.h.iii of the MRP for interpreting and reporting all Creek Status and Pesticides & Toxicity monitoring data collected during WY 2020 by SCVURPPP. Data presented in this report were collected pursuant to water quality monitoring requirements in provisions C.8.d (Creek Status Monitoring) and C.8.g (Pesticides & Toxicity Monitoring) of the MRP.[2] 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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[1] 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 2020 (WY 2020) began on October 1, 2019 and concluded on September 30, 2020.

[2] Monitoring data collected pursuant to other C.8 provisions (e.g., Pollutants of Concern Monitoring, Stressor/Source Identification Monitoring Projects) are reported in other Parts of the SCVURPPP Urban Creeks Monitoring Report (UCMR) for WY 2020.

1.1 COVID-19 Emergency

During WY 2020, Program management activities were impacted by the COVID-19 public health emergency and issuance of State and local orders requiring that residents of Santa Clara County reduce the spread of the disease by staying home as much as possible. The County Shelter in Place (SIP) order has generally been more restrictive than the State order and has required extended restrictions for all activity, travel, and governmental and business functions not deemed "essential." On March 20, 2020, the State Water Resources Control Board (State Water Board) informed the regulated community, via a website post[3], that timely compliance with all Water Board orders, including NPDES Permits, is generally considered to be an essential function during the COVID-19 response. As a result, activities necessary to implement MRP monitoring requirements were conducted by SCVURPPP consistent with SIP directives and in consideration of the State Water Board communications.

To control the spread of COVID-19 during implementation of monitoring activities, Program staff developed Standard Operating Procedures (SOPs) based on Center for Disease Control (CDC) guidance. The SOPs consist of hygiene and social distancing practices, and are updated as needed when new information regarding COVID-19 becomes available and/or when State and local SIP orders are revised.

In spite of the challenges presented by the COVID-19 public health emergency, SCVURPPP successfully completed all WY 2020 water quality monitoring requirements described in provisions C.8.d (Creek Status Monitoring) and C.8.g (Pesticides & Toxicity Monitoring) of the MRP. Implementation of the COVID-19 SOPs did not impact sampling results or data quality.

1.2 Monitoring Objectives

Provision C.8.d of the MRP 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.

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[3] https://www.waterboards.ca.gov/resources/covid-19_updates/index.html

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 Management Agencies Association (BASMAA) Regional Monitoring Coalition (RMC). Monitoring results are evaluated to determine whether triggers are met and further investigation should be considered as part of a potential 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 2019 were detailed in prior reports (SCVURPPP 2020, SCVURPPP 2019a, SCVURPPP 2018, SCVURPPP 2017, SCVURPPP 2016, SCVURPPP 2015, SCVURPPP 2014).

1.3 Regional Monitoring Coalition

Provision C.8.a (Compliance Options) of the MRP allows Permittees 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.[4] Implementation of the RMC's 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.

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[4] 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 Regional Projects include all MRP Permittees.

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 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. 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 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 2012 - 2020, chlorine was measured at probabilistic and targeted bioassessment sites.

1.4 Monitoring and Data Assessment Methods

1.4.1 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 SOPs (BASMAA 2016) and the associated Quality Assurance Project Plan (QAPP; BASMAA 2020). These documents are updated as needed to stay current and optimize applicability. Where applicable, monitoring data were collected using methods comparable to those specified by the SWAMP Quality Assurance Program Plan (QAPrP)[5], and were submitted in SWAMP-compatible format to the Regional Water Board. 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.

1.4.2 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

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

sent to laboratories for analysis were analyzed and reported per SWAMP-comparable methods as described in the BASMAA QAPP (BASMAA 2020). Analytical laboratory methods, reporting limits and holding times for chemical water quality parameters are also described in the BASMAA QAPP (2020). Analytical laboratory contractors in WY 2020 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

1.4.3 Data Analysis Methods

Monitoring data generated during WY 2020 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). 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 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 are selected from this list.

1.5 Setting

1.5.1 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 reservoirs managed by Valley Water (formerly Santa Clara Valley Water District) and other agencies. Many of the reservoirs are located at the transition between the foothills and the valley floor. Water is captured during the winter rainy season and released in the spring at managed rates to allow for percolation through the stream bed or off-channel ponds to groundwater aquifers and to protect fish habitat downstream of the reservoirs. To varying degrees, portions of all streams 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 SCBWMI 2003
NA – not available

1.5.2 WY 2020 Creek Status and Pesticides & Toxicity Monitoring Stations

The complete list of probabilistic and targeted monitoring sites sampled by SCVURPPP in WY 2020 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 2016), are provided. Monitoring locations from WY 2020 with monitoring parameter(s) are shown in Figure 1.2.

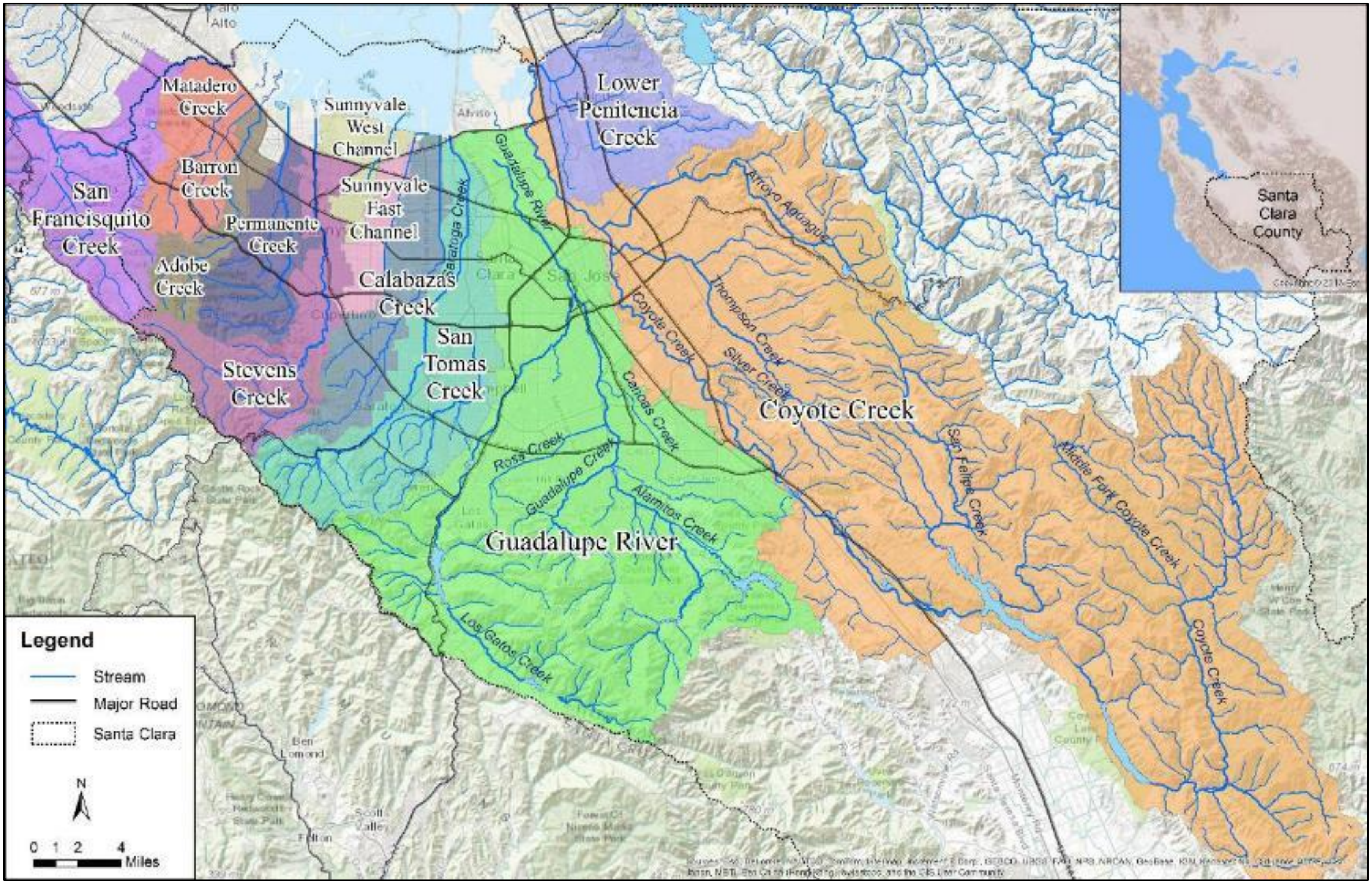

Figure 1.1. Watersheds within SCVURPPP jurisdictional boundaries.

Table 1.4. Sites and parameters monitored in WY 2020 in Santa Clara County.

Map ID [1]	Station ID	Watershed	Creek Name	Land Use	Latitude	Longitude	Bioassessment, Nutrients, General WQ	Chlorine	Pesticides & Toxicity	Temp [2]	Cont. WQ [3]	Pathogen Indicators
26	205R00026	Guadalupe River	Los Gatos Creek	U	37.2307	-121.9732	X	X				
200	205COY200	Coyote Creek	Thompson Creek	U	37.3263	-121.8086	X	X				
227	205R00227	Matadero Creek	Matadero Creek	U	37.4098	-122.1383	X	X				
282	205R00282	Guadalupe River	Guadalupe Creek	U	37.2374	-121.8887	X	X				
419	205R00419	Stevens Creek	Stevens Creek	U	37.3199	-122.0617	X	X				
602	205R00602	Guadalupe River	Los Alamitos Creek	U	37.2302	-121.8659	X	X				
714	205R00714	Guadalupe River	Los Gatos Creek	U	37.2342	-121.9736	X	X				
787	205R00787	Coyote Creek	Upper Penitencia Cr	U	37.4012	-121.7952	X	X				
979	205R00979 / 205COY183	Coyote Creek	Lower Silver Creek	U	37.3542	-121.8469	X	X			X	
3795	205R03795 / 205COY182	Coyote Creek	Lower Silver Creek	U	37.3580	-121.8561	X	X			X	
4523	205R04523	Lower Penitencia Cr	Lower Penitencia Cr	U	37.4132	-121.9041	X	X				
4866	205R04866	Guadalupe River	Canoas Creek	U	37.2332	-121.8350	X	X				
4967	205R04967	Coyote Creek	Upper Penitencia Cr	U	37.3972	-121.8257	X	X				
5142	205R05142	Coyote Creek	Thompson Creek	U	37.2906	-121.7664	X	X				
5155	205R05155	Lower Penitencia Cr	Berryessa Creek	U	37.4165	-121.8556	X	X				
5183	205R05183	Coyote Creek	Upper Penitencia Cr	U	37.4050	-121.7898	X	X				
5198	205R05198	Guadalupe River	Canoas Creek	U	37.2628	-121.8488	X	X				
5327	205R05327	Permanente Creek	Hale Creek	U	37.3604	-122.0998	X	X				
5587	205R05587	Stevens Creek	Stevens Creek	U	37.3053	-122.0743	X	X				
5650	205R05650	Guadalupe River	Alamitos Creek	U	37.2023	-121.8297	X	X				
121	205COY121	Coyote Creek	Upper Penitencia Cr	U	37.3953	-121.8279				X		
132	205COY132	Coyote Creek	Upper Penitencia Cr	U	37.3931	-121.8158				X		
135	205COY135	Coyote Creek	Upper Penitencia Cr	U	37.3965	-121.8045				X		
140	205COY140	Coyote Creek	Upper Penitencia Cr	U	37.4012	-121.7953				X		
142	205COY142	Coyote Creek	Upper Penitencia Cr	U	37.4036	-121.7925				X		
145	205COY145	Coyote Creek	Upper Penitencia Cr	U	37.4047	-121.7917				X		
010	205AAG010	Coyote Creek	Arroyo Aguague	NU	37.4011	-121.7888				X		
015	205AAG015	Coyote Creek	Arroyo Aguague	NU	37.4008	-121.7860				X		
025	205AAG025	Coyote Creek	Arroyo Aguague	NU	37.3971	-121.7858				X		
195	205COY195	Coyote Creek	Lower Silver Creek	U	37.3395	-121.8032					X	
182.5	205COY182.5	Coyote Creek	Lower Silver Creek	U	37.3547	-121.84923					X	
420	205LGA420	Guadalupe River	Los Gatos Creek	U	37.2203	-121.9830						X
033	205LGA033	Guadalupe River	Los Gatos Creek	U	37.2951	-121.9335						X

Map ID [1]	Station ID	Watershed	Creek Name	Land Use	Latitude	Longitude	Bioassessment, Nutrients, General WQ	Chlorine	Pesticides & Toxicity	Temp [2]	Cont. WQ [3]	Pathogen Indicators
400	205LGA400	Guadalupe River	Los Gatos Creek	U	37.2388	-121.9708						X
330	205COY330	Coyote Creek	Coyote Creek	U	37.2902	-121.8183						X
392	205COY392	Coyote Creek	Coyote Creek	U	37.2350	-121.7611						X
021	205STE021	Stevens Creek	Stevens Creek	U	37.4098	-122.0691			X			
010	205STQ010	San Tomas Aquino	San Tomas Aquino	U	37.3886	-121.9685			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 1 to 2-week periods (spring and summer).

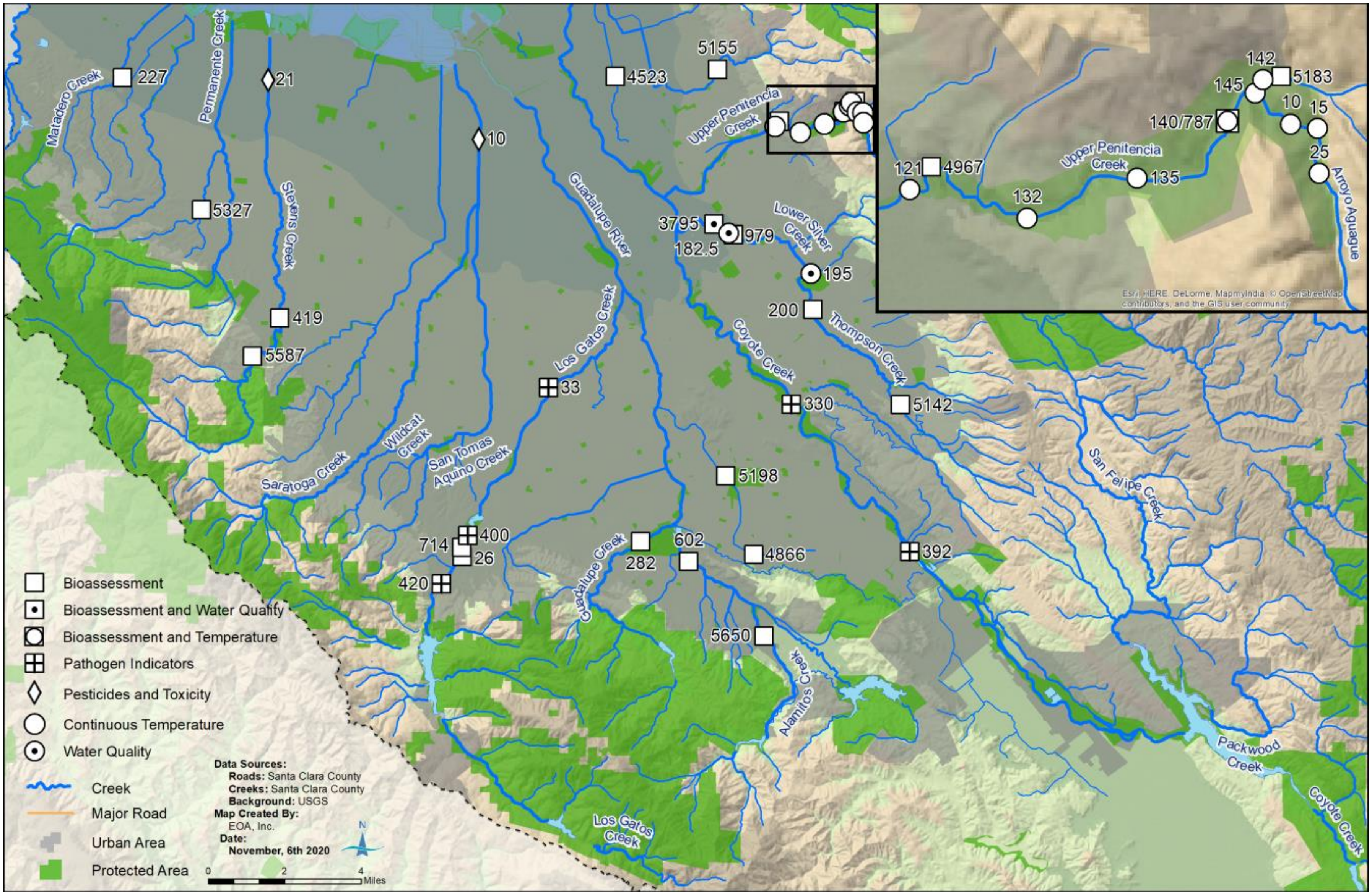

Figure 1.2. SCVURPPP Program Area, major creeks, and sites monitored in WY 2020.

1.5.3 Designated Beneficial Uses

Beneficial Uses in Santa Clara Valley creeks are designated by the Regional Water Board 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 Use. 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 Use in the Santa Clara Basin, meaning that they either historically or currently 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 Use, such as swimming, where ingestion of water is considered reasonably possible; however, for most creeks this is a presumed Use that has not been documented and may not actually exist. Fecal indicator bacteria WQOs are identified to protect the REC-1 Beneficial Use. Los Gatos Creek is designated as having the municipal and domestic supply (MUN) Beneficial Use. The Basin Plan identifies WQOs for several constituents of concern that apply only to waters with the MUN Beneficial Use, i.e., chloride and nitrate. Beneficial Uses for creeks monitored in WY 2020 are listed in Table 1.5.

Table 1.5. Beneficial Uses designated by the Regional Water Board for creeks monitored in WY 2020 in the Santa Clara Valley (SFBRWQCB 2017).

Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
Alamitos Creek			E	E					E			E	E	E	E	E	E	E	
Arroyo Aguague									E			E	E	E	E	E	E	E	
Berryessa Creek															E	E	E	E	
Canoas Creek															E	E	E	E	
Coyote Creek				E			E		E			E	E	E	E	E	E	E	
Guadalupe Creek			E	E					E			E	E	E	E	E	E	E	
Hale Creek									E						E	E	E	E	
Los Alamitos Creek			E	E					E			E	E	E	E	E	E	E	
Los Gatos Creek		E	E	E					E			P	E	P	E	E	E	P	
Lower Penitencia Creek															E	E	E	E	
Lower Silver Creek															E	E	E	E	
Matadero Creek									E			E	E	E	E	E	E	E	
Saratoga Creek	E		E	E					E						E	E	E	E	
Stevens Creek			E	E					E			E	E	E	E	E	E	E	
Thompson Creek															E	E	E	E	
Upper Penitencia Creek			E	E					E			E	E	E	E	E	E	E	

Notes:
E = Existing Use, P = Potential Use

1.5.4 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 which can result in large differences in temperature and rainfall within relatively short distances. 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[6]). Figure 1.3 illustrates the geographic variability of mean annual precipitation in the area based on statistical models; 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 (station SJC) from WY 1946 to WY 2020. 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 2020, rainfall was below average at station SJC but was preceded by a relatively wet year in WY 2019.

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, and sea level in the Bay Area has risen over eight 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, wildfire and other events are also predicted 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 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 index scores 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

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

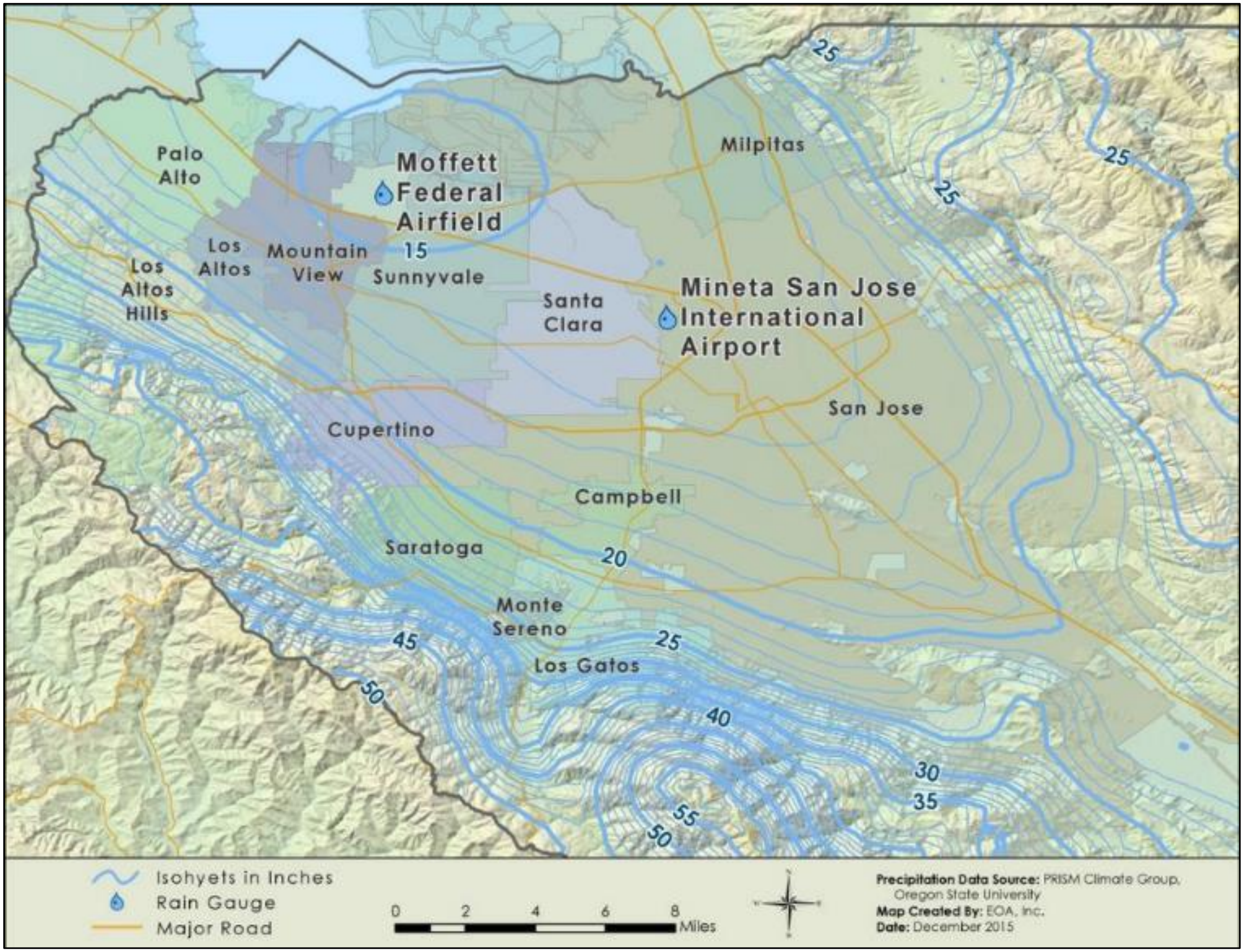

Figure 1.3. Average annual precipitation in Santa Clara Valley, as modeled by the PRISM Climate Group for the period of 1981-2010.

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.

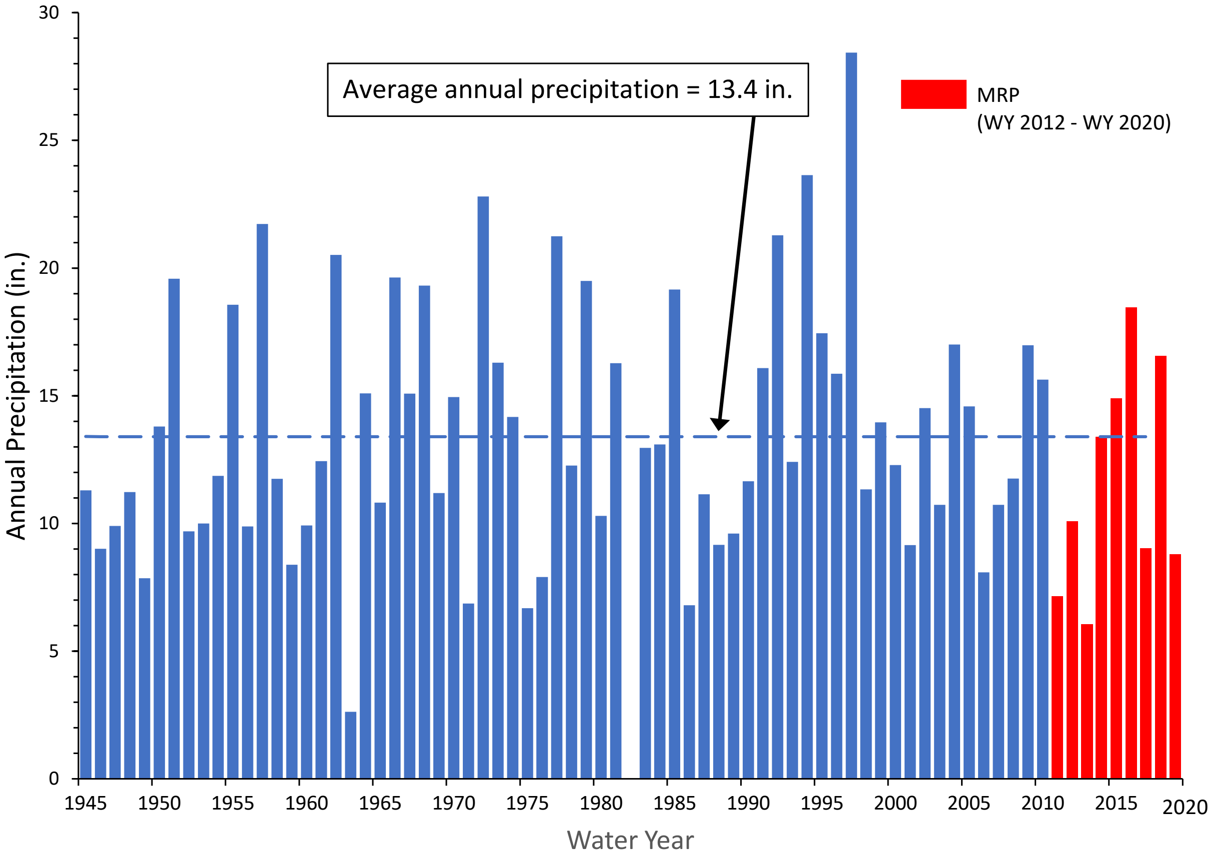

Figure 1.4. Annual rainfall recorded at the San José Airport, WY 1946 – WY 2020.

1.6 Statement of Data Quality

A comprehensive Quality Assurance/Quality Control (QA/QC) program was implemented by SCVURPPP covering all aspects of Creek Status and Pesticides & Toxicity monitoring. In general, QA/QC procedures were implemented as specified in the BASMAA RMC QAPP (BASMAA, 2020) and monitoring was performed according to protocols specified in the BASMAA RMC SOPs (BASMAA 2016). Both of these documents were adapted from the methods detailed in the SWAMP QAPrP.[7]

Overall, the results of the QA/QC review suggests that the Creek Status and Pesticides & Toxicity Monitoring data generated during WY 2020 were of sufficient quality, in comparison to objectives outlined in the QAPP. However, some data were rejected or flagged in accordance with QA/QC protocols. A summary of the QA/QC analysis is provided below:

- All ammonia concentrations are potentially biased high, but data were not flagged or rejected until this finding can be confirmed and the source identified. A small-scale investigation of ammonia analytical methods is planned for WY 2021.
- All of the continuous pH data collected at station 205COY195 during the June 2020 deployment were rejected due to sensor drift outside of measurement quality objectives (MQOs).
- Some data were flagged for reasons such as results below the reporting limit but above the detection limit (free chlorine and total chlorine residual), and field duplicates exceeding relative percent difference MQOs (ash free dry mass, chlorophyll a, Total Kjeldahl Nitrogen).

A detailed QA/QC report for WY 2020 data is included as Attachment 1.

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[7] 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 Santa Clara Valley creeks 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 randomly selected sites using a probabilistic monitoring design. The probabilistic monitoring design allows each individual RMC participating program to objectively assess overall creek 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 probabilistic 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 nine years (WY 2012 through WY 2020), SCVURPPP and the Regional Water Board have sampled 174 probabilistic and 14 targeted sites[8] in the Santa Clara Valley. The number of probabilistic samples is sufficient to estimate ambient biological condition for both urban and non-urban streams.[9] There is still an insufficient number of samples to accurately assess the biological condition for many watersheds and smaller jurisdictional areas (i.e., cities).

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[8] MRP 2.0 allows for up to 20% of bioassessment surveys at targeted sites to address other types of management questions.

[9] 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).

During site evaluation process in WY 2020, the complete list of Santa Clara County probabilistic urban sites from the RMC Sample Frame was evaluated for sampling[10]. As a result, bioassessment surveys were conducted at a combination of probabilistic and targeted sites to meet MRP requirements for bioassessments to be conducted at twenty sites each year. A total of ten targeted sites were selected. Nine of the ten targeted sites were previously sampled probabilistic sites, two of these sites were in the Lower Silver – Thompson Creek watershed. The remaining targeted site was a new sampling location in Thompson Creek.

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 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. Understanding changes in biological condition over time can help evaluate the effectiveness of management actions. Although, long-term trend analysis for the probabilistic survey will require more than nine 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.

All three management questions were comprehensively evaluated using eight years of bioassessment data (WY 2012 – WY 2019) and reported in the Program's WY 2019 Integrated Monitoring Report (IMR) (SCVURPPP 2020). Results presented in the IMR were similar to findings from an analysis of regional probabilistic data collected during WY 2012 – WY 2016 (BASMAA 2019)..

This section of the report presents bioassessment results from WY 2020. In compliance with Provision C.8.d.i.(8) of the MRP, WY 2020 data are compared to triggers and water quality objectives identified in the MRP. Sites with results exceeding trigger thresholds were added to the list of candidate SSID projects.

2.2 Methods

2.2.1 Probabilistic Survey Design

In WY 2020, the Program sampled ten sites that were selected using the RMC probabilistic 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

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[10] A high proportion of probabilistic sites that were evaluated in WY 2020 could not be sampled due to an exceptionally dry wet season and a resulting lack of stream flow.

Coalition's (SMC) regional monitoring program conducted by municipal stormwater programs in Southern California (SCCWRP 2007).

Monitoring 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 (see 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.

2.2.2 Site Evaluations

Sites identified in the master draw are evaluated by each RMC participant in chronological order using the process described in RMC Standard Operating Procedure FS-12 (BASMAA 2016) 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 2020) and SOPs (BASMAA 2016). In accordance with the RMC QAPP (BASMAA 2020) 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.[11] In WY 2020, bioassessment sampling occurred between May 4 and June 4, 2020. The last significant storm of the season occurred on April 6, 2020, which was approximately 30 days prior to bioassessment sampling.

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

Each bioassessment sampling site consisted of a 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 each of the 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 that are 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 2016). Water samples were also collected and analyzed in the field for free chlorine and total chlorine residual using a Pocket Colorimeter^{TM} II and DPD Powder Pillows according to SOP FS-3 (BASMAA 2016) (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 2020 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 WQOs 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

Benthic Macroinvertebrates

The benthic (i.e., bottom-dwelling) macroinvertebrates collected through this monitoring program 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 is an indicator of the biological condition of the stream.

The California Stream Condition Index (CSCI) is an assessment tool that was developed by the State Water Board to support the development of California's statewide Biological Integrity Plan[12]. 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.

Odonata cordulegastridae
"Spiketail Dragonfly"

Megaloptera corydalidae
"Dobsonflies"

Ephemeroptera ephemerellidae
"Spiny Crawler Mayflies"

Trichoptera limnephilidae
"Northern Caddisflies"

Diptera ceratopogonidae
"Biting Midges"

Coleoptera psephenidae
"Water Penny Beetle"

Source: http://www.dfg.ca.gov/abl/Reference/California/CA_digital_ref_familylevel_home.asp

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).

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[12] 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 WQO for biostimulatory substances (e.g., nitrate) along with a program of implementation. A draft policy document for public review is anticipated in late 2021.

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 are an indicator of stream health. When evaluated with the CSCI, biological indices based on benthic algae can provide a more complete picture of the streams 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 updated and finalized the Algae Stream Condition Index (ASCI)[13] which uses benthic algae data as a measure of biological condition for streams in California (Theroux et al. 2020*).* The ASCI uses predictive multimetric indices to evaluate ecological conditions. There are three versions of the ASCI pMMI: 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 Theroux et al. for precision, accuracy, responsiveness, and regional bias. The diatom and hybrid indices were found to be the most sensitive to anthropogenic stressor gradients.

ASCI scores for the diatom and hybrid indices were generated using an RStudio based reporting module developed by SCCWRP. However, at the time of the data analysis for this report, the available reporting module was not correctly calculating the hybrid ASCI score (Andy Rehn, CDFW, personal communication, 2020). Therefore, only the diatom ASCI index (i.e., D_ASCI) was used to analyze algae samples collected at twenty bioassessment sites in WY 2020.

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.

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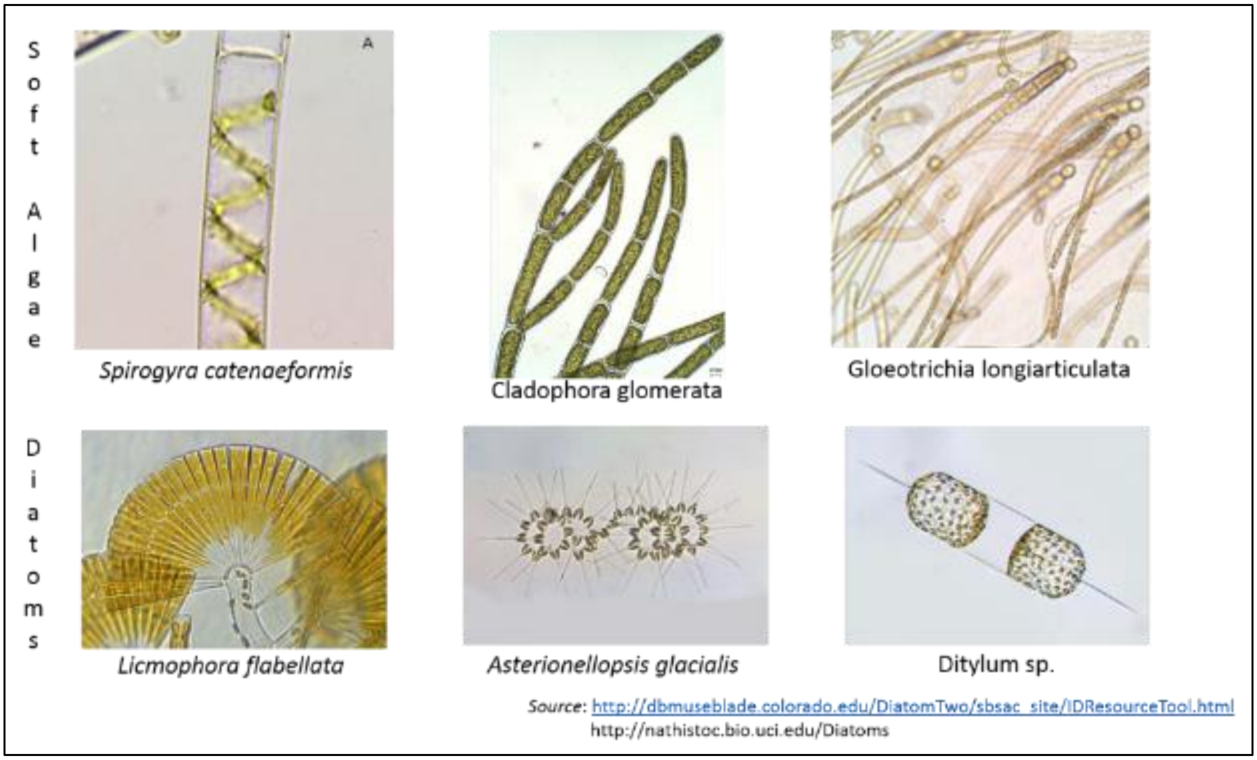
[13] Previously reported ASCI scores summarized in the SCVURPPP IMR (SCVURPPP 2020) have been superseded.



Spirogyra catenaeformis
Cladophora glomerata
Gloeotrichia longiarticulata
Licmophora flabellata
Asterionellopsis glacialis
Ditylum sp.

Source: http://dbmuseblade.colorado.edu/DiatomTwo/sbsac_site/IDResourceTool.html
http://nathistoc.bio.uci.edu/Diatoms

Figure 2.2. Examples of soft algae and diatoms.

2.2.4.2 Physical Habitat Indicators

The condition of the physical habitat within the riparian corridor 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 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^{TM} 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 et al. 2016) 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 12 of the metrics generated by the SWAMP RM (Table 2.1). 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.

Table 2.1. Physical habitat metrics calculated from bioassessment data collected in WY 2020. The 12 metrics used to calculate IPI scores are also shown.

Type/Class	Metric/Variable Name	Variables used for IPI Score
Channel Morphology	Mean Bankfull Width (SBKF_W)	x
	Mean Slope of Reach (XSLOPE)	x
	Percent Stable Banks (PBM_S)	
Flow Habitat	Evenness of Flow Habitat Types (Ev_FlowHab)	x
	Percent Pools in Reach (PCT_POOL)	x
	Shannon Diversity (H) of Aquatic Habitat Types (H_AqHab)	x
	Percent Fast Water (PCT_FAST)	
Instream Cover	Mean Filamentous Algae Cover (XFC_ALG)	x
	Natural Shelter cover – SWAMP (XFC_NAT_SWAM)	
	Mean Undercut Banks Cover (XFC_UCB)	
Riparian Cover	Mean Upper Canopy Trees and Saplings (XC)	x
	Riparian Cover Sum of Three Layers (SCMG)	x
Substrate	Percent Concrete/Asphalt (PCT_RC)	x
	Percent Sand (PCT_SA)	x
	Percent Gravel – coarse (PCT_GC)	
	Percent Substrate Smaller than Sand (<2 mm) (PCT_SAFN)	x
	Shannon Diversity (H) of Natural Substrate Types (H_SubNat)	x
	Median Particle Size (d50) (SB_PT_D50)	

2.2.4.3 Biological and Physical Habitat Condition Thresholds

Existing thresholds for CSCI scores (Mazor 2015) and ASCI scores (Theroux et al. 2020) were used to evaluate the BMI and algae data collected in Santa Clara County and analyzed in this report (Table 2.2). 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).

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.

Table 2.2. Condition categories used to evaluate CSCI, D_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	ASCI	≥ 0.94	≥ 0.86 to < 0.94	≥ 0.75 to < 0.86	< 0.75
Physical Habitat	IPI	≥ 0.94	≥ 0.84 to < 0.94	≥ 0.71 to < 0.83	< 0.70

2.2.4.4 Stressor Variables

Attachment A includes biological condition scores (CSCI, D_ASCI, IPI) and potential stressor data for bioassessment sites monitored in WY 2020. Stressors are conditions that affect the biological condition of a stream. They include, but are not limited to, the types of physical habitat, landscape characteristics, general water quality, and water chemistry data that are collected during bioassessment surveys. The IMR evaluated the relationship between potential stressors and biological condition (i.e., CSCI and ASCI scores) for the WY 2012 through WY 2019 probabilistic dataset (SCVURPPP 2020) using statistical analyses such as correlation and random forest models. Those analyses were not updated to include WY 2020 data because the findings are unlikely to change with the addition of ten new probabilistic sites. Potential stressors included in Appendix A are:

- ***Physical habitat*** stressor variables include metrics developed by the SWAMP RM (described above) and physical habitat variables from the reachwide qualitative assessments that are conducted in compliance with the BASMAA (BASMAA 2016) and SWAMP (Ode et al. 2016) SOPs. The reachwide assessment includes 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 optimal condition. The total "PHAB" score is the sum of the three individual attribute scores, with a score of 60 representing the highest possible score.

- ***Land Use*** variables are calculated in GIS by overlaying land use and transportation layers with the drainage area upstream of the sampling location. Appendix A includes percent urban area, percent impervious area, and road density.

- ***Water quality*** stressor variables include the general parameters measured in the field (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:

  - Unionized ammonia is calculated from measured concentrations of total ammonia, pH, temperature, and specific conductance using a formula provided by the American Fisheries Society (AFS; https://fisheries.org/wp-content/uploads/2016/03/Copy-of-pub_ammonia_fwc.xls).

- 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.

2.2.4.5 Trigger Thresholds

In compliance with provision C.8.h.iii.(4) of the MRP, water chemistry data collected at the bioassessment sites during WY 2020 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 the MRP. Except for temperature and specific conductance, these conform to 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).

Ammonia, specifically unionized ammonia, is toxic to aquatic life. Therefore, the Basin Plan states that discharge of wastes shall not cause receiving waters to contain annual median concentrations of un-ionized ammonia in excess of 0.025 mg/L or maximum concentrations above 0.4 mg/L in the Lower Bay, which includes creeks in the Santa Clara Basin (SFBRWQCB 2017). Conversion of measured total ammonia to the more toxic form of unionized ammonia was calculated to compare with the WQOs in the San Francisco Basin Water Quality Control Plan (Basin Plan) (SFRWQCB 2017).

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
Unionized Ammonia, annual median [b]	mg/L	0.025	Increase	Basin Plan
Unionized Ammonia, maximum	mg/L	0.4	Increase	Basin Plan
Chloride [a]	mg/L	250	Increase	Basin Plan
General Water Quality				
Oxygen, Dissolved[d]	mg/L	5.0 or 7.0	Decrease	Basin Plan
pH	--	6.5 to 8.5	Both	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.

[d] The WQO for WARM and COLD Beneficial Use is 5.0 and 7.0, respectively.

2.2.4.6 SCAPE Modeling to Assess CSCI Scores

Biological conditions, based on CSCI scores, for the 20 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 within the sampling reach watershed (Beck et al. 2019). 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 2020 are presented in the section below.

- **Section 2.3.1** presents a summary of biological assessment data collected at twenty sites in Santa Clara County during WY 2020.
- **Section 2.3.2** presents an evaluation of bioassessment results with the SCAPE model.
- **Section 2.3.3** presents a comparison of BMI and algae data collected during two sampling events between 2012 and 2020 at nine targeted sites. Comparison of data from different years provides insight into the variability of biological conditions over time.

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

2.3.1 Bioassessment Results (WY 2020)

This section documents the biological condition and stressor data collected at twenty sites in Santa Clara County during WY 2020. Bioassessments were conducted at ten targeted sites and ten new probabilistic sites derived from the RMC sample frame.[14] All sites are classified as urban in the RMC sample frame. The targeted sites include nine previously sampled probabilistic sites and one non-probabilistic site. Data from four of the sites were also used to evaluate biological conditions as part of the Lower Silver Creek-Thompson Creek SSID Project.[15] The WY 2020 bioassessment sites are listed in Table 2.4 and mapped in Figure 2.4.

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[14] During WY 2020, the SCVURPPP exhausted the list of sites classified as urban in the RMC Sample Frame. As a result, previously sampled urban sites were used to obtain the minimum of 20 bioassessment sites.

[15] Results of the SSID project will be submitted in mid-2021.

Table 2.4. Bioassessment sampling dates and locations in Santa Clara County in WY 2020.

Station Code	Creek	Sample Date	Elevation (m)	Latitude	Longitude	New Probabilistic	Targeted		Selected for SSID Project*
							Re-sampled Probabilistic	Non-Probabilistic	
205COY200	Thompson Creek	6/3/2020	44	37.326300	-121.808560			x	x
205R00026	Los Gatos Creek	5/4/2020	107	37.230665	-121.973148		x		
205R00227	Matadero Creek	5/5/2020	20	37.409835	-122.138310		x		
205R00282	Guadalupe Creek	5/11/2020	70	37.237401	-121.888689		x		
205R00419	Stevens Creek	5/14/2020	91	37.319854	-122.061760		x		
205R00602	Alamitos Creek	5/13/2020	69	37.230180	-121.865880		x		
205R00714	Los Gatos Creek	6/1/2020	96	37.234155	-121.973602		x		
205R00787	Upper Penitencia Creek	6/4/2020	206	37.401220	-121.795240		x		
205R00979	Lower Silver Creek	6/2/2020	28	37.354240	-121.846850		x		x
205R03795	Lower Silver Creek	6/2/2020	25	37.357960	-121.856070		x		x
205R04523	Lower Penitencia Creek	5/7/2020	8	37.413181	-121.904053	x			
205R04866	Canoas Creek	5/12/2020	49	37.233168	-121.835035	x			
205R04967	Upper Penitencia Creek	5/6/2020	87	37.397218	-121.825691	x			
205R05142	Thompson Creek	6/3/2020	124	37.290590	-121.766350	x			x
205R05155	Berryessa Creek	5/7/2020	55	37.416485	-121.855600	x			
205R05183	Upper Penitencia Creek	5/6/2020	260	37.405029	-121.789790	x			
205R05198	Canoas Creek	5/12/2020	47	37.262760	-121.848750	x			
205R05327	Hale Creek	5/5/2020	58	37.360413	-122.099794	x			
205R05587	Stevens Creek	5/28/2020	124	37.305323	-122.074310	x			
205R05650	Alamitos Creek	5/13/2020	98	37.202252	-121.829720	x			

“ Data from four WY 2020 bioassessment stations were used to inform the Lower Silver Creek – Thompson Creek SSID Project.

2.3.1.1 Biological and Physical Habitat Conditions

Biological condition, as represented by CSCI and D_ASCI scores, for the 20 bioassessment sites sampled by SCVURPPP in WY 2020 is shown in Table 2.5. Physical habitat condition, as represented by IPI scores, is also shown in Table 2.5. Scores in the two higher condition categories for each indicator (as defined in Table 2.2) are shown in shaded cells with bold text. Condition scores are mapped in Figure 2.4.

CSCI Scores

The CSCI scores ranged from 0.19 to 1.30 across the twenty bioassessment sites sampled in WY 2020 (Table 2.5). Four of the twenty bioassessment sites (20%) had CSCI scores in the two higher condition categories: “possibly intact” and “likely intact.” Although these four sites are classified as urban in the RMC sample frame, impervious area in their contributing watersheds is relatively low, less than three percent. Three of the four high scoring sites were located in Upper Penitencia Creek within Alum Rock Park (see photo in Figure 2.3 for one example). The remaining site was in Berryessa Creek, just inside the San José urban boundary.

Six sites (30%) were ranked as “likely altered” (CSCI score ≥0.63 to < 0.79). All of these sites had moderately low impervious area (2% to 5%) but were downstream of major dams. The remaining 10 sites were ranked as “very likely altered” (CSCI score < 0.63), indicating highly degraded conditions. Nine of these sites were predominantly urban (9% to 69% impervious watershed area) and majority of these sites also had highly modified channels. Sites with CSCI scores below 0.795 will be considered as candidates for SSID projects.

Table 2.5. Biological condition, presented as CSCI and D_ASCI scores, and physical habitat condition, presented as IPI score, for twenty sites sampled in Santa Clara County during WY 2020. Bold-shaded values indicate scores in the two highest condition categories for each indicator. Overall condition scores, i.e., the sum of the three individual index scores, are also shown. The four sites with highest overall condition score are shown in bold. Site characteristics related to percent impervious watershed area and channel modification are also presented.

Station Code	Creek	Modified Channel[1]	Impervious Watershed Area	CSCI Score	D_ASCI Score	IPI Score	Overall Score
205COY200	Thompson Creek	Y	18%	0.44	0.48	0.44	1.36
205R00026	Los Gatos Creek		5%	0.64	0.74	**1.15**	2.53
205R00227	Matadero Creek	Y	17%	0.43	0.55	**0.86**	1.84
205R00282	Guadalupe Creek		4%	0.78	0.81	**1.13**	2.72
205R00419	Stevens Creek		3%	0.67	0.44	**1.08**	2.19
205R00602	Alamitos Creek		7%	0.64	0.64	**1.01**	2.29
205R00714	Los Gatos Creek		5%	0.73	0.66	**1.13**	2.52
205R00787	Upper Penitencia Creek		1%	**1.30**	0.77	**1.00**	**3.07**
205R00979	Lower Silver Creek	Y	24%	0.49	0.39	0.75	1.63
205R03795	Lower Silver Creek	Y	25%	0.39	0.39	0.81	1.59
205R04523	Lower Penitencia Creek	Y	69%	0.19	0.48	0.74	1.41
205R04866	Canoas Creek	Y	35%	0.43	0.53	0.43	1.39
205R04967	Upper Penitencia Creek		2%	**1.08**	0.60	**1.12**	**2.80**
205R05142	Thompson Creek		9%	0.56	0.52	**0.90**	1.98
205R05155	Berryessa Creek		3%	**1.03**	0.79	**1.00**	**2.82**
205R05183	Upper Penitencia Creek		1%	**1.18**	0.84	**1.02**	**3.04**
205R05198	Canoas Creek	Y	43%	0.28	0.48	0.47	1.23
205R05327	Hale Creek	Y	21%	0.41	0.50	0.68	1.59
205R05587	Stevens Creek		2%	0.53	0.70	**1.10**	2.33
205R05650	Alamitos Creek		2%	0.67	0.74	**1.13**	2.54

[1] Sampling reaches with an engineered flood control channel and/or including predominately hardened banks and/or channel bed were classified as modified channels.

ASCI Diatom Scores

The D_ASCI scores ranged from 0.39 to 0.84 across the twenty bioassessments sites sampled in WY 2020 (Table 2.5). There were no sites with D_ASCI scores in the two higher condition categories: “possibly intact” and “likely intact.” There were four sites with D_ASCI scores in the “likely altered” (≥ 0.75 to < 0.86) condition category. All four of these sites had relatively low urban development in their contributing watershed area (impervious area less 4%). Two of the four sites were located in Upper Penitencia Creek. The other two sites were in Berryessa Creek and Guadalupe Creek. The remaining 16 sites sampled in WY 2020 were ranked as “very likely altered" (D_ASCI score < 0.75). A majority of these sites were highly developed and/or were located downstream of a major dam. There is no MRP trigger for the D_ASCI index.

IPI Scores

Physical habitat conditions, as represented by IPI scores, ranged from 0.44 to 1.15 across the twenty bioassessment sites sampled in WY 2020 (Table 2.5). Thirteen of the twenty sites had IPI scores that were in the top two condition categories (≥ 0.83).

Overall Condition

The overall site condition was calculated by summing the two biological condition index scores (CSCI and D_ASCI) and the physical habitat condition score (IPI). The four sites with the highest overall scores were the same as those in the top two CSCI condition categories.

Figure 2.3. Waterfall in Upper Penitencia Creek at the upper end of the assessment reach (station 205R05183). The CSCI score at this site is 1.18.

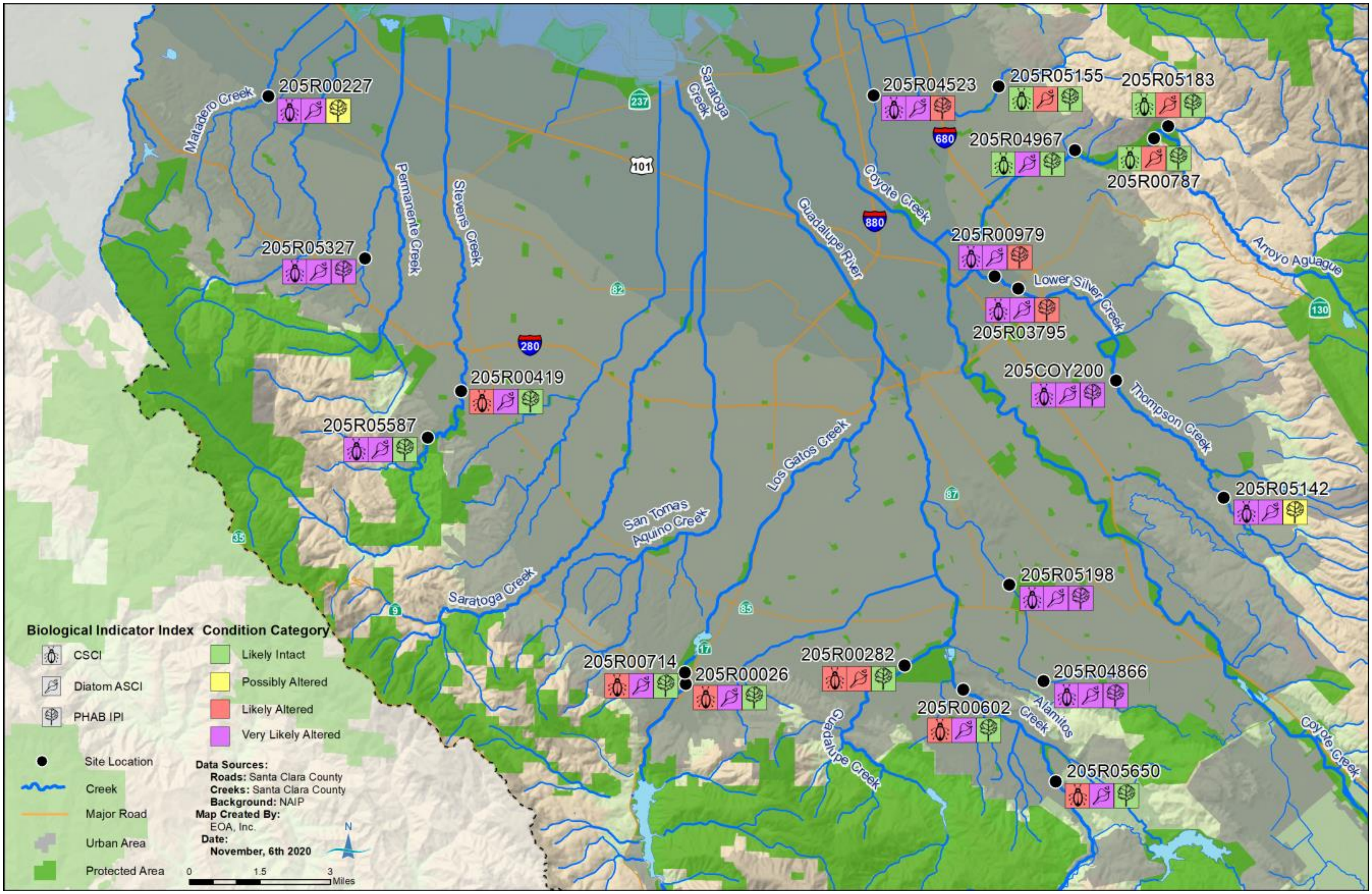

Figure 2.4. Condition category as represented by CSCI, D_ASCI, and IPI scores for 20 sites sampled in Santa Clara County during WY 2020.

2.3.1.2 Stressor Assessment (WY 2020)

This section presents results for stressor data collected at the twenty bioassessment sites in WY 2020. The comparison of WY 2020 stressor data to associated MRP triggers and/or WQOs is documented for the purposes of maintaining the list of sites with trigger exceedances for SSID project consideration.

General Water Chemistry

Results of general water quality measurements collected at the twenty bioassessment sites in WY 2020 are listed in Table 2.6. No WQOs were exceeded.

Table 2.6. General water quality measurements at twenty bioassessment sites in Santa Clara County, WY 2020.

Station Code	Creek Name	Sample Date	DO (mg/L)	Temp (Deg C)	Specific Cond (uS/cm)	pH
205COY200	Thompson Creek	6/3/2020	8.5	24.3	1154	7.8
205R00026	Los Gatos Creek	5/4/2020	11.6	11.4	413	7.9
205R00227	Matadero Creek	5/5/2020	7.7	13	1281	7.8
205R00282	Guadalupe Creek	5/11/2020	8.8	14.4	506	7.7
205R00419	Stevens Creek	5/14/2020	10.5	12.9	569	7.9
205R00602	Alamitos Creek	5/13/2020	11.9	15.1	502	8.2
205R00714	Los Gatos Creek	6/1/2020	9.3	14	432	7.5
205R00787	Upper Penitencia Creek	6/4/2020	10.9	14.8	703	8.2
205R00979	Lower Silver Creek	6/2/2020	6.1	20.1	1354	8.2
205R03795	Lower Silver Creek	6/2/2020	14.5	25.5	1250	8.5
205R04523	Lower Penitencia Creek	5/7/2020	11.9	22.7	1474	8.0
205R04866	Canoas Creek	5/12/2020	5.5	17	1242	7.6
205R04967	Upper Penitencia Creek	5/6/2020	10.7	17.5	1241	8.5
205R05142	Thompson Creek	6/3/2020	6.3	17.6	1297	8.0
205R05155	Berryessa Creek	5/7/2020	10.2	13.6	657	8.4
205R05183	Upper Penitencia Creek	5/6/2020	10.0	10.8	771	8.3
205R05198	Canoas Creek	5/12/2020	8.5	20.1	1016	7.9
205R05327	Hale Creek	5/5/2020	9.6	15.4	1886	7.9
205R05587	Stevens Creek	5/28/2020	8.8	12.9	545	7.7
205R05650	Alamitos Creek	5/13/2020	11.0	12.2	405	8.0

Water Chemistry (Nutrients)

Nutrient and conventional analyte concentrations measured in water samples collected at twenty bioassessment sites in Santa Clara County during WY 2020 are listed in Table 2.7. No WQOs or MRP trigger thresholds were exceeded.

Table 2.7. Nutrient and conventional constituent concentrations in water samples collected at 20 sites in Santa Clara County during WY 2020.

Station Code	Creek Name	Ammonia (as N)	Unionized Ammonia (as N)	Chloride	Nitrate (as N)	Nitrite (as N)	Total Kjeldahl Nitrogen (as N)	Total Nitrogen	Ortho-Phosphate (as P)	Phosphorus	Silica (as SiO2)	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***
205COY200	Thompson Creek	0.18	0.005	99	4.4	0.02	0.04	4.5	0.032	0.04	27	302	68
205R00026	Los Gatos Creek	0.13	0.002	12	0.14	0.003 J	0.04	0.2	0.01	0.02	15	37	30
205R00227	Matadero Creek	0.13	0.002	140	1.0	0.02	0.04	1.1	0.18	0.02	15	147	48
205R00282	Guadalupe Creek	0.13	0.001	18	0.08 J	0.002 J	0.04	0.1	0.018	0.026	15	118	51
205R00419	Stevens Creek	0.51	0.008	25	0.2	0.004 J	0.04	0.2	0.029	0.043	13	230	61
205R00602	Alamitos Creek	0.64	0.023	40	0.18	0.002 J	0.28	0.5	0.049	0.061	17	149	114
205R00714	Los Gatos Creek	0.12	0.001	14	0.12	0.002 J	0.08 J	0.2	0.02	0.023	13	105	42
205R00787	Upper Penitencia Creek	0.49	0.016	18	0.17	0.001	0.04	0.2	0.027	0.028	15	67	59
205R00979	Lower Silver Creek	0.24	0.012	120	2.4	0.03	0.41	2.8	0.057	0.087	24	735	213
205R03795	Lower Silver Creek	0.16	0.022	120	2.4	0.03	0.5	2.9	0.045	0.058	20	575	305
205R04523	Lower Penitencia Creek	0.19	0.007	120	1.3	0.02	0.33	1.6	0.032	0.05	21	725	92
205R04866	Canoas Creek	0.14	0.002	73	2.7	0.07	0.19	3.0	0.014	0.027	27	292	164
205R04967	Upper Penitencia Creek	0.23	0.017	110	0.19	0.002 J	0.22	0.4	0.003	0.015	10	119	132
205R05142	Thompson Creek	0.13	0.004	150	0.08 J	0.002 J	0.3	0.4	0.130	0.13	27	33	167
205R05155	Berryessa Creek	0.31	0.016	24	0.01	0.003 J	0.22	0.2	0.160	0.16	28	162	12
205R05183	Upper Penitencia Creek	0.15	0.006	22	0.10 J	0.001 J	0.33	0.4	0.063	0.09	18	44	13
205R05198	Canoas Creek	0.53	0.015	66	1.5	0.1	3.2	4.8	0.086	0.17	18	500	245
205R05327	Hale Creek	0.16	0.003	210	1.9	0.01	0.63	2.5	0.20	0.22	43	271	32
205R05587	Stevens Creek	0.23	0.002	20	0.09	0.007	0.17	0.3	0.027	0.054	16	52	85
205R05650	Alamitos Creek	0.13	0.003	8.2	0.08 J	0.001 J	0.22	0.3	0.035	0.046	19	32	52
Number of exceedances		NA	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA

AFDM = Ash Free Dry Mass, NA = Not Applicable, NR = Not Reported

J = The reported result is an estimate. The value is less than the reporting limit but greater than the detection limit.

[a] Chloride and nitrate WQOs only apply to waters with MUN designated Beneficial Uses, i.e., Los Gatos Creek.

[b] This threshold is an annual median value and is not typically applied to individual samples.

Total nitrogen concentrations ranged from 0.1 to 4.8 mg/L. The two highest nitrogen concentrations were measured in Canoas Creek (4.8 mg/L; site 205R05198) and Thompson Creek (4.5 mg/L; site 205COY200). Total phosphorus concentrations ranged from <0.02 to 0.22 mg/L. The highest phosphorus concentration was measured in Hale Creek (site 205R05327).

Chlorophyll a and ash free dry mass (AFDM) are two indicators of biomass. The highest concentration of chlorophyll a (305 mg/m^2) was measured in Lower Silver Creek (site 205R03795). The highest concentration of AFDM (735 g/ m^2) was measured in Lower Silver Creek (site 205R00979).

Physical Habitat

There are no WQOs or MRP triggers associated with the physical habitat measurements that are collected during bioassessment surveys. However, physical habitat is an important factor that may influence biological conditions. The qualitative habitat (PHAB) scores, including individual scores for channel alteration, epifaunal substrate and sedimentation attributes[16], and total PHAB (sum of the three attributes scores) are shown in Table 2.8, with CSCI and IPI scores for comparison. Total PHAB scores ranged from 8 to 55 (total possible is 60).

Table 2.8. Qualitative physical habitat scores for twenty bioassessment sites in Santa Clara County sampled in WY 2020. CSCI and IPI scores are provided for comparison.

Station Code	Creek Name	CSCI Score	Channel Alteration	Epifaunal Substrate	Sediment Deposition	Total PHAB	IPI Score
205COY200	Thompson Creek	0.44	7	6	4	17	0.44
205R00026	Los Gatos Creek	0.64	14	14	13	41	1.15
205R00227	Matadero Creek	0.43	6	7	11	24	0.86
205R00282	Guadalupe Creek	0.78	19	17	9	45	1.13
205R00419	Stevens Creek	0.67	15	15	8	38	1.08
205R00602	Alamitos Creek	0.64	NR	NR	NR	NR	1.01
205R00714	Los Gatos Creek	0.73	14	14	11	39	1.13
205R00787	Upper Penitencia Creek	1.30	19	19	16	54	1.0
205R00979	Lower Silver Creek	0.49	5	6	14	25	0.75
205R03795	Lower Silver Creek	0.39	7	6	14	27	0.81
205R04523	Lower Penitencia Creek	0.19	3	3	2	8	0.74
205R04866	Canoas Creek	0.43	1	4	13	18	0.43
205R04967	Upper Penitencia Creek	1.08	16	15	16	47	1.12
205R05142	Thompson Creek	0.56	18	13	8	39	0.90
205R05155	Berryessa Creek	1.03	10	9	10	29	1.0
205R05183	Upper Penitencia Creek	1.18	20	18	17	55	1.02
205R05198	Canoas Creek	0.28	1	3	15	19	0.47
205R05327	Hale Creek	0.41	9	9	7	25	0.68
205R05587	Stevens Creek	0.53	17	17	13	47	1.1
205R05650	Alamitos Creek	0.67	15	16	16	47	1.13

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

Comparison of qualitative PHAB scores with the IPI scores indicates there are differences in how these two measures evaluate physical habitat conditions. Bioassessment sites that received IPI scores > 1.0 (n=11) had total PHAB scores that ranged between 29 and 55. The biggest discrepancy in these measures occurred at a sampling location in Berryessa Creek (site 205R05155), which had PHAB score of 29 and IPI score 1.0. This site also received one of the highest CSCI scores of WY 2020 (1.03), indicating that the IPI score was a better indicator for this site.

In contrast, seven of the eleven bioassessment sites with IPI scores > 1.0, exhibited low CSCI scores, ranging from 0.53 to 0.78. All seven of these sites were downstream of dams with moderately low development in their contributing watersheds (< 5% imperviousness). One explanation for sites having high IPI scores and low CSCI scores is that the metrics used to generate IPI scores do not account for physical impacts (e.g., altered flow patterns, sediment transport), and water quality impacts (temperature, food resources) associated with dams. The total PHAB scores for these seven sites ranged from 38 to 47, with most of these sites having low sediment deposition scores.

2.3.2 SCAPE Tool Comparison

The SCAPE tool (discussed in Section 2.2.4.7) provides a context for evaluating stream health by estimating an expectation of biological condition for 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 the twenty sites sampled in Santa Clara County in WY 2020 were compared to the range of scores predicted by the SCAPE model (Figure 2.5). The predicted range of CSCI scores for these sites fall into three stream classifications: possibly unconstrained (light blue), possibly constrained (light red), and likely constrained (dark red). 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”).

There were five sampling locations that scored above the range of CSCI scores predicted by the SCAPE model. Three of the five sites were in Alum Rock Park on Upper Penitencia Creek. A fourth site (205R05155) was on Berryessa Creek in the Lower Penitencia Creek watershed at the urban/non-urban boundary. The last site (205R00282) was in a restored reach of Guadalupe Creek. Continued monitoring at these sites may provide additional information on the importance of restoration projects and other factors when evaluating biological conditions.

There were a few sites that scored at the low end of the range predicted by the SCAPE model. For example, one site was in Lower Penitencia Creek (205R04523) and another was in Canoas Creek in the Guadalupe River watershed (205R05198). These findings suggest that factors other than those assessed by the SCAPE developed landscape model may be affecting biological condition. These include physical habitat and water quality stressors. Follow-up monitoring could be implemented at these sites to evaluate which stressors are impacting conditions, and further illuminate management actions that could improve biological condition.

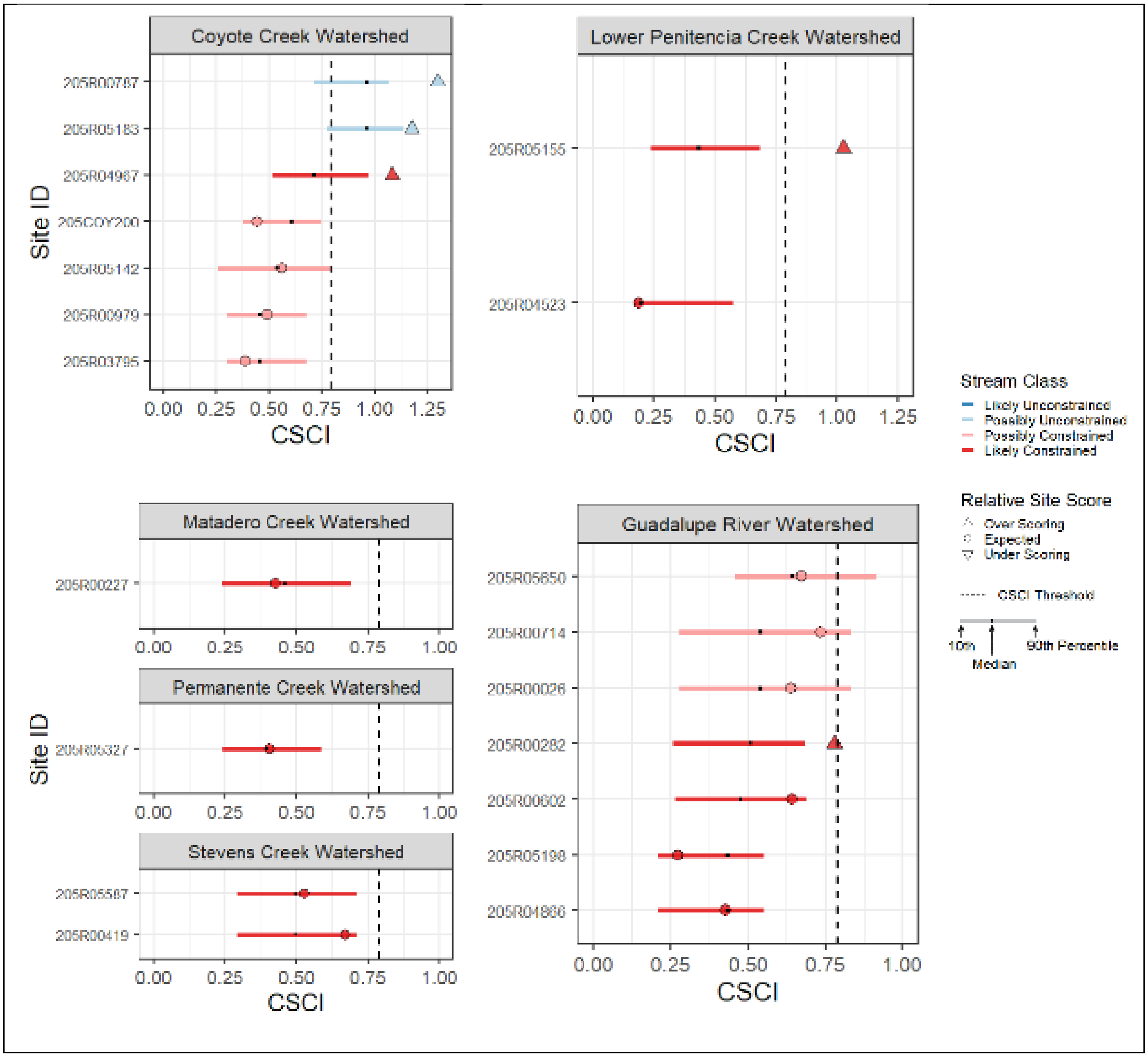

Figure 2.5. Comparison of CSCI scores for 20 sites sampled in WY 2020 in Santa Clara County with predicted CSCI scores based on SCAPE model (Beck et al. 2019).

2.3.3 Temporal Variability in Site Conditions

Biological conditions based on CSCI and D_ASCI scores for nine targeted sites in WY 2020 were compared with scores from prior year (Table 2.9). There was no consistent trend for either biological index. There was little change in CSCI scores between sampling events for six of the nine sites (i.e., between 0.01 and 0.04 difference). Exceptions to this pattern include site 205R00602 on Alamitos Creek, which had an increase in CSCI score of 0.09 that resulted in higher condition category (see Table xx for condition category ranges). The remaining two sites in Matadero and Stevens Creek had a decrease in CSCI scores over time.

The D_ASCI scores were more variable, with scoring differences of up to 0.22 points. Sites with score differences of 0.08 or greater were evenly split between increasing and decreasing scores.

Table 2.9. Comparison of CSCI and D_ASCI scores for bioassessment data collected for two different sampling events at nine targeted bioassessment sites. Score differences of 0.08 and greater are shown in bold.

Station Code	Creek	Pre-WY 2020			WY 2020	
		WY	CSCI Score	D_ASCI Score	CSCI Score	D_ASCI Score
205R00026	Los Gatos Creek	2012	0.68	**0.53**	0.64	**0.74**
205R00227	Matadero Creek	2012	**0.59**	0.61	**0.43**	0.55
205R00282	Guadalupe Creek	2012	0.74	**0.70**	0.78	**0.81**
205R00419	Stevens Creek	2013	**0.75**	**0.66**	**0.67**	**0.44**
205R00602	Alamitos Creek	2013	**0.55**	**0.75**	**0.64**	**0.64**
205R00714	Los Gatos Creek	2013	0.71	0.59	0.73	0.66
205R00787	Upper Penitencia Creek	2013	1.26	0.79	1.3	0.77
205R00979	Lower Silver Creek	2014	0.46	0.35	0.49	0.39
205R03795	Lower Silver Creek	2018	0.40	0.42	0.39	0.39

Evaluating trends using bioassessment data may be challenging with small data sets over relatively short time periods (i.e., less than 10 years). Biological conditions can be influenced by many factors that change from year to year, including timing and magnitude of storm events during the 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, if any, might be associated with changes in biological conditions at these watersheds/sites.

3.0 CONTINUOUS WATER QUALITY MONITORING

3.1 Introduction

During WY 2020 water temperature and general water quality were monitored in compliance with Creek Status Monitoring Provisions C.8.d.iii – iv of the MRP. Monitoring was conducted at selected sites using a targeted design based on the directed principle[17] 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 2020. Conclusions and recommendations for continuous monitoring are presented in Section 7.0.

3.2 Methods

Continuous water quality and temperature data were collected in accordance with SWAMP-comparable methods and procedures described in the BASMAA RMC SOPs (BASMAA 2016) and associated QAPP (BASMAA 2020). Data were evaluated with respect to the MRP provision C.8.d “Follow-up” 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 30 through September 24, 2020. Procedures used for calibrating, deploying, programming, and downloading data are described in RMC SOP FS-5 (BASMAA 2016). SCVURPPP typically deploys temperature loggers at more than minimum number of sites in anticipation of field equipment being stolen or washed downstream.

3.2.2 Continuous General Water Quality

Water quality monitoring equipment recording dissolved oxygen, temperature, conductivity, and pH (Eureka Manta+35 water probes and/or 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

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[17] 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."

events: spring season (Event 1) and summer season (Event 2). Procedures for calibrating, deploying, programming and downloading data are described in RMC SOP FS-4 (BASMAA 2016).

3.2.3 Data Evaluation

Continuous temperature and water quality data generated during WY 2020 were analyzed and evaluated to identify potential stressors that may be contributing to degraded or impacted biological conditions, including exceedances of WQOs. Provision C.8.d of the MRP identifies trigger criteria as the principal means of evaluating the creek status monitoring data to identify sites where water quality impacts may have occurred. Sites with targeted monitoring results exceeding the trigger criteria are identified as candidate SSID projects. The relevant trigger criteria for continuous temperature and water quality data are listed in Table 3.1.

Table 3.1. Water Quality Objectives and thresholds used for trigger evaluation.

Monitoring Parameter	Objective/Trigger Threshold	Units	Source
Temperature	Two or more weekly average temperatures exceed the Maximum Weekly Average Temperature (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 provision C.8.d.iii. Sullivan et al. 2000
General Water Quality Parameters[1]	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 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 [2]	pH	SF Bay Basin Plan Ch. 3, p. 3-4
Temperature	Same as Temperature (See Above)		

[1] Triggers are associated with continuous general water quality data.

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

3.3 Study Area

In compliance with the MRP, continuous temperature monitoring was conducted at a minimum of eight sites, and continuous general water quality monitoring at a minimum of three sites. In WY 2020, the targeted monitoring design focused on sites selected based on the presence of significant fish and wildlife resources as well as historical and/or recent indications of water quality concerns.

3.3.1 Temperature

Continuous (hourly) water temperature measurements were collected from April through September 2020, at nine locations[18] in the Upper Penitencia Creek watershed. Six stations were located along Upper Penitencia Creek and three stations were on Arroyo Aguague, an upper watershed tributary within Alum Rock Park (Figure 3.1). Monitored reaches within Alum Rock Park are perennial and support both rearing and spawning habitat for steelhead, as well as other native fishes (Stillwater 2006). Downstream of the monitoring stations, the lower watershed is characterized by urban/residential development and unconfined geology conducive to infiltration. Flows in the lower reaches are seasonal and are supplemented by releases of imported water from the Robert Gross Percolation Ponds which are operated by Valley Water and located about 0.5 mile downstream of the lowermost station (COY121). The temperature logger at station COY132 was discovered as missing and thus replaced in late June, resulting in only 12 weeks of data for that station.

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[18] SCVURPPP typically monitors water temperature at more stations than the MRP required minimum of eight to mitigate for potential equipment loss.

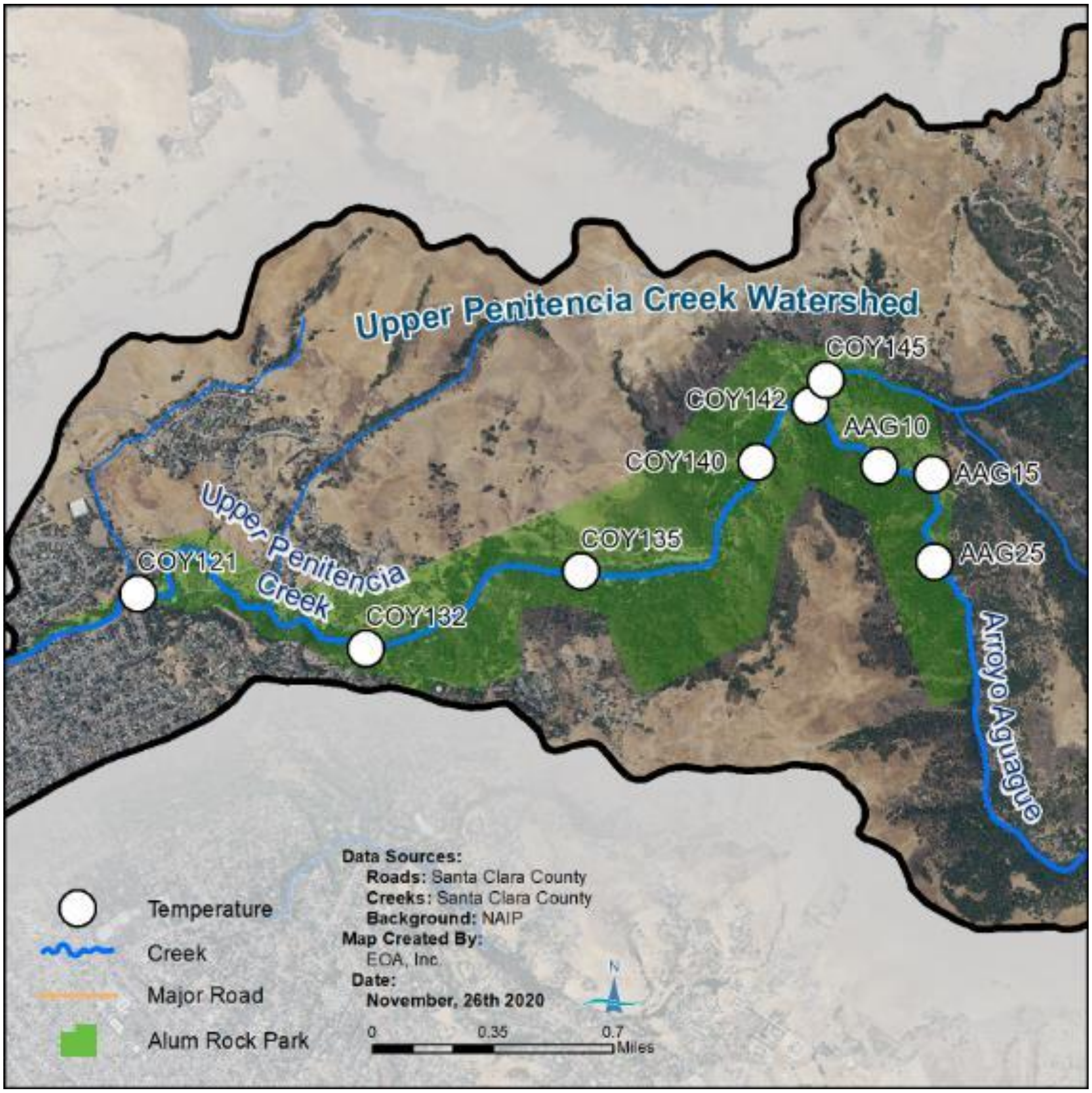

Figure 3.1. Continuous temperature stations in the Upper Penitencia Creek watershed, WY 2020.

3.3.2 General Water Quality

Continuous (15-minute) general water quality measurements (DO, specific conductance, pH, and temperature) were recorded at four locations on Lower Silver Creek (Figure 3.2). This creek was targeted to generate data in support of the Lower Silver Creek-Thompson Creek SSID project which investigates nutrients as a potential cause of poor biological condition. It is anticipated that the SSID project report will be submitted to the Regional Water Board by the end of Fiscal Year 2020/21.

The first continuous general water quality monitoring event was conducted in early June, concurrent with bioassessment monitoring, and is referenced as Event 1. Bioassessment monitoring was also conducted at two of the continuous general water quality monitoring stations (205COY182 and 205COY183); results are described in Section 2.0.

Sample Event 2 was initially conducted in early September 2020. However, due to equipment failure, no data were collected. Therefore, the Program used data collected in July 2020 as part of the Lower Silver Creek – Thompson Creek SSID Project to partially satisfy Provision C.8.d.iv requirements. The July 2020 deployment (referred to as Event 2.1) was along the same reach as Event 1, but station 205COY183 was replaced with station 205COY182.5 to evaluate water quality impacts associated with stormwater discharge from an outfall between the two sites. In order to fulfill Provision C.8.d.iv requirements, a third deployment was conducted in late September 2020 (Event 2.2) at two of the stations previously monitored in Event 1 or Event 2.1. The combined three events resulted in three of the four sample locations being monitored twice. The date ranges and locations for Events 1, 2.1, and 2.2 are shown in Table 3.2.

Table 3.2. Date range for continuous general water quality during Events 1, 2.1, and 2.2.

	205COY182	205COY182.5	205COY183	205COY195
Event 1	6/1/2020 to 6/18/2020	--	6/1/2020 to 6/18/2020	6/1/2020 to 6/18/2020
Event 2.1	7/14/2020 to 7/27/2020	7/14/2020 to 7/27/2020	--	--
Event 2.2	--	9/15/2020 to 9/29/2020	--	9/15/2020 to 9/29/2020

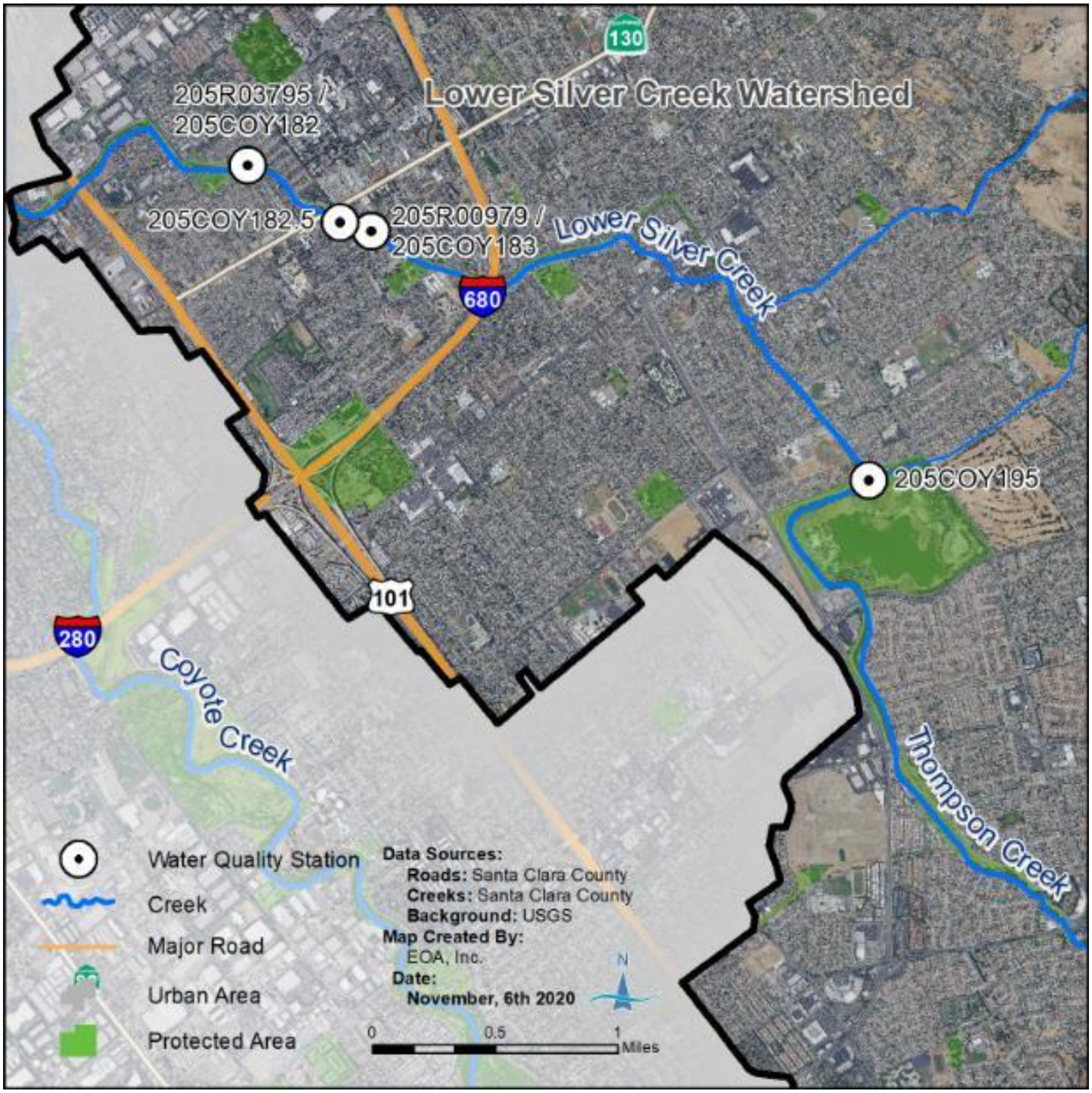

Figure 3.2. Continuous water quality stations in Lower Silver Creek watershed, WY 2020.

3.4 Results and Discussion

The section below summarizes results from continuous temperature and water quality monitoring conducted during WY 2020 for Provision C.8.d.iii and iv compliance. Additional review of the water quality monitoring data will be discussed in the Lower Silver Creek – Thompson Creek SSID project report which will be submitted by the end of Fiscal Year 2020/21. Conclusions and recommendations for this section are presented in Section 7.0.

3.4.1 Continuous Temperature

Temperature loggers were deployed at nine sites in the Upper Penitencia Creek watershed on April 30, 2020; checked and downloaded on July 8, 2020; and removed on September 24, 2020 (21 weeks). During the mid-season check on July 8, the temperature logger at site COY132 could not be found. A new logger was deployed, resulting in only 12 weeks of data recorded at that site.

Summary statistics for continuous water temperature data collected at the nine sites are listed in Table 3.3. The number and percent of measurements from each site that exceed the instantaneous maximum temperature trigger of 24°C is shown in the table. The MRP trigger threshold of 20% of monitoring results greater than 24°C was not exceeded at any sampled location; however, instantaneous temperatures greater than 24°C were recorded at two sites (COY132 and COY135) during the month of August. At site COY132, 33 measurements exceeded the temperature trigger, roughly 2%. At site COY135, 6 measurements exceeded the temperature trigger accounting for less than 1% of the total number of observations.

Maximum Weekly Average Temperature (MWAT) values were calculated for each of the nine monitoring sites (Table 3.4). Consistent with MRP requirements, the MWAT was calculated for non-overlapping, seven-day periods. The MWAT values across all the sites ranged from lows of 12.4°C to 15.5°C during early-May to highs of 17.3 °C to 22.5°C during mid-August. After the high temperatures in August, the MWAT began to decrease through the end of the deployment period in September. All sites exceeded the MWAT trigger for the weeks of August 13, August 20, and September 3 (Table 3.4 and Figure 3.3). Those weeks coincide with heat waves when air temperatures in the area ranged between 90°F and 105°F multiple days in a row (Figure 3.5). The MWAT trigger was exceeded at all sampling locations; thus, all sites will be added to the list of potential sites considered for SSID projects.

Water temperature data, calculated as a daily average, for monitoring sites in the Upper Penitencia Watershed in WY 2020, are shown in Figure 3.4. Maximum daily air temperature data recorded at San Jose Airport are shown in Figure 3.5. Water temperatures generally increased throughout the summer months of May through mid-August followed by a slow decline. Spikes in the daily average water temperatures observed in early-June, mid-August, and early-September correspond to spikes in maximum daily air temperature observed during the same time frame. Water temperatures were generally lower at the upstream sites (205COY145, 205AAG025) compared to the downstream locations for both mainstem Upper Penitencia Creek and the tributary Arroyo Aguague.

Table 3.3. Descriptive statistics for continuous water temperature measured between April 30 and September 24, 2020 at nine sites in the Upper Penitencia Creek watershed, Santa Clara County.

		Upper Penitencia Creek (downstream ---------------------------- upstream)						**Arroyo Aguague (downstream ---------------------------- upstream)**		
	Site ID	**205COY121**	**205COY132**	**205COY135**	**205COY140**	**205COY142**	**205COY145**	**205AAG010**	**205AAG015**	**205AAG025**
	Start Date	4/30/2020	7/8/2020	4/30/2020	4/30/2020	4/30/2020	4/30/2020	4/30/2020	4/30/2020	4/30/2020
	End Date	9/24/2020	9/24/2020	9/24/2020	9/24/2020	9/24/2020	9/24/2020	9/24/2020	9/24/2020	9/24/2020
Temperature (ºC)	Minimum	11.6	15.5	12.1	10.9	10.0	10.3	9.4	9.6	9.5
	Median	17.0	19.3	18.4	16.0	16.4	16.0	17.5	16.2	16.5
	Mean	17.2	19.6	18.5	16.1	16.5	15.5	17.2	16.0	16.1
	Maximum	22.4	25.7	24.4	22.1	23.2	18.5	22.3	20.8	19.2
	N (# individual measurements)	3524	1868	3525	3527	3527	3526	3524	3525	3525
# Measurements > 24°C		0	33	6	0	0	0	0	0	0
% Measurements > 24°C		0%	2%	0%	0%	0%	0%	0%	0%	0%

Table 3.4. MWAT values for water temperature data collected at nine stations in Upper Penitencia Creek watershed, WY 2020. Values that exceed the MWAT threshold (17°C) are indicated in bold.

	Upper Penitencia Creek **(downstream -- upstream)**						**Arroyo Aguage** **(downstream ---------------- upstream)**		
Station	**205COY121**	**205COY132**	**205COY135**	**205COY140**	**205COY142**	**205COY145**	**205AAG010**	**205AAG015**	**205AAG025**
Date	**Weekly Average Temperature (°C)**								
4/30/2020	15.5	-	15.1	13.3	13.2	12.4	12.9	12.6	12.4
5/7/2020	15.8	-	16.1	13.7	14.1	13.0	13.9	13.5	13.2
5/14/2020	15.8	-	15.8	13.8	14.0	13.2	13.8	13.5	13.3
5/21/2020	15.8	-	**17.6**	14.3	15.6	13.7	15.3	14.5	14.1
5/28/2020	**17.5**	-	**19.0**	15.9	16.8	14.8	**17.1**	16.4	16.0
6/4/2020	16.0	-	**18.1**	15.2	15.5	14.4	16.0	15.0	15.4
6/11/2020	16.3	-	**17.9**	15.2	15.6	14.7	16.3	15.0	15.1
6/18/2020	16.7	-	**19.2**	16.3	**17.3**	15.8	**17.8**	16.0	15.8
6/25/2020	**17.2**	-	**19.6**	16.6	**18.1**	16.3	**18.9**	16.7	**17.2**
7/2/2020	16.2	**21.1**	**18.6**	16.0	**17.2**	15.8	**17.5**	15.4	16.3
7/9/2020	**17.6**	**19.8**	**19.5**	16.4	16.3	16.2	**18.7**	16.4	16.4
7/16/2020	**18.4**	**19.6**	**19.1**	16.4	16.4	16.2	**19.3**	16.8	**17.1**
7/23/2020	**18.3**	**19.5**	**18.9**	16.5	16.4	16.1	**19.1**	16.7	**17.0**
7/30/2020	**18.1**	**19.0**	**18.6**	16.4	16.1	16.0	**18.6**	16.4	16.9
8/6/2020	**17.7**	**19.9**	**19.3**	16.9	**17.2**	16.3	**18.8**	16.9	16.9
8/13/2020	**20.6**	**22.5**	**22.0**	**19.0**	**19.6**	**17.3**	**20.8**	**19.2**	**18.1**
8/20/2020	**19.6**	**21.0**	**20.6**	**18.5**	**18.7**	**17.4**	**19.5**	**18.8**	**18.6**
8/27/2020	**17.0**	**18.8**	**18.2**	16.9	16.9	16.6	**17.6**	16.9	**17.8**
9/3/2020	**17.8**	**19.7**	**19.2**	**17.5**	**17.8**	**17.0**	**17.3**	**17.1**	**17.0**
9/10/2020	16.2	**17.5**	**17.3**	16.1	16.1	16.2	15.8	15.7	16.4
9/17/2020	**17.0**	**18.1**	**17.6**	16.7	16.6	16.5	15.9	16.0	16.1
Total Weeks	21	12	21	21	21	21	21	21	21
Max MWAT	**20.6**	**22.5**	**22**	19	19.6	17.4	**20.8**	19.2	18.6
Number >17°C	12	12	18	3	7	3	13	3	7
> MRP Trigger	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**

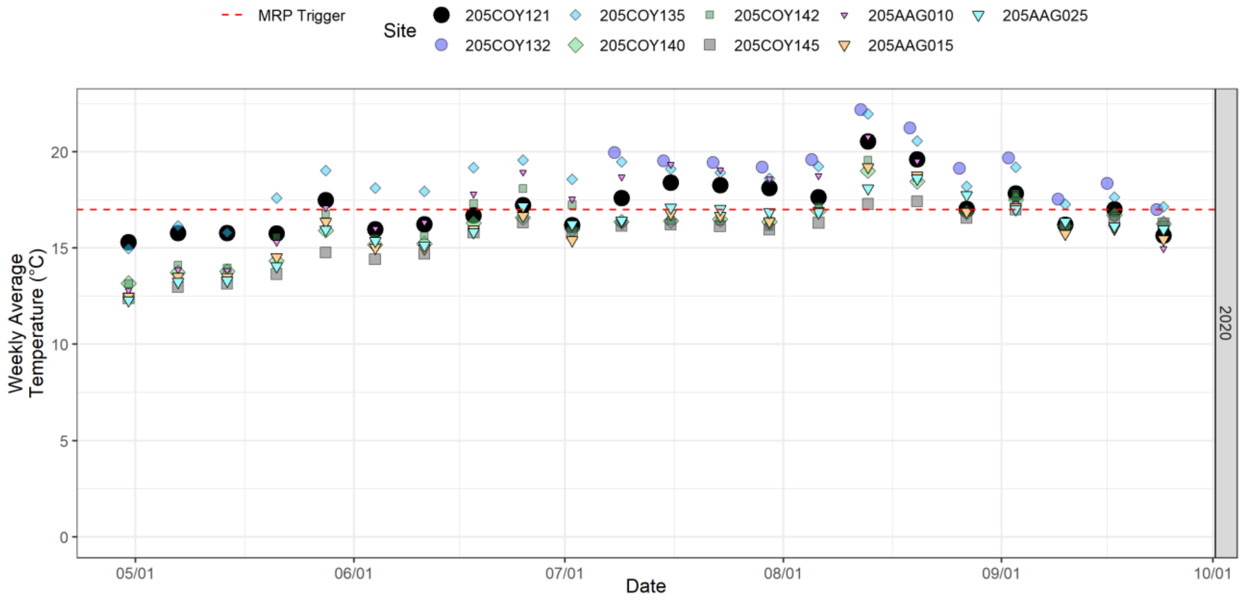

Figure 3.3. Maximum Weekly Average Temperature (MWAT) values calculated for water temperature collected at four sites in the Upper Penitencia Creek watershed over 21 weeks of monitoring in WY 2020. The MWAT threshold (17°C) is shown for comparison.

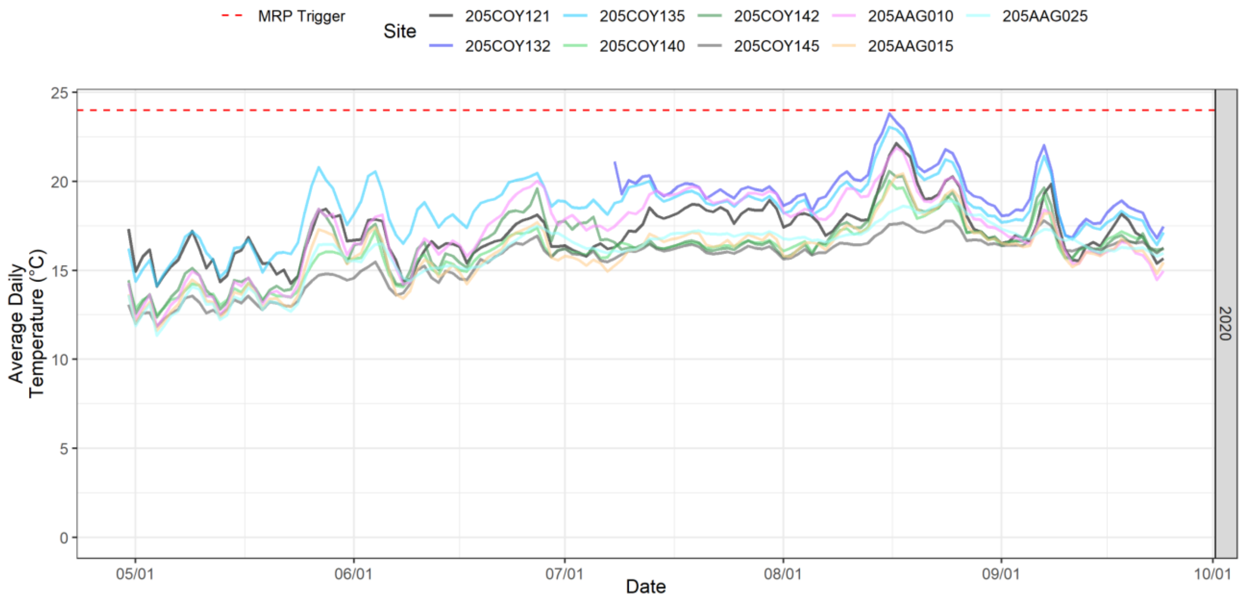

Figure 3.4. Water temperature, shown as daily average, collected between April and September at nine sites in the Upper Penitencia Creek watershed during WY 2020.

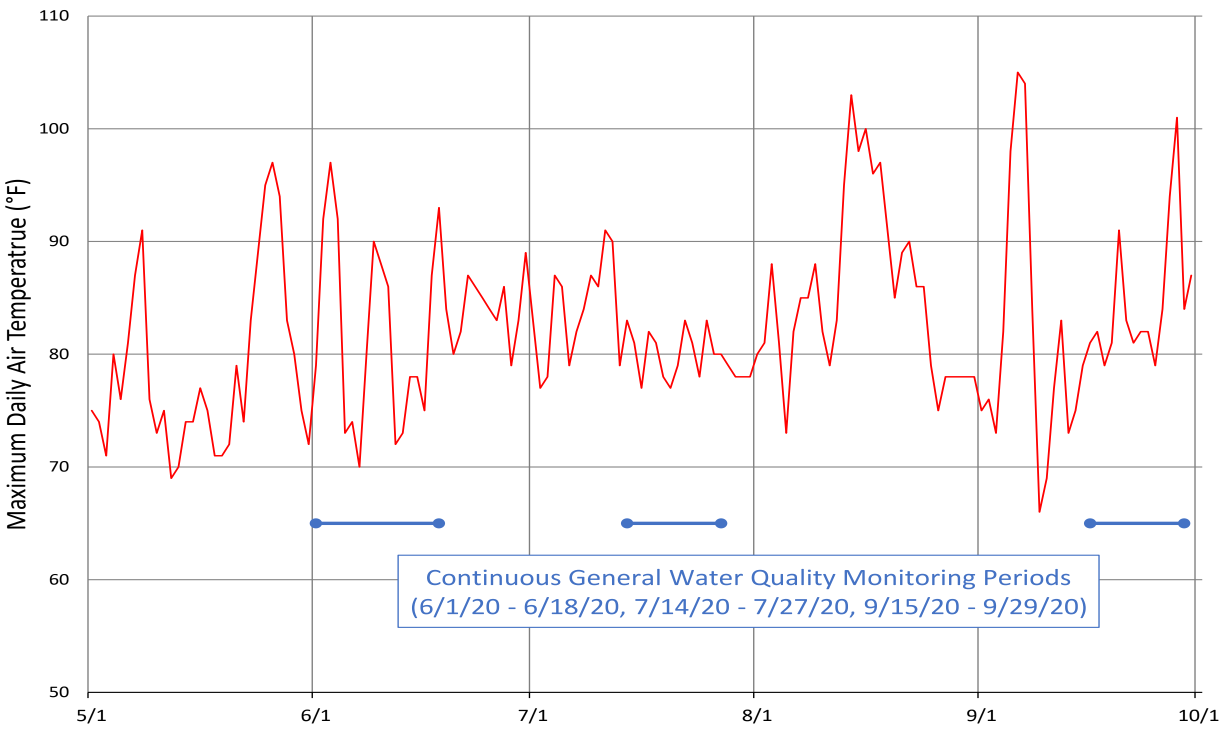

Figure 3.5. Maximum daily air temperatures at San Jose International Airport, May – September 2020 (NOAA station USW00023293).

3.4.2 General Water Quality

Summary statistics for general water quality measurements (dissolved oxygen, pH, specific conductance, temperature) collected at the three sites in Lower Silver Creek during WY 2020 are listed in Table 3.5. Monitoring was conducted at three stations from June 1 through June 18, 2020 during Event 1. Event 2 was composed of two monitoring periods across three stations: July 14 through July 27, 2020 (stations 205COY182 and 205COY182.5) and September 15 to September 29, 2020 (stations 205COY182.5 and 205COY195). Plots for all water quality parameters measured during Events 1 (June), 2.1 (July), and 2.2 (September) are shown Figure 3.6.

General water quality sampling locations are mapped in Figure 3.2. Station 205COY195 is located on the north end of Lake Cunningham Regional Park in Lower Silver Creek just downstream of the confluence with Flint Creek. Station 205COY183 is located approximately 2.75 miles downstream of COY195, just upstream of the S Sunset Av road crossing. Station 205COY182.5 is located between S Sunset Av bridge and Alum Rock Av bridge. Station 205COY182 is located at the upstream end of Arroyo Plato Park, just below the end of the concrete channel. There is one tributary (South Babb Creek) between 205COY195 and the downstream stations. All three stations are within the urban envelope; however, there is also a riparian corridor at all four stations. Photos of the four stations are included in Figure 3.7.

Table 3.5. Descriptive statistics for continuous water temperature, dissolved oxygen, pH, and specific conductance measured at four Lower Silver Creek sites in Santa Clara County during WY 2020. Data were collected every 15 minutes over three 2-week time periods during June (Event 1), July (Event 2.1) and September (Event 2.2).

Parameter	Data Type	205COY182			205COY182.5			205COY183			205COY195		
		Event 1	Event 2.1	Event 2.2	Event 1	Event 2.1	Event 2.2	Event 1	Event 2.1	Event 2.2	Event 1	Event 2.1	Event 2.2
Assessment Date Range:		6/1-6/18	7/14-7/27	9/15-9/29	6/1-6/18	7/14-7/27	9/15-9/29	6/1-6/18	7/14-7/27	9/15-9/29	6/1-6/18	7/14-7/27	9/15-9/29
Temperature (°C)	Minimum	17.7	20.2	--	--	20.2	18.4	17.2	--	--	16.9	--	18.6
	Median	21.4	22.5	--	--	23.1	21.0	22.0	--	--	21.9	--	20.8
	Mean	21.7	22.8	--	--	23.2	21.0	21.9	--	--	21.9	--	20.8
	Maximum	27.4	26.7	--	--	26.4	23.7	27.4	--	--	27.4	--	23.2
	% > 24	14%	**24%**	--	--	**35%**	0%	18%	--	--	18%	--	0%
Specific Conductivity (uS/cm)	Minimum	1211	1270	--	--	1255	1295	1214	--	--	1179	--	1116
	Median	1390	1358	--	--	1324	1316	1284	--	--	1216	--	1150
	Mean	1409	1407	--	--	1324	1317	1286	--	--	1224	--	1152
	Maximum	1569	1538	--	--	1387	1344	1386	--	--	1604	--	1239
	% > 2000	0%	0%	--	--	0%	0%	0%	--	--	0%	--	0%
pH	Minimum	7.5	7.7	--	--	8.1	8.2	8.1	--	--	--	--	7.7
	Median	8.1	8.1	--	--	8.3	8.2	8.2	--	--	--	--	7.9
	Mean	8.1	8.0	--	--	8.3	8.2	8.2	--	--	--	--	7.9
	Maximum	8.6	8.4	--	--	8.5	8.3	8.5	--	--	--	--	8.0
	% < 6.5 or > 8.5	4%	0%	--	--	3%	0%	0%	--	--	--	--	0%
Dissolved Oxygen (mg/L)	Minimum	4.2	5.0	--	--	4.5	5.7	5.0	--	--	3.4	--	4.3
	Median	8.2	8.0	--	--	7.5	6.7	8.3	--	--	5.7	--	5.4
	Mean	9.6	9.0	--	--	8.3	7.0	8.5	--	--	6.1	--	5.8
	Maximum	25.1	15.1	--	--	13.3	9.2	13.4	--	--	10.7	--	9.9
	% < 5	10%	0%	--	--	2%	0%	0%	--	--	**30%**	--	**27%**
Total number of data points (N)		1617	1241			1239	1323	1619			1619		1624

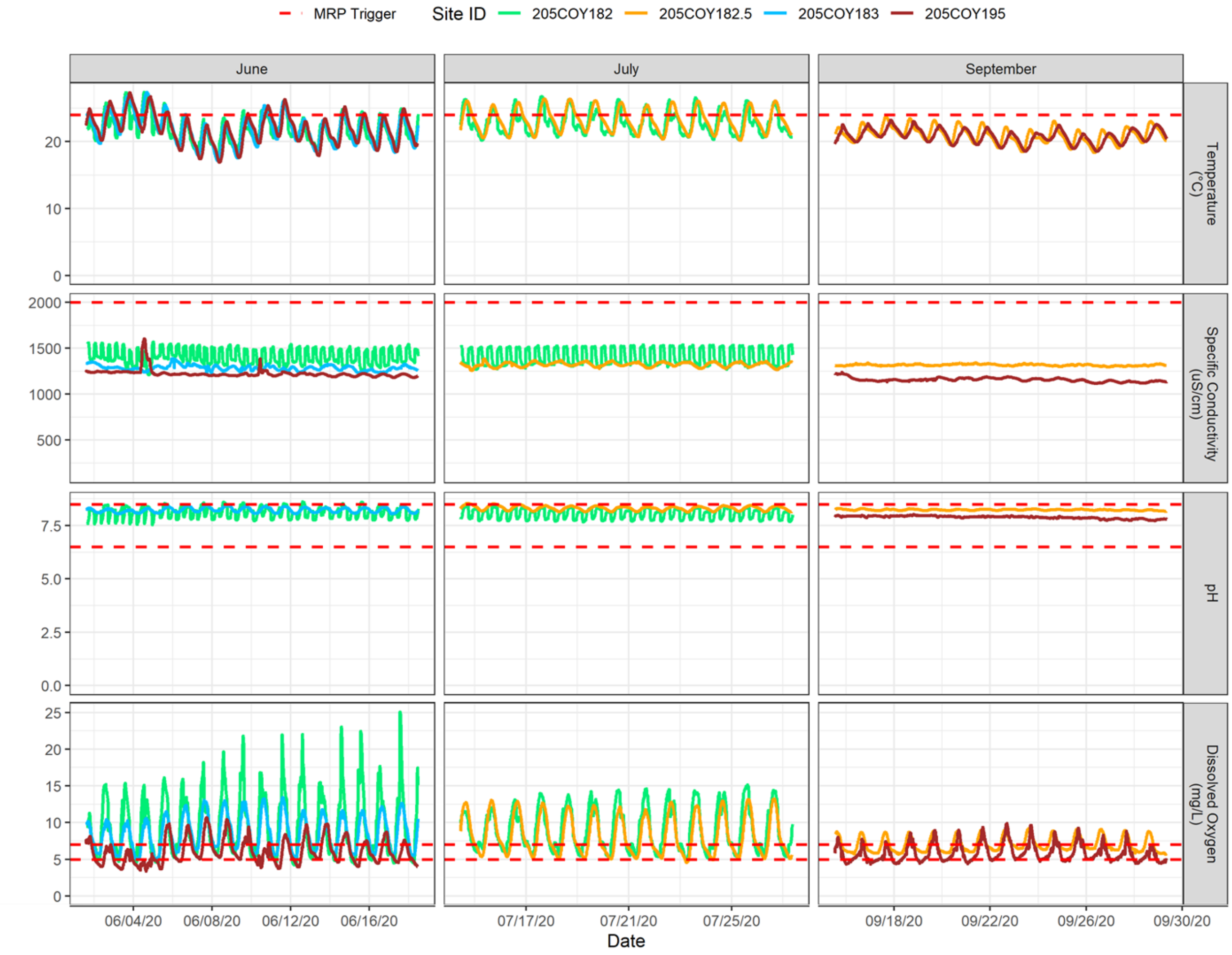

Figure 3.6. Continuous water quality data (temperature, specific conductance, pH, and dissolved oxygen collected at four sites in Lower Silver Creek in June, July, and September 2020.

Figure 3.7. Lower Silver Creek at stations 205COY195, 205COY183, 205COY182.5 and 205COY182. Photos captured Sept. 13, 2020.

Temperature

The water temperature data follow a similar pattern at all four sites during the three sample events (Figure 3.6) - cooler temperatures are recorded at night and warmer temperatures in the afternoon. During the June event there were two overall peaks in water temperature which appear to follow high air temperatures reported for the San Jose International Airport station (Figure 3.5). Water temperatures are relatively steady throughout the July event (Event 2.1). Water temperatures were cooler during the September event (Event 2.2), likely as a result of cooler air temperatures reported shortly before equipment were deployed (Figure 3.5).

Water temperatures exceeded 24°C at all three sites during Event 1, but the exceedances did not comprise more than 20% of the results (Table 3.5). During Event 2.1, the 24°C instantaneous maximum was exceeded in 24% of results at site COY182 and 35% of results at COY182.5. The MWAT threshold (17 °C) was exceeded at all four stations during all weeks of the three events.

Lower Silver Creek is not listed as having COLD Beneficial Uses and does not provide spawning or rearing habitat for steelhead in any reaches. Therefore, these exceedances of the MRP temperature trigger may not indicate water quality concerns.

Specific Conductance

Specific conductance ranged between 1116 to 1605 µS /cm at all four sites during all sampling events, and thus, never exceeded the MRP trigger threshold (2000 µS/cm). There was very little seasonality to the record with roughly the same levels measured during June compared to September. There was a distinct pattern in the record for station COY182, the downstream-most station which was monitored during Event 1 and Event 2.1, with spikes of 200 µS /cm three times a day at regular intervals. These spikes are likely associated with discharges from an upstream outfall located approximately 1200 fee upstream of station COY182 that drains a catchment containing a pump station that is owned and operated by Caltrans. During the dry season, water, presumably groundwater, accumulates in the storm drain system and is removed by the pump. A similar thrice-daily pattern was seen in the pH record for station COY182.

pH

Measured pH values ranged from a low of 7.5 at station COY182 during Event 1 to a high of 8.6, also measured at station COY182 during Event 1 (Table 3.5). Overall, pH values were similar across all three stations during the three events; however, there was a thrice-daily pattern to the record at station COY182, likely caused by pump station operations in a catchment upstream of COY182 but downstream of COY182.5. The upper WQO of 8.5 for pH was exceeded in some measurements at stations COY182 and COY182.5. Because less than 20% of the results were above pH 8.5, the MRP trigger threshold was not exceeded. Calibration checks of the water probe that was deployed at station COY195 during Event 1 showed a drift in the pH sensor of over 0.2 units, which was not consistent with MQOs in the project QAPP (BASMAA 2020). Those pH data were rejected and not used in the analyses.

Dissolved Oxygen

Lower Silver Creek has WARM Beneficial Uses, but not COLD Beneficial Uses. Therefore, the trigger threshold for dissolved oxygen (DO) is 5.0 mg/L; DO concentrations should remain above 5.0 mg/L. Overall dissolved oxygen concentrations ranged from a low of 3.4 mg/L at COY195 during Event 1 to a high of 25.1 at COY182 during Event 1. The MRP trigger of at least 20% of results below the 5 mg/L threshold was exceeded at COY195 during Event 1 (Table 3.5).

DO concentrations followed a diurnal pattern at all stations during all events (Figure 3.6). During the June event, there was high variability in DO concentrations at station COY182, with readings ranging from around 5 mg/L in the evenings to approximately 25 mg/L in the afternoons. These fluctuations could be attributed to active aquatic vegetation in the proximity of the water probe and/or influence from the upstream outfall that discharges water from the Caltrans pump station. The high variability was not observed during Event 2.1 when DO concentrations at station COY182 were similar to those measured at station COY182.5. The causes for the change in DO variability at station COY182 are unknown but could be related to differences in aquatic vegetation, water column depth, and stream flow between June and July. At station COY182.5, there was less variability in the diurnal DO fluctuations during the September sampling event compared to the other events, likely due to lower water temperatures (Figure 3.6).

Continuous Water Quality Trigger Summary

All three sites exceeded the MRP triggers for MWAT and site COY195 exceeded the MRP trigger for DO. All stations are part of the ongoing Lower Silver Creek -Thompson Creek SSID study that is anticipated for completion in June 2021.

4.0 PATHOGEN INDICATORS

4.1 Introduction

This section describes the results of pathogen indicator monitoring that was conducted during WY 2020 in compliance with Creek Status Monitoring Provision C.8.d.v of the MRP. Monitoring sites were selected 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 the MRP, five samples were collected in WY 2020. The sections below summarize methods and results from pathogen indicator monitoring conducted during the current year. 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 2016) and QAPP (BASMAA 2020). Sampling techniques for pathogen indicators (*E. coli*, enterococci) 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 2020).

4.2.2 Data Evaluation

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 the adopted WQOs are both based on the 2012 USEPA recommended recreational water quality criteria (RWQC). The 2012 RWQC offers two sets of numeric thresholds for *E. coli* and enterococci intended to protect water contact recreation 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). The MRP specifies the illness rate of 36/1,000 as a trigger threshold; whereas the State Water Board adopted the more conservative set of criteria based on the illness rate of 32/1,000.

The WQOs adopted by the State Water Board use *E. coli* as the sole indicator organism for freshwaters (i.e., salinity is equal to or less than 1 part per thousand (ppth) 95 percent or more of the time) and enterococci as the sole indicator for marine and brackish waters (i.e., salinity is greater than 1 ppth more than 5 percent of the time).

The WQOs consist of both a geometric mean (GM) and a Statistical Threshold Value (STV). The GM criteria is applied when there are at least five samples distributed over a six-week period. The STV criteria should not be exceeded by more than 10 percent of the samples taken in a month, and therefore the STV approximates 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.

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

Pathogen Indicator	**State Water Board WQO (Estimated Illness Rate 32/1,000) ***		**MRP Trigger Threshold (Estimated Illness Rate 36/1,000)**	
	GM	STV	GM	STV
E. coli (cfu/100 mL)	100	320	125	410
Enterococci (cfu/100 mL)	30	110	35	130

* The State Water Board WQOs use *E. coli* as the indicator for freshwater and enterococci as the indicator for marine and brackish water.

4.3 Study Area

In compliance with Provision C.8.d.v of the MRP, five pathogen indicator samples were collected in WY 2020. Samples were collected during one sampling event (July 17, 2020) at five sites located in municipal parks with public access to creeks and thus potential for recreational water contact (Figure 4.1). Sites were located on Coyote Creek at Hellyer Park (205COY330) and Metcalf Park (205COY392) and on Los Gatos Creek at Pruneyard (205LGA033), Vasona Park (205LGA400), and Novitiate Park (205GLA420). These stations have been monitored by the Program for pathogen indicators in past years (WYs 2013, 2017, 2018, and 2019). Historical data are included with WY 2020 data in Table 4.2. Repeat sampling can provide information (albeit limited) on the variability at each site.

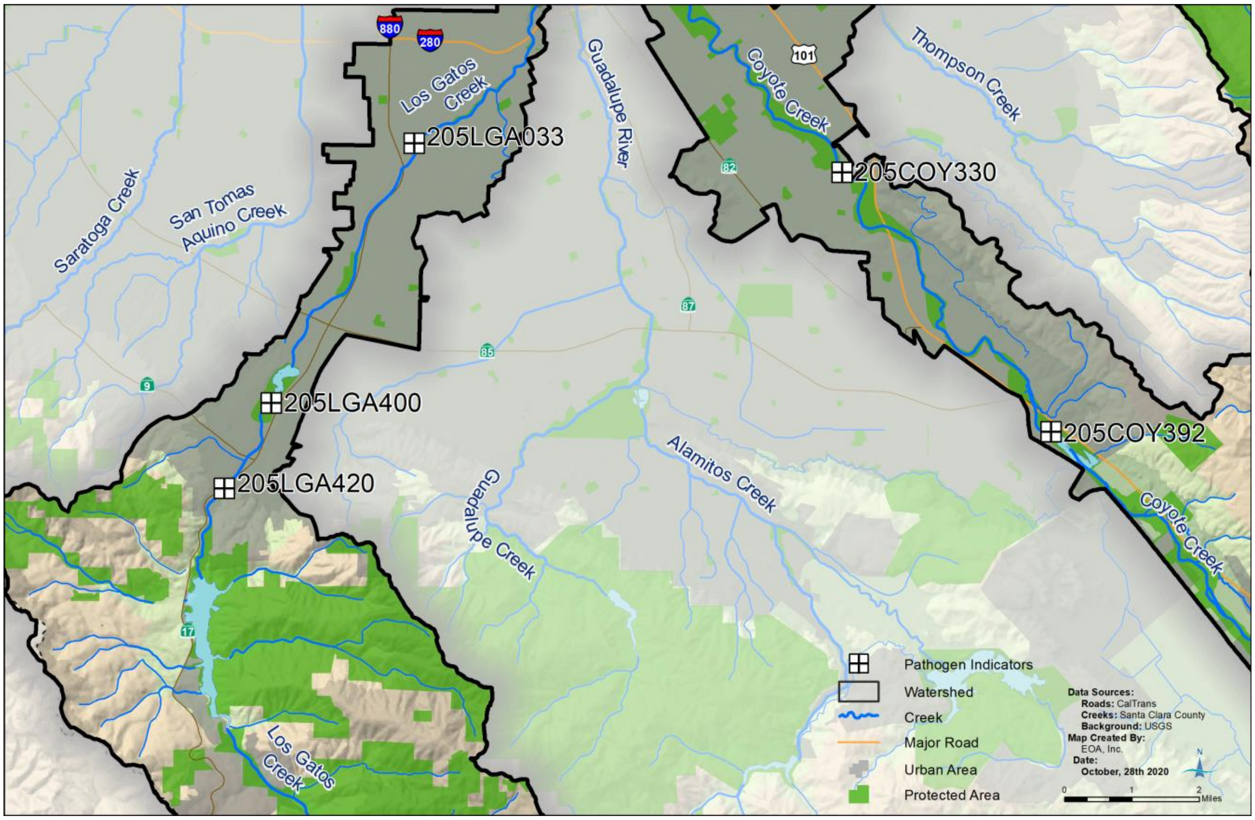

Figure 4.1. Pathogen indicator monitoring sites sampled in Santa Clara County in WY 2020.

4.4 Results and Discussion

Pathogen indicator (*E. coli* and enterococci) densities measured in grab samples collected on July 17, 2020 are listed in Table 4.2 along with historical data for those stations. Stations are mapped in Figure 4.1. There were no measurements that exceeded the MRP trigger or more conservative State Water Board WQO for *E. coli* in WY 2020. However, one sample exceeded the MRP trigger for enterococci (station 205LGA033). The field crew observed waterfowl in the creek at the time of sample collection, which could contribute to the bacterial counts. Pathogen indicator densities measured at this site in WY 2019 did not exceed the MRP trigger.

Table 4.2 includes pathogen indicator density data from prior years for the WY 2020 stations. Although this multi-year dataset is insufficient to identify trends, it does highlight the variability in microbial data in Santa Clara Valley creeks. For example, although enterococci densities (concentrations) at station 205LGA033 exceeded the MRP trigger in WY 2020 they were an order of magnitude lower in WY 2019.

Table 4.2. Enterococci and *E. coli* levels measured in Santa Clara County during WY 2020. Results exceeding the MRP trigger are highlighted. Results exceeding the more conservative WQO are bolded.

Site ID	Creek Name	Site Name	Enterococci (cfu/100ml) (MPN/100ml)[1]	*E. Coli* (cfu/100ml) (MPN/100ml) [1]	Sample Date
MRP Trigger Threshold (USEPA 2012; 36 per 1000 recreators)			130	410	
Statewide WQO (based on 32 per 1000 recreators)			110 [2]	320	
205COY330	Coyote Creek	Coyote Creek at Hellyer Park	38.8	30.5	07/17/2020
			157	70	08/01/2019
			110	110	07/22/2013
205COY392	Coyote Creek	Coyote Creek at Metcalf Park	5.2	22.6	07/17/2020
			7.4	27.2	08/01/2019
205LGA033	Los Gatos Creek	Los Gatos Creek at Pruneyard	1046	304	07/17/2020
			12.1	102	08/01/2019
205GLA400	Los Gatos Creek	Los Gatos Creek at Vasona Park	120	60.5	07/17/2020
			17.1	**326**	08/01/2019
			88.6	138	07/27/2018
			28.5	NR	07/17/2017
			NR	240	07/22/2013
205GLA420	Los Gatos Creek	Los Gatos Creek at Novitiate Park	23.8	45.7	07/17/2020
			14.8	7.5	08/01/2019

NR = not reported

[1] USEPA 2012 water quality criteria are given in cfu/100 mL; whereas, the analytical method used by the Program gives results in MPN/100 mL. These units are used interchangeably in this analysis.

[2] Statewide WQOs for enterococci do not apply to freshwaters.

It is important to recognize that "most strains of *E. coli* and enterococci do not cause human illness (that is, they are not human pathogens); rather, they indicate the presence of fecal contamination" because they often co-occur with pathogens (USEPA 2012). Thus, pathogen indicators do not directly represent actual pathogen concentrations, nor do they distinguish among sources of bacteria. Testing water samples for specific pathogens is generally not practical for several 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, and the number of possible pathogens to potentially test for 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 in humans. However, the same chlorine can be toxic to aquatic species if unmanaged. Chlorinated water may be inadvertently discharged to the MS4s and/or urban creeks from residential activities, such as pool dewatering, over-watering landscaping, or from municipal activities such as hydrant flushing or water main breaks.

In compliance with Provision C.8.d.ii of the MRP and to assess whether chlorine in receiving waters is present at concentrations potentially toxic to the aquatic life, 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 theoretically 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), WY2020 field testing for free chlorine and total chlorine residual was conducted at all twenty bioassessment sites concurrent with spring bioassessment sampling. Bioassessment site selection is 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 2016), which are comparable to those specified in the SWAMP QAPP. Per SOP FS-3 (BASMAA 2016), water samples were collected and analyzed for free and total chlorine using a Pocket Colorimeter^{TM} II and DPD Powder Pillows, which has a manufacturer reported method detection limit of 0.02 mg/L. If concentrations exceed the MRP trigger criteria of 0.1 mg/L, the site was immediately resampled. 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 also specifies that “Permittees report the observation to the appropriate Permittee central contact point for illicit discharges so 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

In WY 2020, SCVURPPP monitored the twenty bioassessment sties for free chlorine and total chlorine residual. These measurements were compared to the MRP trigger threshold of 0.1 mg/L. Results are listed in Table 5.1. The trigger thresholds for free chlorine and total chlorine residual were not exceeded in WY 2020.

For unknown reasons, the free chlorine result was greater than the total residual chlorine result at four stations (Table 5.1). Inverted results such as these have been occasionally noted through the WY 2012 – WY 2020 monitoring program (SCVURPPP 2020). 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 sample, but alkalinity was not measured. At all but one station (205R00714), 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. 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 0.1mg/L as a reporting limit for field measurements of total chlorine residual.

Table 5.1. Chlorine testing results compared to MRP trigger of 0.1 mg/L, WY 2020.

Site ID	Date	Creek	Free Chlorine (mg/L) [1,2]	Total Residual Chlorine (mg/L) [1,2]
205COY200	06/03/20	Thompson Creek	0.05	0.03
205R00026	05/07/2020	Los Gatos Creek	0.03	0.03
205R00227	05/05/2020	Matadero Creek	0.02	0.03
205R00282	05/11/2020	Guadalupe Creek	0.02	0.02
205R00419	05/14/2020	Stevens Creek	0.03	0.05
205R00602	05/13/2020	Los Alamitos Creek	0.03	0.04
205R00714	06/01/2020	Los Gatos Creek	0.02	<0.02
205R00787	06/04/2020	Upper Penitencia Creek	<0.02	0.02
205R00979	06/02/20	Lower Silver Creek	0.04	0.06
205R03795	06/02/20	Lower Silver Creek	0.04	0.07
205R04523	05/07/2020	Lower Penitencia Creek	0.04	0.09
205R04866	05/12/2020	Canoas Creek	0.03	0.04
205R04967	05/6/2020	Upper Penitencia Creek	0.03	0.03
205R05142	06/03/20	Thompson Creek	0.02	<0.02
205R05155	05/07/2020	Berryessa Creek	0.02	0.02
205R05183	05/06/2020	Upper Penitencia Creek	0.02	0.02
205R05198	05/12/2020	Canoas Creek	0.06	0.05
205R05327	05/05/2020	Hale Creek	0.03	0.06
205R05587	05/28/2020	Stevens Creek	0.1 *	NR
205R05650	05/13/20	Alamitos Creek	0.05	0.07

*, NR = The colorometer malfunctioned during the attempt to measure total chlorine residual at Station 205R05587 and no data were reported. The free chlorine result for this station was flagged as suspect due to the malfunctioning colorometer.

[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.

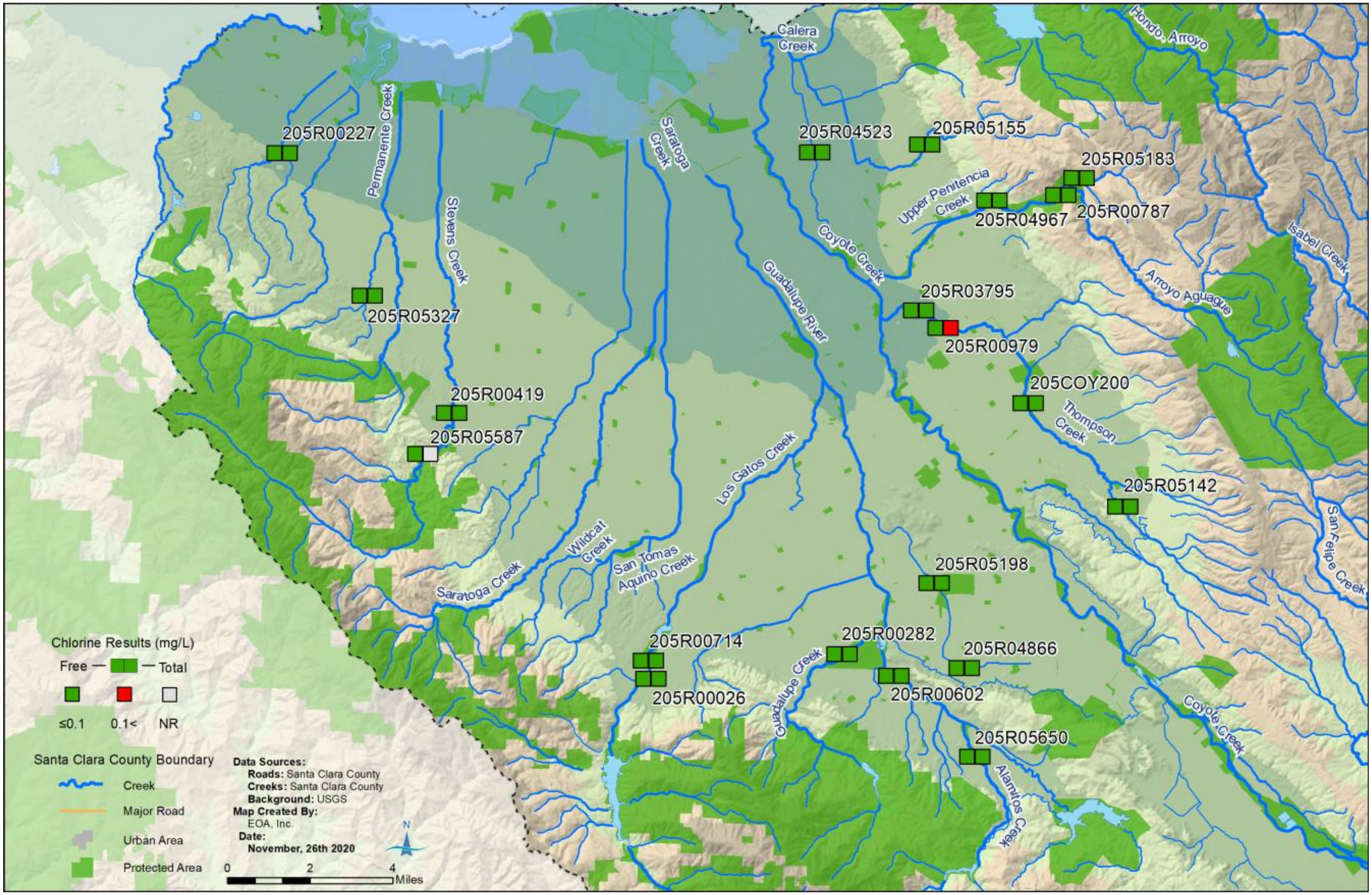

Figure 5.1 Chlorine sample stations and results WY 2012 – WY 2020 in Santa Clara County.

6.0 TOXICITY AND SEDIMENT CHEMISTRY MONITORING

6.1 Introduction

This section describes the results of toxicity testing and sediment chemistry monitoring (collectively referred to as pesticides and toxicity monitoring) conducted during WY 2020 in compliance with Provision C.8.g of the MRP. The following discussion includes historical data from the WY 2020 stations as well as local pesticides and toxicity monitoring results from projects external to SCVURPPP to inform management efforts for Santa Clara Basin urban creeks with respect to achievement of WQOs and support of beneficial uses.

Toxicity testing provides a tool for assessing the toxic effects (acute and chronic) of all chemicals in samples of 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 monitored. 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.

Provision C.8.g of the MRP requires both wet and dry weather monitoring of pesticides and toxicity in urban creeks.

Dry Weather

Provision C.8.g of the MRP 2.0 requires the Program to sample two stream sites each year during the dry season for pesticides and toxicity. The MRP 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 the MRP include:

- 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.

Wet Weather

Provision C.8.g.iii.(3) of the MRP requires a collective total of ten wet weather toxicity and water chemistry samples if the wet weather monitoring is conducted by the RMC on behalf of all Permittees.. The MRP 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. 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.[19] All ten 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

Throughout the term of the MRP, the Program has collected dry weather samples each year from the same two sites on 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) (see Figure 6.1 for SPoT and DPR monitoring stations). SCVURPPP stations within the Stevens Creek and San Tomas Aquino Creek 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 SCVURPPP will continue to sample these same two stations during the remainder 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 the MRP, 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 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.

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 2016) and the associated QAPP (BASMAA 2020). 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 2016).

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

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[19] Standard analytical methods for indoxacarb were not available in 2018; thus the samples were not analyzed for indoxacarb.

chemical or toxicological analysis using standard clean sampling techniques (see SOP FS-6, BASMAA 2016).

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 2016).

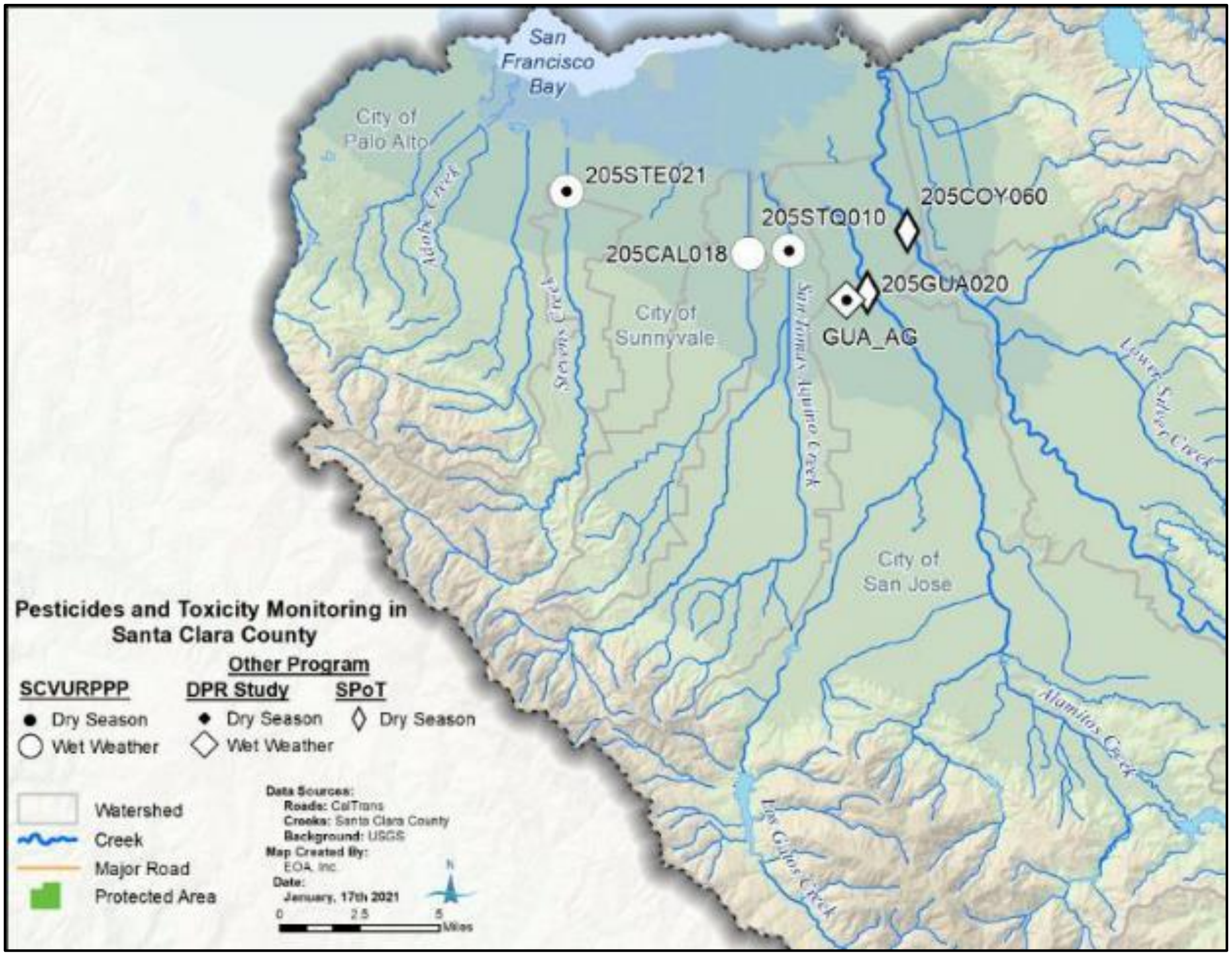

Figure 6.1. Pesticides and toxicity sampling stations in the Santa Clara Basin during WY 2020.

6.2.3 Data Evaluation

Water and Sediment Toxicity

Toxicity data evaluation required by the MRP involves first assessing whether the samples are toxic to the test organisms relative to the laboratory control treatment using the Test of Significant Toxicity (TST) statistical approach. For samples with toxicity (i.e., those that "fail" the TST), the Percent Effect is evaluated. The Percent Effect compares sample endpoints (survival, reproduction, growth) to the laboratory control endpoints. Follow-up sampling is required if any test organism is reported as "fail" via the TST approach *and* the Percent Effect is ≥ 50%. Both the TST result and the Percent Effect are determined by the laboratory. If both the initial and follow-up sample are reported as "fail" with ≥ 50% Percent Effect, the site is added to the list of candidate SSID projects.

Sediment Chemistry

In compliance with MRP Provision C.8.g.iv, sediment sample results are compared to Probable Effects Concentrations (PECs) and Threshold Effects Concentrations (TECs) as defined by MacDonald et al. (2000). 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). All results where a PEC or TEC quotient is equal to or greater than 1.0 are identified and added to the list of candidate SSID projects.

PECs and TECs are listed in MacDonald et al. (2000) for total PAHs, rather than the individual PAHs that are reported by the laboratory. 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 may be artificially elevated (and contribute to trigger exceedances) due to the method used to account for filling in 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 the Santa Clara Valley. All sites in Santa Clara 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., serpentinite) and soils that contribute to TEC and PEC quotients. These conditions will be considered when making decisions about SSID projects.

The current MRP does not require consideration of pyrethroid, fipronil, or carbaryl sediment chemistry data for follow-up SSID projects, perhaps because pyrethroids are ubiquitous in the urban environment and little is known about fipronil and carbaryl distribution. However, SCVURPPP computed toxicity unit (TU) equivalents for individual pyrethroid results based on available literature values for pyrethroids in sediment LC50 values.[20,21] Because organic carbon mitigates the toxicity of pyrethroid pesticides in sediments, the LC50 values were derived on the basis of TOC-normalized concentrations. Therefore, the pesticide concentrations as reported by the lab were divided by the measured total organic carbon (TOC) concentration at each site, and the TOC-normalized concentrations were then used to compute TU equivalents for each constituent. Concentrations equal to one-half of the respective laboratory method detection limits were substituted for non-detect data so that these statistics could be computed, potentially resulting in artificially elevated results.

Water Chemistry

Provision C.8.g.iv of MRP 2.0 requires that chemical pollutant data from water and sediment monitoring be compared to the corresponding WQOs in the Basin Plan for each analyte sampled. If concentrations in the samples exceed their WQOs, then the site at which the exceedances were observed will be added to the list of candidate SSID projects. However, the Basin Plan does not contain numeric WQOs for the chemical analytes encompassed within the wet weather pesticide monitoring.

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

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

6.3 Results and Discussion

From WY 2016 through WY 2020, dry weather water and sediment toxicity and sediment chemistry monitoring took place at the same two sites in Stevens Creek and San Tomas Aquino Creek over all five years. In WY 2018, wet weather toxicity and water chemistry monitoring was conducted at three sites to satisfy Provision C.8.g.iii of the MRP. Two of the wet weather 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

Table 6.1 provides a summary of toxicity testing results for water and sediment samples collected during dry weather on July 22, 2020.

- **San Tomas Aquino Creek (205STQ010).** The dry weather sediment sample at this site was not toxic to either of the test organisms utilized. The water sample was significantly toxic to two of the five test organisms (*C. dilutus* and *C. dubia*). 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 not significantly toxic. This test organism is sensitive to a broad range of aquatic contaminants, and the cause of the July 22, 2020 water toxicity remains unknown.

- **Stevens Creek (205STE021).** The dry weather sediment sample at this site was not toxic to either of the test organisms. The water sample was significantly toxic to one of the five test organisms (*C. dubia* reproduction, a chronic toxicity endpoint) with a Percent Effect greater than 50%, the threshold for follow-up. The follow-up water sample was not significantly toxic. As in the case of the San Tomas Aquino Creek sample and its *C. dubia* reproduction results, the cause of the water toxicity is unknown. Chronic (reproduction) toxicity to *C. dubia*, however, has been observed in some prior samples collected by SCVURPPP (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). See below for a discussion of the potential causes of *C. dubia* toxicity.

Table 6.1. Summary of SCVURPPP dry weather toxicity results for WY 2020.

Site	Organism	Test Type	Unit	Results		% Effect	TST Value	Follow up needed (TST "Fail" and ≥50%)
				Lab Control	Organism Test			
205STQ010 San Tomas Aquino Creek July 22, 2020	**Water**							
	Ceriodaphnia dubia	Survival	%	100	80	20%	NA[1] (Pass)	No
		Reproduction	Num/Rep	34.4	11.5	67%	Fail	Yes
	Pimephales promelas	Survival	%	97.5	97.5	0.0%	Pass	No
		Growth	mg/ind	0.72	0.845	-18%	Pass	No
	Chironomus dilutus	Survival	%	90	62.5	31%	Fail	No
	Hyalella azteca	Survival	%	96	96	0.0%	Pass	No
	Selenastrum capricornutum	Growth	cells/ml	891000	1860000	-109%	Pass	No
	Sediment							
	Chironomus dilutus	Survival	%	93.8	91.2	2.7%	Pass	No
	Hyalella azteca	Survival	%	96.3	81.2	16%	Pass	No
205STQ010 San Tomas Aquino Cr Sept 9, 2020	**Water - Resample**							
	Ceriodaphnia dubia	Survival	%	100	90	10%	NA[1] (Pass)	No
		Reproduction	Num/Rep	33.5	29.2	13%	Pass	No
205STE021 Stevens Creek July 22, 2020	**Water**							
	Ceriodaphnia dubia	Survival	%	100	70	30%	NA[1] (Fail)	No
		Reproduction	Num/Rep	34.4	7.3	79%	Fail	Yes
	Pimephales promelas	Survival	%	97.5	100	-2.6%	Pass	No
		Growth	mg/ind	0.717	0.722	-0.67%	Pass	No
	Chironomus dilutus	Survival	%	90	82.5	8.3%	Pass	No
	Hyalella azteca	Survival	%	96	100	-4.2%	Pass	No
	Selenastrum capricornutum	Growth	cells/ml	891000	1730000	-94%	Pass	No
	Sediment							
	Chironomus dilutus	Survival	%	93.8	86.2	8.0%	Pass	No
	Hyalella azteca	Survival	%	96.3	87.5	9.1%	Pass	No
205STE021 Stevens Cr Sept 9, 2020	**Water - Resample**							
	Ceriodaphnia dubia	Survival	%	100	100	0.0%	NA[1] (Pass)	No
		Reproduction	Num/Rep	33.5	29.2	11%	Pass	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 2020 Toxicity Resampling Event, September 22, 2020

Although toxicity to *C. dubia* was not observed during the September 9, 2020 resampling event, the date was notable for poor air quality throughout the Bay Area. In mid-August 2020, following record-breaking heat, lightning strikes from a rare summer thunderstorm ignited hundreds of wildfires. By September, over two million acres were actively burning in California and Oregon, including four major fires encircling the Bay Area. On the morning of September 9, 2020, residents of the Bay Area awoke to an apocalyptic reddish-orange skies resulting from wildfire smoke from wildfires near and far filtering out blue light from the sun. Figure 6.2 is one of the iconic photos from the day published in local newspapers. Figure 6.3 illustrates the difference in air quality conditions between the initial, July 22, 2020 event and the September 9 resampling event at the San Tomas Aquino Creek station.

Figure 6.2. The San Francisco Bay Bridge under orange smokey skies caused by wildfires, September 9, 2020 (source: Stephen Lam \ Reuters).

July 22, 2020

September 9, 2020

Figure 6.3. San Tomas Aquino Creek (station 205STQ010) under clear skies on July 22, 2020 and orange, smokey skies on September 9, 2020. Source: Kinnetic Laboratories, Inc. staff.

WY 2016 – WY 2020 Results Summary

Toxicity results from water and sediment samples collected in San Tomas Aquino and Stevens Creek during WY 2016 through WY 2020 are summarized in Table 6.2. Details of the WY 2016 to WY 2018 toxicity tests can be found in the UCMR for each associated year (SCVURPPP 2019a, SCVURPPP 2018, SCVURPPP 2017). Details of WY 2019 toxicity test results are compiled with prior years in the IMR ((SCVURPPP 2020).

From WY 2016 through WY 2020, one sediment sample and four dry season 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 triggers). There were an additional nine dry season test results where significant toxicity was observed, but the Percent Effect did not exceed the MRP trigger threshold. For the wet weather water samples there were two with toxicity results exceeding the MRP evaluation criteria and two with toxicity but a Percent Effect below 50%. None of the follow-up tests exceeded the trigger threshold.

A review of the five-year toxicity summary in Table 6.2 suggests several findings:

- ***H. azteca*.** Toxicity to *H. azteca*, a test organism known to be sensitive to pyrethroid pesticides, was not observed in dry season sediment or water samples, but was observed in the wet weather water samples collected in WY 2018. Pyrethroid pesticides tend to accumulate in sediment and pyrethroids in sediment samples collected synoptic with the dry season toxicity samples (summarized for WY 2016 – WY 2020 in Table 6.7) sometimes approach or exceed levels of concern (i.e., toxicity unit equivalent of 1.0), but these concentrations are not resulting in sediment toxicity to *H. azteca*. Furthermore, long-term monitoring of local creeks by the SPoT program suggests that pyrethroid concentrations in sediment have decreased since 2011/2012 (SCVURPPP 2019b). It is unknown whether the toxicity to *H. azteca* observed in the wet weather samples is related to pyrethroids suspended in the water column or some other toxic substance present in the creeks.
- ***C. dilutus.*** Toxicity to *C. dilutus*, a test organism known to be sensitive to neonicotinoids (e.g., imidacloprid) and fipronil, was observed in sediment and water samples collected during the dry season, although only once with a Percent Effect exceeding the MRP threshold for resampling. Toxicity to *C. dilutus* was not observed in the three wet weather samples collected in WY 2018. Although fipronil and its degradates are rarely detected in synoptic sediment samples, 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 pesticides gain market share.
- ***C. dubia* (reproduction).** Of the 15 dry season samples where significant toxicity was observed, half were water samples with *C. dubia* reproduction toxicity. *C. dubia* is a water flea that is sensitive to a broad range of aquatic contaminants. However, the specific cause of the chronic *C. dubia* toxicity in San Tomas Aquino and Stevens Creek is unknown, not seemingly explained by the synoptic sediment chemistry results. It is possible that these toxicity results are erroneous artifacts of laboratory QA/QC procedures.

  In preparation for reissuance of the SWAMP QAPrP in 2013, the SWAMP Toxicity Work Group examined conductivity tolerance in freshwater toxicity test species with respect to the relationship between sample water conductivity and observed toxicity. It was determined that *C. dubia* survival and reproduction are negatively affected at high and low conductivities. The SWAMP Toxicity Work Group (2013) recommended "appropriate controls" when sample water has high (>1900 µS/cm) or low (<100 µS/cm) conductivities because the *C. dubia* test organisms cultivated in the laboratory under standard laboratory conditions (e.g., 310 to 360 µS/cm) may perish or experience reduced reproduction when exposed to the sample water. In light of these findings, SCVURPPP compiled the results of conductivity measurements taken from sample water associated with toxicity monitoring from WY 2012 through WY 2020 to compare with the laboratory water used in these toxicity tests and the results of the tests themselves. In almost all cases, it was found that the sample water conductivity was higher or lower by several hundred µS/cm compared to the laboratory control samples (a mean difference of 433 µS/cm). However, no correlation was found between *C. dubia* toxicity and sample water/laboratory control water conductivity differences.

Statewide, there have been other reports of unexplained chronic *C. dubia* toxicity, within and between laboratory variability in the magnitude of toxicity, and suspicion of false positives. Recent analysis by SWAMP in conjunction with the Statewide Toxicity Provisions adopted by the State Water Board on December 1, 2020 indicates that *C. dubia* toxicity variability could arise from inconsistencies in QA procedures used by laboratories. A new Special Study requested by the State Water Board will be carried out in 2021 and 2022 with a work plan developed by SCCWRP and a report anticipated in December 2022. This study will contain recommendations for improvements to laboratory QA procedures associated with the *C. dubia* toxicity tests and may also yield related findings pertaining to the causes of spurious *C. dubia* toxicity (SWRCB 2020).

Table 6.2. Toxicity test result summary, WY 2016 – WY 2020. The Percent Effect is indicated for test results with toxicity relative to the lab control. Test results with toxicity exceeding the MRP trigger thresholds are highlighted.

Station ID	Creek	Date	Water Year	Season	Sediment		Water						
					C. dilutus	*H. azteca*	*C. dubia*		*P. promelas*		*C. dilutus*	*H. azteca*	*S. capricornutum*
					Survival	Survival	Survival	Reproduction	Survival	Growth	Survival	Survival	Growth
San Tomas Aquino Creek Dry Season Samples													
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	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 [1]	No	--	No	--	--	--	--	--	--
205STQ010	San Tomas Aquino Cr	7/22/2020	WY 2020	Dry	No	No	No	**Yes** (67%)	No	No	**Yes** (31%)	No	No
205STQ010	San Tomas Aquino Cr	9/9/2020	WY 2020	Dry [1]	--	--	--	No	--	--	--	--	--
Stevens Creek Dry Season Samples													
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 [1]	--	--	No	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 [1]	--	--	No	**Yes** (47%)	--	--	--	--	--
205STE021	Stevens Cr	7/22/2020	WY 2020	Dry	No	No	**Yes** (30%)	**Yes** (79%)	No	No	No	No	No
205STE021	Stevens Cr	9/9/2020	WY 2020	Dry [1]	--	--	--	No	--	--	--	--	--
Wet Weather Samples													
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 [1]	--	--	No	--	--	--	--	No	--
205STE021	Stevens Cr	1/8/2018	WY 2018	Wet	--	--	No	No	No	No	No	**Yes** (28%)	No
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 [1]	--	--	No	--	--	--	--	**Yes** (12%)	--

[1] Resample.

6.3.2 Sediment Chemistry

Sediment chemistry results from WY 2020 were evaluated as potential stressors based on TEC and PEC quotients according to MRP trigger thresholds (see Section 6.2.3). The Program also evaluated TU equivalents of pyrethroids and fipronil to inform stormwater management.

Table 6.3 lists concentrations and TEC quotients for sediment chemistry constituents (metals and total PAHs) collected in WY 2020 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)[22]. 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 of having at least one result exceeding the TEC and will be added to the list of potential SSID projects. At both sites, the constituents with TEC quotients ≥ 1.0 included nickel, chromium, copper and zinc. Nickel and chromium are expected in watersheds draining hillsides underlain by serpentine formations. Copper and zinc are not necessarily associated with this geochemistry; however, the TEC quotients for these metals exceeded the threshold by just 0.1 in all samples.

Table 6.4 lists concentrations and PEC quotients for sediment chemistry constituents (metals and total PAHs) collected in WY 2020. 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 1.3.

Table 6.3. Threshold Effect Concentration (TEC) quotients for WY 2020 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**	**TEC Quotient**	**Concentration**	**TEC Quotient**
Arsenic	9.79	2.7	0.28	2.8	0.29
Cadmium	0.99	0.35	0.35	0.19	0.19
Chromium	43.4	72	**1.7**	47	**1.1**
Copper	31.6	35	**1.1**	35	**1.1**
Lead	35.8	18	0.50	19	0.53
Nickel	22.7	62	**2.7**	47	**2.1**
Zinc	121	130	**1.1**	130	**1.1**
PAHs (ug/kg DW)					
Total PAHs	1610	1516 [a]	0.94 [a]	355 [a]	0.22 [a]

[a] Total calculated using ½ MDLs for some individual PAHs.

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[22] 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 2020 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**	**PEC Quotient**	**Concentration**	**PEC Quotient**
Arsenic	33.0	2.7	0.08	2.8	0.06
Cadmium	4.98	0.35	0.07	0.19	0.02
Chromium	111	72	0.65	47	0.33
Copper	149	35	0.23	35	0.12
Lead	128	18	0.14	19	0.05
Nickel	48.6	62	**1.3**	47	0.7
Zinc	459	130	0.28	130	0.13
PAHs (ug/kg DW)					
Total PAHs	22,800	1516 [a]	0.07 [a]	355 [a]	0.016 [a]

[a] Total calculated using ½ MDLs for some individual PAHs.

Table 6.5 lists the concentrations of pesticides measured in sediment samples collected in WY 2020, 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 individual constituent had a TU equivalent exceeding 1.0; however, the sum of TU equivalents for pyrethroid pesticides in Stevens Creek was 1.3. The highest TU equivalent in both samples was for bifenthrin (0.59 in Stevens Creek and 0.54 in San Tomas Aquino Creek). This pesticide 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).

Table 6.5. Pesticide concentrations and calculated toxic unit (TU) equivalents, July 22, 2020.

			205STE021			**205STQ010**		
			Stevens Creek			**San Tomas Aquino Creek**		
Analyte	**Unit**	**LC50** [c]	**Concentration**	**Normalized to TOC**	**TU Equivalent**	**Concentration**	**Normalized to TOC**	**TU Equivalent**
Total Organic Carbon	**%**	NA	1.2	NA	NA	2.8	NA	NA
Pyrethroid								
Bifenthrin	µg/g dw	0.52	0.0037	0.31	0.59	0.0078	0.28	0.54
Cyfluthrin	µg/g dw	1.08	0.0018	0.15	0.14	0.0025	0.09	0.08
Cypermethrin	µg/g dw	0.38	0.0014	0.12	0.31	0.0008 [b]	0.03	0.07
Deltamethrin	µg/g dw	0.79	0.0003 [a]	0.02	0.03	0.0003 [a]	0.01	0.01
Esfenvalerate	µg/g dw	1.54	0.0003 [a]	0.02	0.02	0.0003 [a]	0.01	0.01
Lambda-Cyhalothrin	µg/g dw	0.45	0.0014	0.12	0.26	0.0007 [b]	0.03	0.06
Permethrin	µg/g dw	10.83	0.0002 [a]	0.02	0.002	0.0031	0.11	0.01
			Sum of TU Equivalents		**1.3** [a]	Sum of TU Equivalents		**0.8** [a]
Other MRP Pesticides of Concern								
Carbaryl	mg/Kg dw	NA [d]	0.01 [a]	0.9	NA	0.01 [a]	0.4	NA
Fipronil	ng/g dw	306	0.21 [a]	17.5	0.06	0.22 [a]	7.9	0.03
Fipronil Desulfinyl	ng/g dw	NA [d]	0.21 [a]	17.5	NA	0.22 [a]	7.9	NA
Fipronil Sulfide	ng/g dw	435	0.21 [a]	17.5	0.04	0.22 [a]	7.9	0.02
Fipronil Sulfone	ng/g dw	158	0.21 [a]	17.5	0.11	0.53 [b]	18.9	0.12

‘dw = dry weight

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 2020 sediment samples (Table 6.6). The Stevens Creek (205STE021) sample was 21.60% fines (i.e., 12.4% clay and 9.2% silt); and the San Tomas Aquino Creek (205STQ010) sample was 26.0% fines (i.e., 9.0% clay and 17.0% silt).

Table 6.6. Summary of grain size for the two locations sampled in Santa Clara County during WY 2020.

Grain Size (%)		205STE021 Stevens Creek	205STQ010 San Tomas Aquino Creek
Clay	<0.0039 mm	12.4%	9.0%
Silt	0.0039 to <0.0625 mm	9.2%	17.0%
Sand	V. Fine 0.0625 to <0.125 mm	31.8%	10.4%
	Fine 0.125 to <0.25 mm	35.1%	18.9%
	Medium 0.25 to <0.5 mm	8.9%	25.7%
	Coarse 0.5 to <1.0 mm	1.4%	11.0%
	V. Coarse 1.0 to <2.0 mm	1.0%	7.9%
Granule	2.0 to <4.0 mm	1.2%	5.2%
Pebble	Small 4 to <8 mm	3.1%	3.9%
	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.

WY 2016 – WY 2020 Summary

Between WY 2016 and WY 2020, no sediment samples had PEC quotients 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. Excluding chromium and nickel, there were four samples in the WY 2016 through WY 2020 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 PAHs from Stevens Creek in WY 2017 and WY 2018.
- Zinc and copper from Stevens Creek and San Tomas Aquino Creek in WY 2020.

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 2016 – WY 2020. Carbaryl has not been detected in any sample. Fipronil and its degradates[23] (desulfinyl, sulfide, sulfone) have been detected at TOC-normalized concentrations below the LC50 in three samples, both WY 2016 samples and the WY 2020 sample from San Tomas Aquino Creek. The sum-of-pyrethroids TU equivalents ranged from 0.11 (Stevens Creek in WY 2017) to 1.3 (Stevens Creek in WY 2020). Since WY 2016, two samples collected from Stevens Creek in

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[23] Fipronil degrades via UV exposure,oxidation, and hyrolosis to form four principal degradates: fipronil desulfinyl, fipronil sulfide, fipronil sulfone, and fipronil amide. The degradates tend to be more stable and persistent than the parent compound; therefore, SCVURPPP added the first three of the degradates to the monitoring program in WY 2017.

2016 and 2020 have had a sum-of-pyrethroids TU equivalent ≥ 1.0. There are no apparent trends in TU equivalents for pesticides in San Tomas Aquino Creek or Stevens Creek between WY 2016 and WY 2020.

Table 6.7. Toxicity Unit (TU) equivalent summary for Santa Clara County sediment samples, WY 2014 – WY 2020. See Table 6.5 for WY 2020 concentration data.

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**													
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
205STQ010	San Tomas Aquino	7/22/2020	0.54	0.08	0.07	<MDL	<MDL	0.06	0.01	**0.77** [a]	<MDL	<MDL	<MDL	<MDL	0.12
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
205STE021	Stevens Creek	7/22/2020	0.59	0.14	0.31	<MDL	<MDL	0.26	<MDL	**1.3** [a]	<MDL	<MDL	<MDL	<MDL	<MDL

‘dw = dry weight

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, 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 the MRP, which requires aquatic toxicity testing and monitoring of water column pesticide concentrations. Results were reported in the WY 2018 UCMR (SCVURPPP 2019a). 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 because the Percent Effect was below the 50% threshold. 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 the 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 SCVURPPP 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.

DPR SWPP Monitoring

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 2016 through WY 2020 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.

SPoT Monitoring Program

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 (Phillips et al. 2014) (Figure 6.1). In most years, sediments are analyzed for toxicity, metals, PCBs, mercury, organic pollutants, and pesticides, including pyrethroids and fipronil and its degradates. The most recent technical report prepared by SPoT program staff was published in 2020 and describes ten-year trends from the initiation of the program in 2008 through 2017 (Phillips et al. 2020).

Toxicity testing of sediment was conducted by SPoT in Santa Clara County watersheds using indicator organisms *H. azteca*, which is sensitive to pyrethroids, and *C. dilutus*, added in 2015 to assess neonicotinoid and fipronil impacts. Toxicity samples were evaluated using the TST statistical approach (Phillips et al. 2020).

- ***H. azteca***. In Guadalupe River, chronic *H. azteca* toxicity has not been observed in the entire dataset and acute *H. azteca* has not been observed since 2014. In Coyote Creek, both acute and chronic *H. azteca* toxicity have been observed but there is a trend of decreasing toxicity.

- **C. dilutus**. In Guadalupe River, neither acute nor chronic *C. dilutus* toxicity have been observed since monitoring for this organism began in 2015. In Coyote Creek, *acute C. dilutus* toxicity has not been observed, but moderate chronic *C. dilutus* was observed in at least one sample.

The SPoT toxicity results contrast with SCVURPPP monitoring results from Stevens Creek and San Tomas Aquino Creek. SCVURPPP has not detected acute *H. azteca* toxicity in sediment samples from these creeks but has observed acute *C. dilutus* toxicity in two of six samples from San Tomas Aquino Creek. The MRP does not require analysis of chronic toxicity endpoints for sediment samples.

The SPoT sediment chemistry results from Guadalupe River and Coyote Creek do not show statistically significant trends in sum-of-pyrethroid concentrations or sum-of-fipronil-and-its-degradates concentrations over the 2008 – 2017 dataset reviewed by Philips et al. (2020). A review of SPoT data from 2008 to 2019 downloaded from CEDEN suggests the following findings that are in line with SCVURPPP data from Stevens Creek and San Tomas Aquino:

- **Coyote Creek.** Dry season pyrethroid concentrations in Coyote Creek peaked in July 2012 (674 ng/g). This concentration was largely driven by cyfluthrin, which was measured at 539 ng/g, a concentration 26 times higher than the next highest cyfluthrin measurement (20.2 ng/g in September 2012) and 90 times higher than the average cyfluthrin concentration in the dataset sans July 2012. In most other years, the individual pyrethroid with the highest concentration in Coyote Creek is bifenthrin. Although fipronil has only been detected once in Coyote Creek the years it was monitored (2013 – 2019), its degradates (fipronil desulfinyl, fipronil sulfide, fipronil sulfone) are usually found at measurable concentrations, with no obvious long-term trends.

- **Guadalupe River.** Similar to Coyote Creek, sum-of-pyrethroid concentrations in Guadalupe River peaked in 2012 (165 ng/g), but was driven by a high permethrin concentration that year (76 ng/g) rather than cyfluthrin (21.7 ng/g). In most other years, the individual pyrethroid with the highest concentration in Guadalupe River is bifenthrin. Fipronil has never been detected in Guadalupe River. Only one degradate (fipronil sulfone) was detected in 2013 – 2014. More recent samples have detections of at least two degradates.

7.0 CONCLUSIONS AND RECOMMENDATIONS

This section includes conclusions and recommendations from the review of WY 2020 Creek Status and Pesticides & Toxicity Monitoring data that are presented in the previous sections of this report.

In WY 2020, in compliance with provisions C.8.d and C.8.g of the MRP and the BASMAA RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012), SCVURPPP continued to implement a 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 (including SCVURPPP) 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 2020 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 monitoring data with respect to WQOs and triggers defined in the MRP. A summary of trigger exceedances observed for each site in WY 2020 is presented in Table 7.1. In compliance with Provision C.8.e.i of the MRP, 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 are 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 were conducted using methods consistent with the BASMAA RMC QAPP (BASMAA 2020) and SOPs (BASMAA 2016). Recommendations for future monitoring are described in Section 7.3.

7.1 Conclusions

7.1.1 Biological Condition Assessment

In WY 2020, bioassessment monitoring was conducted at twenty sites in compliance with provision C.8.d.i of the MRP. Sites were sampled for benthic macroinvertebrates, benthic algae, and nutrients. Physical habitat and general water quality parameters were also measured at each site. In WY 2020, ten of the twenty bioassessment surveys were conducted at sites selected randomly using the regional probabilistic monitoring design, and ten were conducted at targeted sites. All sites are classified as urban in the RMC sample frame.

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 nine years (WYs 2012 through 2020), SCVURPPP and the Regional Water Board have sampled 174 probabilistic sites in Santa Clara Valley streams, a sufficient sample size to estimate ambient biological condition for urban streams within known estimates of precision. Stream condition is assessed using three different types of indices/tools: 1) the BMI-based CSCI, 2) the benthic diatom-based D_ASCI, 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 condition. Assessing the extent and relative risk of stressors can help prioritize 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 and the effects of changes in factors affecting biological community composition (e.g., climate change).

All three management questions were comprehensively evaluated using eight years of bioassessment data (WY 2012 – WY 2019) and reported in the Program's WY 2019 Integrated Monitoring Report (SCVURPPP 2020); whereas this report primarily focuses on WY 2020 data.

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 the MRP (see Section 7.3).

Biological Condition Assessment

The CSCI scores across the twenty bioassessment sites sampled in WY 2020 ranged from 0.19 to 1.30, with sixteen of the twenty sites having scores below the MRP trigger threshold of 0.795.

- The four sites with CSCI scores in the “possibly intact” and “likely intact” condition categories (above 0.795), although classified as urban in the RMC sample frame, have relatively low impervious area in their contributing watersheds, i.e., less than three percent. Three of these sites are located in Upper Penitencia Creek within Alum Rock Park, City of San José.
- The six sites with CSCI scores in the “likely altered” condition category (≥ 0.63 to < 0.79) have moderately low impervious area (2% to 5%) but are downstream of major dams.
- The ten sites with CSCI scores in the “very likely altered” condition category (<0.63) have relatively high percent impervious area in their contributing watersheds (9% to 69%). Eight of these were located in sampling reaches with engineered flood control channels and/or have hardened banks.

The D_ASCI scores ranged from 0.39 to 0.84 across the twenty bioassessments sites sampled in WY 2020. There were no sites with D_ASCI scores in the two higher condition categories: “possibly intact” and “likely intact” (>0.86)

Physical habitat conditions, as represented by IPI scores, ranged from 0.44 to 1.15 across the twenty bioassessment sites sampled in WY 2020 (Table 2.5). Thirteen of the twenty sites had IPI scores that were in the top two condition categories (≥ 0.83).

SCAPE Tool Comparison

The CSCI scores were compared to predicted scores for each assessed stream reach generated from the SCAPE model, which is based on land use within the sampling reach watershed (Beck et al. 2019). There were five sites that scored above the range of CSCI scores predicted by the SCAPE model, including the three high-scoring sites in Alum Rock Park and a site in a restored reach of Guadalupe Creek. There were three sites that scored at the low end of the predicted range of CSCI scores. Follow-up monitoring could be implemented at these sites to evaluate which stressors are impacting conditions.

Temporal Variability in Biologic Condition

Nine of the WY 2020 bioassessment surveys were conducted at sites previously monitored by the Program. CSCI and D_ASCI scores for WY 2020 were compared with scores from prior years; however, there was no consistent trend for either biological index.

7.1.2 Continuous Monitoring for Temperature and General Water Quality

Continuous monitoring of water temperature and general water quality in WY 2020 was conducted in compliance with provision C C.8.d.iii – iv of the MRP. Hourly temperature measurements were recorded at nine sites in the Upper Penitencia Creek watershed from April through September. General water quality parameters (specific conductance, DO, pH, and temperature) were recorded continuously (15-minute interval) at four sites in Lower Silver Creek during two 1 to 2-week periods in spring (Event 1) and summer (Events 2.1 or 2.2). Monitoring was conducted to address the following management questions from the BASMAA RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012):

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?*

Sites with continuous monitoring results exceeding the MRP trigger criteria and/or WQOs are identified as candidate SSID projects.

Spatial and Temporal Variability (Temperature)

Continuous temperature monitoring was conducted along stream reaches in Upper Penitencia Creek and its tributary Arroyo Aguague within Alum Rock Park. These reaches were targeted for temperature monitoring because they convey perennial flow and support rearing and spawning habitat for steelhead and other native fishes (Stillwater 2006). In general, water temperatures were lower at the upstream sites compared to the downstream locations for both mainstem Upper Penitencia Creek and the tributary Arroyo Aguague. Temperatures at all stations followed a similar pattern with temperatures gradually increasing from the time loggers were deployed in April through late-August, and then gradually decreasing until the loggers were removed on September 24, 2020. The overall pattern was interrupted with several multi-day spikes in water temperature corresponding to local heat waves. Although few instantaneous measurements exceeded the maximum MRP threshold of 24°C, more than two MWAT values at each station exceeded the MRP threshold of 17°C; thus all sites will be added to the list of candidate SSID projects. Exceedances of the MWAT trigger may not be of concern in Santa Clara County because the MWAT threshold was developed for streams of the Pacific Northwest, a cooler region with inherently lower water temperatures.

Spatial and Temporal Variability (General Water Quality)

Continuous general water quality monitoring was conducted at four stations in Lower Silver Creek. Monitoring results for temperature followed predictable daily patterns at all four sites during all events. In contrast, monitoring results for specific conductance and pH followed an unusual pattern at the lowermost site (COY182), with a thrice daily peak in values. It is possible that a pump station upstream of the lowermost station but downstream of the other two stations is the cause of the unusual pattern. All four sites exceeded the MRP triggers for MWAT and the uppermost site (COY195) exceeded the MRP trigger for DO. Monitoring activities at all four stations are part of the ongoing Lower Silver Creek -Thompson Creek SSID study that is anticipated for completion in June 2021.

7.1.3 Pathogen Indicators

Pathogen indicator monitoring in WY 2020 was conducted in compliance with provision C.8.d.v of the MRP. Samples for pathogen indicator analysis were collected during one monitoring event at five 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 of the stations targeted in WY 2020 were also sampled in prior years. The overall goal of pathogen indicator monitoring is to assess whether WQOs are being met, i.e. supportive of REC-1 Beneficial Uses.

In WY 2020, no samples exceeded the MRP trigger or the more conservative statewide WQO for *E. coli*. One sample, collected from Los Gatos Creek at Pruneyard, did exceed the MRP trigger for enterococci. Enterococci was not adopted by the State for use as a pathogen indicator in freshwaters; therefore, there is no WQO to use for comparison. A review of pathogen indicator monitoring results from the same stations in prior years 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 in the targeted creeks 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

In compliance with Provision C.8.c.ii, free chlorine and total chlorine residual were measured at twenty sites concurrent with bioassessment surveys. While chlorine residual is generally not a concern in Santa Clara Valley urban creeks, prior monitoring results suggest there are occasional free chlorine and total chlorine residual exceedances in the County. Trigger exceedances that are observed are usually 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 dirt and organic matter. In WY 2020, there were no exceedances of the MRP trigger for chlorine (0.1 mg/L). The Program will continue to monitor chlorine in compliance with the MRP and will follow-up with illicit discharge staff as needed.

7.1.5 Pesticides and Toxicity Monitoring

Toxicity testing of water and sediment samples and sediment chemistry monitoring, collectively referred to as pesticides and toxicity monitoring, was conducted during WY 2020 in compliance with provision C.8.g of the MRP. Samples were collected from Stevens Creek and San Tomas Aquino Creek at the same stations that were monitored for pesticides and toxicity during WY 2016 to WY 2019, building a long-term dataset.

Data Evaluation Summary

There are five toxicity test species analyzed in water samples and two test species in sediment samples. The test organism *H. azteca*, required for water and sediment samples is known to be sensitive to pyrethroid pesticides. The test organism *C. dilutus*, 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. If the MRP trigger threshold of 50 Percent Effect is exceeded, a follow-up sample is collected.

Sediment chemistry data for metals and PAHs compared to Threshold Effect Concentrations (TECs) and Probable 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 pesticides are compared to TOC-normalized LC50s, calculated as Toxicity Unit equivalents. There are no WQOs for the suite of monitored constituents for comparison to water chemistry data.

WY 2020 Results

In WY 2020, 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 San Tomas Aquino 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 not significantly toxic. The sediment sample taken at the San Tomas Aquino 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 Stevens Creek during dry season sampling in July 2020 and the Percent Effect exceeded the MRP threshold for follow-up. The follow-up sample was not significantly toxic. The sediment sample taken at the Stevens Creek site was not toxic to either of the test organisms.

Pesticide concentrations in the WY 2020 sediment samples were all very low, most below the MDL. The exceptions were bifenthrin, cyfluthrin, cypermethrin, and cyhalothrin in Stevens Creek and bifenthrin, cyfluthrin, cypermethrin, and permethrin in San Tomas Aquino. When normalized to TOC, the sum of the TU equivalents calculated for these pyrethroid pesticides were 1.3 in Stevens Creek and 0.8 in San Tomas Aquino. Although these TU equivalents approach or exceed 1.0, toxicity to *H. azteca* in sediments was not observed in WY 2020.

WY 2016 – WY 2020 Data Summary

The results of pesticides and toxicity monitoring conducted in San Tomas Aquino and Stevens Creek during WY 2016 through WY 2020 were analyzed to identify trends.

- Toxicity to *H. azteca*, a test organism known to be sensitive to pyrethroid pesticides, was not observed in dry season sediment or water samples but was observed in the wet weather water samples collected in WY 2018.
- Toxicity to *C. dilutus*, a test organism known to be sensitive to neonicotinoids (e.g., imidacloprid) and fipronil, was observed in sediment and water samples collected during the dry season, although only once with a Percent Effect exceeding the MRP threshold for resampling.
- Of the 15 dry season samples where significant toxicity was observed, half were water samples with *C. dubia* reproduction toxicity. *C. dubia* is a water flea that is sensitive to a broad range of aquatic contaminants. However, the specific cause of the chronic *C. dubia* toxicity in San Tomas Aquino and Stevens Creek is unknown, and not seemingly explained by the synoptic sediment chemistry results. It is possible that the chronic *C. dubia* toxicity observed in water samples are false positives resulting from inconsistencies in laboratory QA procedures. Statewide, there have been other reports of unexplained chronic *C. dubia* toxicity, and the State Water Board is currently carrying out a Special Study to examine the issue.

Between WY 2016 and WY 2020, no sediment samples in San Tomas Aquino or Stevens Creek had PEC quotients that exceeded 1.0 for analytes other than chromium and nickel. Excluding chromium and nickel, there were four samples in the WY 2016 through WY 2020 dataset with TEC quotients ≥ 1.0, the more conservative of the two sediment chemistry evaluation criteria. These include total PAHs from Stevens Creek in WY 2017 and WY 2018, and zinc and copper from Stevens Creek and San Tomas Aquino Creek in WY 2020. 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. 2020).

The pesticides and toxicity data collected from WYs 2014 through 2020 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 WY 2020 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 can be selected from this list. Table 7.1 lists candidate SSID projects based on WY 2020 Creek Status and Pesticides & Toxicity monitoring data. Trigger and WQO exceedances from WY 2014 through WY 2019 were reported in the IMR (SCVURPPP 2020) and prior UCMRs (SCVURPPP 2015, 2016, 2017, 2018, and 2019a).

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 7.1. Summary of SCVURPPP Trigger Threshold Exceedance Analysis, WY 2020. "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]
205R00026	Los Gatos Creek	Yes	No	No	--	--	--	--	--	--	--	--
205COY200	Thompson Creek [11]	Yes	No	No	--	--	--	--	--	--	--	--
205R00227	Matadero Creek	Yes	No	No	--	--	--	--	--	--	--	--
205R00282	Guadalupe Creek	Yes	No	No	--	--	--	--	--	--	--	--
205R00419	Stevens Creek	Yes	No	No	--	--	--	--	--	--	--	--
205R00602	Los Alamitos Creek	Yes	No	No	--	--	--	--	--	--	--	--
205R00714	Los Gatos Creek	Yes	No	No	--	--	--	--	--	--	--	--
205R00787	Upper Penitencia Cr	No	No	No	--	--	--	--	--	--	--	--
205R00979 / 205COY183	Lower Silver Creek [11]	Yes	No	No	--	--	--	Yes	No	No	No	--
205R03795 / 205COY182	Lower Silver Creek [11]	Yes	No	No	--	--	--	Yes	No	No	No	--
205R04523	Lower Penitencia Cr	Yes	No	No	--	--	--	--	--	--	--	--
205R04866	Canoas Creek	Yes	No	No	--	--	--	--	--	--	--	--
205R04967	Upper Penitencia Cr	No	No	No	--	--	--	--	--	--	--	--
205R05142	Thompson Creek [11]	Yes	No	No	--	--	--	--	--	--	--	--
205R05155	Berryessa Creek	No	No	No	--	--	--	--	--	--	--	--
205R05183	Upper Penitencia Cr	No	No	No	--	--	--	--	--	--	--	--
205R05198	Canoas Creek	Yes	No	No	--	--	--	--	--	--	--	--
205R05327	Hale Creek	Yes	No	No	--	--	--	--	--	--	--	--
205R05587	Stevens Creek	Yes	No	No	--	--	--	--	--	--	--	--
205R05650	Alamitos Creek	Yes	No	No	--	--	--	--	--	--	--	--
205COY121	Upper Penitencia Cr	--	--	--	--	--	--	Yes	--	--	--	--
205COY132	Upper Penitencia Cr	--	--	--	--	--	--	Yes	--	--	--	--
205COY135	Upper Penitencia Cr	--	--	--	--	--	--	Yes	--	--	--	--
205COY140	Upper Penitencia Cr	--	--	--	--	--	--	Yes	--	--	--	--
205COY142	Upper Penitencia Cr	--	--	--	--	--	--	Yes	--	--	--	--
205COY145	Upper Penitencia Cr	--	--	--	--	--	--	Yes	--	--	--	--
205AAG010	Arroyo Aguague	--	--	--	--	--	--	Yes	--	--	--	--
205AAG015	Arroyo Aguague	--	--	--	--	--	--	Yes	--	--	--	--
205AAG025	Arroyo Aguague	--	--	--	--	--	--	Yes	--	--	--	--
205COY195	Lower Silver Creek [11]	--	--	--	--	--	--	Yes	Yes	No	No	--
205COY182.5	Lower Silver Creek [11]	Yes	No	No	--	--	--	Yes	No	No	No	--
205LGA420	Los Gatos Creek	--	--	--	--	--	--	--	--	--	--	No
205LGA033	Los Gatos Creek	--	--	--	--	--	--	--	--	--	--	Yes
205LGA400	Los Gatos Creek	--	--	--	--	--	--	--	--	--	--	No
205COY330	Coyote Creek	--	--	--	--	--	--	--	--	--	--	No
205COY392	Coyote Creek	--	--	--	--	--	--	--	--	--	--	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 % in initial and follow-up samples.
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 continuous monitoring results = DO < 7.0 mg/L in COLD streams or DO < 5.0 mg/L in WARM streams.
8. Twenty percent of continuous monitoring results = pH < 6.5 or pH > 8.5.
9. Twenty percent of continuous monitoring results = specific conductance > 2000 uS.
10. Enterococcus ≥ 130 cfu/100ml or *E. coli* ≥ 410 cfu/100ml.
11. Exceedances in Lower Silver Creek and Thompson Creek are being investigated as part of an ongoing SSID project.

7.3 Recommendations

The recommendations presented in this section are directed towards the implementation of monitoring requirements in Provisions C.8.d and C.8.g through the remainder of term during which MRP 2.0 remains in effect. At this time, it is anticipated that MRP 2.0 will be replaced with MRP 3.0 in July 2022. Thus, the current monitoring requirements will likely be in effect throughout the entirety of WY 2021 and most of WY 2022. The Program is currently working with other members of the RMC and Regional Water Board staff through the MRP 3.0 Steering Committee and the Provision C.8 Water Quality Monitoring Workgroup to negotiate future monitoring requirements.

The following recommendations are based on findings from nine years (WY 2012 through WY 2020) 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.

- **Biological Condition Assessment.** The probabilistic sample draw for urban sites in Santa Clara County has been exhausted. Therefore, SCVURPPP will select all twenty WY 2021 bioassessment sites on a targeted basis. Regional Water Board staff approved this approach in a letter dated January 26, 2021, and provided the following guidance on site selection:

  > *The first and preferred option is to select targeted sites at reaches or watersheds of interest to Permittees and stakeholders in order to 1) fill in spatial data gaps or 2) undertake a watershed or sub-watershed study. Such sites may or may no include sites previously sampled during the probabilistic draw.*
  >
  > *The second option is to resample sites where land use changes or other factors may have resulted in a change in bioassessment results over time. For this option, Permittees are advised to focus on sites where monitoring began prior to adoption of MPR 1, for which the County stormwater program has multiple years of samples and data available.*
  >
  > *The third option is to implement a combination of the first and second options.*

  Program staff will work with SCVURPPP Permittees and stakeholders to identify WY 2021 bioassessment sites according to the options presented by Regional Water Board staff.

- **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) and warm water habitat (WARM) Beneficial Uses. For example, in WY 2020, continuous monitoring data are being used to evaluate biological conditions as part of the Lower Silver Creek-Thompson Creek SSID Project, which will be submitted by June 2021. Program staff will work with SCVURPPP Permittees and stakeholders to identify WY 2021 continuous monitoring sites.

- **Pathogen Indicator Monitoring.** The Program will continue to comply with Provision C.8.d.v requirements by collecting five samples for pathogen indicator analysis from creeks where there is a possibility for water recreation.

- **Chlorine Monitoring**. The Program will continue to comply with Provision C.8.d.ii requirements by measuring free and total chlorine in 20 samples. Measurements will be made synoptic with bioassessment monitoring.

- **Pesticides and Toxicity Monitoring** will be conducted during the dry season at the same two stations targeted in WYs 2016 through 2020: Stevens Creek and San Tomas Aquino Creek. The full dataset from these stations (WY 2016 – WY 2021) will be evaluated in the WY 2021 UCMR.

7.4 Management Implications

The Creek Status and Pesticides and Toxicity Monitoring program (consistent with Provisions C.8.d and C.8.g of the MRP) implemented by SCVURPPP focuses on assessing the water quality condition of urban creeks in the Santa Clara Valley and identifying stressors and sources of impacts observed.

This *Urban Creeks Monitoring Report Part A: Creek Status and Pesticides & Toxicity Monitoring* presents bioassessment and stressor data collected in WY 2020, and builds on the findings of the Program's *Integrated Monitoring Report* (SCVURPPP 2020) which presented a comprehensive review of data collected in WY 2012 through WY 2019. Bioassessment data suggest that most urban streams in the Santa Clara Valley have *likely altered* or *very likely altered* populations of aquatic life indicators (e.g., benthic macroinvertebrates, algae). 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 the MRP, 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) and Green Stormwater Infrastructure (GSI), 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 and GSI measures are expected to reduce the impacts of urban runoff and associated impervious surfaces on stream health. The Program maintains a GSI Database that tracks these projects and illustrates their geographic scope.
- In compliance with provision C.7 of the MRP, the Program and its Co-permittees are implementing stormwater outreach activities through the Watershed Watch Campaign (Campaign) that encourages 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). Some events in WY 2020 were moved to a virtual platform due to the COVID-19 SIP order. 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 the MRP, 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. The Urban Pesticides Amendments team is also 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 or 2022. At this time, the mechanism for implementing the statewide monitoring program is uncertain.
- Trash loadings to local creeks have been reduced through implementation of new control measures in compliance with provision C.10 of the MRP 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. The MRP 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 the MRP, 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 the MRP, 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 the MRP, the Program will continue to identify sources of these pollutants and will implement control actions designed to achieve minimum load reduction goals. In WY 2020, SCVURPPP documented all existing and planned mercury and PCBs control measures to demonstrate attainment of the goals. Most control measures have multiple stormwater treatment benefits such as peak flow reduction and removal many potential pollutants. Monitoring activities conducted in WY 2020 that specifically target mercury and PCBs are described in the Pollutants of Concern Monitoring Data Report that is included as Part D of this UCMR.
- The stormwater community recognizes that illicit discharges from the increasing number of homeless encampments are having a significant impact on the quality of receiving waters, particularly with respect to bacteria and trash pollutants. Program staff are working with Regional Water Board staff to identify opportunities to address this issue in MRP 3.0.

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, the Santa Clara Basin Stormwater Resource Plan[24] supports the development and implementation of MRP-required Green Stormwater Infrastructure Plans and includes a prioritized list 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.

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

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ATTACHMENTS

Attachment 1

QA/QC Report

Urban Creeks Monitoring Report - Creek Status and Pesticides & Toxicity Monitoring

Quality Assurance/Quality Control Report

Water Year 2020

Prepared by:

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Prepared for:

Santa Clara Valley
Urban Runoff
Pollution Prevention Program

March 31, 2021

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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
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 2020 (WY 2020; October 1, 2019 through September 30, 2020), the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP or Program) 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). The Program implemented a comprehensive data quality assurance and quality control (QA/QC) program, covering all aspects of Creek Status and Pesticides & Toxicity monitoring. QA/QC for data collected was performed according to procedures detailed in the BASMAA RMC Quality Assurance Project Plan (QAPP) (BASMAA 2020) and the BASMAA RMC Standard Operating Procedures (SOP; BASMAA 2016), 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, WY 2020 data met overall QA/QC objectives. However, several continuous water quality monitoring parameters were rejected and some additional data were flagged. 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 (two 1-2-week deployments; 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, all samples and field measurements are assumed to be representative 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 90% 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 95% 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, including laboratory, field, and equipment blanks. The RMC QAPP requires collection and analysis of field blank samples at a rate of 5% for orthophosphate. Field blanks are not required for other constituents.

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[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.

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[2] Look up lists available online at https://swamp.waterboards.ca.gov/swamp_checker/LookUpLists.aspx

[3] Checker available online at https://swamp.waterboards.ca.gov/swamp_checker/SWAMPUpload.aspx

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 or shared electrnically, a SCVURPPP QA staff member reviewed the field sheets again and noted any missing data.

2.3.3. Laboratory Results

SCVURPPP QA 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 °C, 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 A-1 and A-2 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 sample duplicates (LCSD), and matrix spike duplicates (MSD). 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, equipment, 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 are considered to be representative of conditions in Santa Clara County Creeks.

3.2. OVERALL PROJECT COMPARABILITY

SCVURPPP creek status monitoring data are considered to be comparable to 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.

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) and chlorophyll a (50 mg/L) were higher than the RMC QAPP target RLs 2 mg/L and 5mg/L, respectively. The elevated RLs were due to high concentrations that required 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.

Reporting 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

Two BMI samples were submitted to an independent QC taxonomic laboratory. One of those samples had four small taxonomic discrepancies and one minor counting error. The other sample had one minor counting error. The QC laboratory calculated sorting and taxonomic identification metrics, which were compared to the measurement quality objectives in Table D-1 in Appendix D of the RMC QAPP. A comparison of the metrics with the MQOs is shown in Table 1. The Taxonomic Identification Error Rate for the first sample (11.76%) exceeded the MQO threshold (10%), but QC laboratory considered this sorting error to be minor; as a result, no samples were flagged. A copy of the QC laboratory report is available upon request.

Table 1. Quality control metrics for taxonomic identification of benthic macroinvertebrates collected in Santa Clara County in WY 2020 compared to measurement quality objectives.

Quality Control Metric	MQO	Sample 1		Sample 2	
		Error Rate	Exceeds MQO?	Error Rate	Exceeds MQO?
Absolute Recount		0.16%	N/A	0.48%	N/A
High Taxonomic Resolution Count	≤10%	0%	No	0%	No
High Taxonomic Resolution Individual	≤10%	0%	No	0%	No
Individual ID	≤10%	0.81%	No	0%	No
Low Taxonomic Resolution Count	≤10%	0%	No	0%	No
Low Taxonomic Resolution Individual	≤10%	0%	No	0%	No
Recount Accuracy	> 95%	99.84%	No	99.84%	No
Taxa Count	≤10%	0%	No	0%	No
Taxa Identification	≤ 10%	11.76%	Yes	0%	No
Taxonomic Resolution Count	≤10%	0%	No	0%	No
Taxonomic Resolution Individual	≤10%	0%	No	0%	No

The analytical lab analyzed laboratory control samples and laboratory control sample duplicates for ash free dry mass. No LCS or LCSD samples were analyzed for chlorophyll a. The PRs for all ash free dry mass LCS and LCSD samples were within the MQO listed in the RMC QAPP (Table A-1), and no samples were flagged for accuracy exceedances.

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

3.3.4. Precision

Field blind duplicate chlorophyll a and ash free dry mass samples were collected at two sites in WY 2020 and were sent to the laboratory for analysis.

Due to the method used to collect duplicate algae field samples, these 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 A-1 in Appendix A 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 only for chlorophyll a at the other site. Ash free dry mass and chlorophyll a samples were flagged as necessary.

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 205R00282, collected on May 11, 2020 and site 205R00787, collected June 4, 2020.

Analyte	Units	205R00282May 11, 2020				205R00787 June 4, 2020			
		Original Result	Duplicate Result	RPD	Exceeds MQO (>25%)[a]	Original Result	Duplicate Result	RPD	Exceeds MQO (>25%)[a]
Chlorophyll a	**mg/m^2**	51	39	26%	Yes	59	46	26%	Yes
Ash Free Dry Mass	**g/m^2**	118	126	6%	No	67	23	98%	Yes

[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

Two ash free dry mass LCS and LCSD pairs were analyzed and the RPDs for both pairs were below the MQO limit, and no samples were flagged.

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.

Additionally, the analytical laboratory ran several method blanks during ash free dry mass and chlorophyll a analysis and no contamination was detected in any of the blank samples.

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 Diethyl-p-phenylene Diamine (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 measured 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.

The Program 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 within 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 2020. 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 Tables A-1 and A-2.

3.5.1. Comparability

Water chemistry data collected in WY 2020 in Santa Clara County are comparable to data collected by SWAMP and other RMC agencies, but WY 2020 ammonia data are potentially *not* comparable to past years' results. Program staff noted that the total Kjeldahl nitrogen (TKN) concentrations were greater than ammonia concentrations for 11 of the 20 Santa Clara creek sites sampled in WY 2020. Given that TKN is the sum of ammonia and organic nitrogen, this scenario is theoretically impossible. Since TKN and ammonia samples are collected in the same sample bottle, sampler error was excluded as a cause of the discrepancy. High nitrate concentrations may bias TKN low, but this explanation did not sufficiently explain the incongruity for all sites. Additionally, TKN concentrations for WY 2020 were comparable to historic TKN concentrations in Santa Clara creeks measured during MRP-compliance monitoring. It was concluded that instead, ammonia concentrations were biased high during WY 2020. Nothing in the QA/QC process would suggest that concentrations are suspect, but WY 2020 ammonia concentrations were demonstrably higher than historic ammonia concentrations measured in the region. A review of all historic ammonia measurements found that concentrations in WY 2019 and four samples in WY 2018 were also noticeably higher than concentrations measured in WYs 2012-2017.

In WY 2016, the RMC QAPP was revised and the target RL was lowered for ammonia to reflect changes made to the SWAMPP QAPrP. Caltest was asked to switch to a low-level ammonia analytical method to meet this lower target RL. However, in WY 2018, the laboratory encountered technical problems with the lower-level analytical method and 16 of the 20 SCVURPPP samples were analyzed with the higher RL. Once the equipment was fixed, the remaining four samples were analyzed via the low-level method. The four samples analyzed via the low-level analysis were noticeably higher than the samples analyzed earlier in the year. The Program hypothesizes that the samples analyzed via the low-level method post-2018 are biased high.

A simple Student's T-test[4] was run to determine if ammonia concentrations in WY 2019 and WY 2020 were significantly higher than samples run prior to the laboratory equipment malfunction. The results of this analysis are shown in Table 3. First combined results via the regular ammonia analytical method (WYs 2012-2015) were compared against combined results via the low-level analytical method used prior to the equipment issues (WY 2016 & 2017). There was no statistically significant difference between these two groups. However, there was a significant difference between ammonia concentrations from WYs 2019 and 2020 and ammonia concentrations from WYs 2012-2017. The same is true for a comparison of years where the low-level analysis was run (WYs 2016 & 2017 versus WYs 2019-2020).

Table 3. Two sample T-test (α = 0.05) comparison of ammonia concentrations from before and after a 2018 laboratory equipment malfunction.

Grouping 1	Grouping 2	Statistically Significant?
WYs 2012-2015	WYs 2016 & 2017	No
WYs 2012-2017	WYs 2019 & 2020	Yes
WYs 2016 & 2017	WYs 2019 & 2020	Yes

Though it appears WY 2019 and 2020 ammonia concentrations are biased high, there is no evidence of laboratory error since there were no significant QA issues during either year. As a result, the ammonia data were not flagged or rejected for being biased high. Caltest and the RMC have proposed two techniques to confirm and determine the source of the ammonia discrepancies including 1) analyzing ammonia samples collected in WY 2021 via both analytical methods; and 2) having Caltest and an unrelated analytical laboratory analyze duplicates samples via the low-level method.

Additionally, three WY 2020 silica samples (sites 205R00026, 205R00227, 205R05327) were not preserved until they arrived at Caltest. While this is a departure from the RMC SOP, the hold time was not exceeded. Furthermore, the silica concentrations for these samples were comparable to the other silica concentrations collected in Santa Clara creeks in WY 2020 and to the silica concentrations measured in Santa Clara creeks in WY 2012-2019. No samples were flagged or rejected due to this incident.

During sample collection at site 205R05198 (Canoas Creek), the caps for two sampling bottles were inadvertently switched after sampling; the cap for the sample bottle for phosphorus, TKN, and ammonia, which contains sulfuric acid, was switched with the cap for nitrate, nitrite, and chloride bottle, which does not have a preservative. When the samples arrived at Caltest, the pH was measured the laboratory determined that the samples were properly preserved and there was likely no sulfuric acid contamination. No samples were flagged or rejected due to this incident.

3.5.2. Completeness

The Program 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.

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[4] Two-sample T-test assuming inequal variance, with a significance level of 0.05.

3.5.3. Sensitivity

Laboratory RLs met or were lower than target RLs for all nutrients except for two nitrite samples, one orthophosphate sample, and all chloride and nitrate samples. The two nitrite and one orthophosphate samples that exceeded their target RL had high concentrations and thus were diluted. If dilution had not been needed, these samples would have met their target RLs. Moreover, the analytes in these samples were detected at concentrations well above their RLs and were not impacted by their elevated RLs. Similarly, the RL for all chloride samples exceeded the target RL, but concentrations were much higher than the RL, and the elevated RL did not decrease confidence in the measurements.

For the nitrate samples, laboratory RLs (0.05-0.1 mg/L) were higher than the target RL (0.01 mg/L). As a result, five samples were flagged as “detected, not quantified” as it was between the MDL and RL. If the laboratory was able to achieve the target RL, this sample would have been quantified and would not need to be flagged. The Program has discussed the RLs with Caltest, and due the methodology, lower limits cannot currently be achieved. Target and actual RLs are shown in Table 4.

Table 4. Target and actual reporting limits for nutrients analyzed in SCVURPPP creek status monitoring. Data in rows highlighted in yellow and orange exceed monitoring quality objectives in RMC QAPP. Orange rows indicate data that exceeded target RLs due to dilutions and would have met the targets if the samples had not been diluted.

Analyte	Target RL mg/L	Actual RL mg/L
Ammonia	0.02	0.02
Chloride	0.25	1-10
Total Kjeldahl Nitrogen	0.5	0.1
Nitrate	0.01	0.05-0.1
Nitrite	0.01	0.005-0.02
Orthophosphate	0.01	0.01-0.02
Silica	1	0.1
Phosphorus	0.01	0.01

3.5.4. Accuracy

The RMC QAPP lists a target recovery 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. However, one silica MS/MSD pair exceeded the MQO range. A second silica MS/MSD pair was also run in the same batch, and this pair did not exceed the MQO. The first pair was run on a non-project sample, while the second pair was run on a SCVURPPP sample. Since the pair that met the MQO was a part of the project, none of the five silica samples run in that batch were flagged.

3.5.5. Precision

Caltest ran several LCS/LCSD and MS/MSD pairs for all target analytes, and the RPD for all pairs were consistently below the MQO target of < 25%.

Water chemistry field duplicates were collected at two sites in Santa Clara County and were compared against the original samples. The field duplicate water chemistry results and their RPDs are shown in Table 5 and Table 6. Because of the variability in reporting limits, RPD was not calculated when either the original or duplicate sample concentration was less than the RL. For WY 2020, one of the TKN duplicate samples slightly exceeded the RPD MQO; the MQO is 25% and the measured RPD was 27%. Likely, this result was due to low TKN concentrations in the sample and duplicate (0.25 mg/L and 0.19 mg/L, respectively) that were slightly above the TKN RL. As a result of the exceedance, TKN samples were flagged. In past years of sampling, TKN 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.

Table 5. Field duplicate water chemistry results for site 205R00282, collected on May 11, 2020. 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	0.11	0.12	9%	No
Chloride	None	mg/L	18	18	0%	No
Nitrate as N	None	mg/L	J 0.084	J 0.081	N/A	No
Nitrite as N	None	mg/L	J 0.002	J 0.002	N/A	N/A
Nitrogen, Total Kjeldahl	None	mg/L	0.25	0.19	27%	Yes
Orthophosphate as P	Dissolved	mg/L	0.018	0.019	5%	No
Phosphorus as P	Total	mg/L	0.026	0.029	11%	No
Silica as SiO2	Total	mg/L	15	15	0%	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 6. Field duplicate water chemistry results for site 205R00787, collected on June 4, 2020. 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	0.49	0.45	9%	No
Chloride	None	mg/L	18	18	0%	No
Nitrate as N	None	mg/L	0.17	0.16	6%	No
Nitrite as N	None	mg/L	ND	ND	N/A	N/A
Nitrogen, Total Kjeldahl	None	mg/L	ND	ND	N/A	N/A
Orthophosphate as P	Dissolved	mg/L	0.027	0.029	7%	No
Phosphorus as P	Total	mg/L	0.028	0.022	24%	No
Silica as SiO2	Total	mg/L	15	16	6%	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

3.5.6. Contamination

During WY 2020, Caltest analyzed one equipment blank (orthophosphate filter blank), three field blanks, and several laboratory blanks. The equipment and field blanks were analyzed for orthophosphate, and no contamination was detected. Silica was detected above the MDL in one laboratory blank, but since the concentration was detected below the RL, the five samples in that batch were flagged, but no corrective action was needed. 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 July 17, 2020.

3.6.1. Completeness

The MRP requires that five pathogen indicator samples be collected in Santa Clara County each year. In WY 2020, all five required/planned pathogen indicator samples were collected for a 100% completeness rate.

3.6.2. Sensitivity

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

3.6.3. Accuracy

Negative and positive laboratory control samples were run for microbial media. A negative response was observed in the negative control and a positive response was observed in the positive control as required by the project QAPP Table A-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 2020, one laboratory duplicate was run for each microbial analyte, but these duplicates are not sufficient to determine precision. Nonetheless, the RPD was calculated for the duplicates - the RPD for *E.coli* was 17% and for the enterococcus the RPD was 20%.

The RMC QAPP does not require a field duplicate to be collected for pathogen indicators. However, one field duplicate was collected in WY 2020 at 205LGA400. The RPD was 0.5% for *E.coli* and 14% for enterococcus. Since there is no requirement for pathogen indicator field duplicates, there is no corresponding MQO, and the precision could not be assessed. See Table 7 for the field and lab duplicate results.

Table 7. Lab and field duplicate pathogen results collected on July 17, 2020.

Duplicate Type	Analyte	Original Result (MPN/100mL)	Duplicate Result (MPN/100mL)	RPD
Lab Duplicate	E.coli	45.7	55.6	17%
Lab Duplicate	Enterococcus	23.8	20.1	20%
Field Duplicate	E.coli	60.5	60.2	0.5%
Field Duplicate	Enterococcus	120.1	104.3	14%

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 2020), concurrent with bioassessments, at two sites in the summer (July 2020), and again at two sites in the late summer (September 2020). Temperature, pH, dissolved oxygen, and specific conductivity were recorded once every 15 minutes for approximately two-weeks using a multi-parameter water quality sonde (Eureka Manta+30 or YSI 6600-V2).

3.7.1. Completeness

The MRP requires SCVURPPP to monitor dissolved oxygen, pH, specific conductance, and temperature at three sites using sondes that record at 15-minute intervals over 1-2 weeks in the spring concurrent with bioassessment sampling and 1-2 weeks in summer at the same sites. In WY 2020, due to equipment issues, SCVURPPP was unable to meet this requirement exactly as prescribed. Three sites were monitored in the spring, two of those sites were monitored in mid-summer, and two were monitored in late-summer. Since all three sites were monitored twice and the three deployments exceeded the one-week minimum deployment requirement, continuous water quality monitoring is considered to meet the spirit of the MRP requirements.

During the spring deployment, the pH sensor for the sonde deployed at station 205COY195 failed and no pH data were collected . That sonde was not used again for subsequent deployments. No other parameters were rejected or missing during the three sonde deployments.

Consequently, the completion rate for continuous monitoring dropped to 95.85%, which is still above the 90% completion threshold.

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

Program staff conduct pre- and post-deployment sonde calibrations for the sondes used during monitoring events and calculate the drift during the deployments. During the first monitoring event in the spring, the pH sensor on the sonde deployed 205COY195 failed and no data were collected and no drift check could be conducted. Additionally, the conductivity post-deployment calibration measurement for 205COY183 for the second event was not recorded. A review of the conductivity data collected during the event and other calibration data for that particular sonde found no reason to reject the data. A summary of the drift measurements is shown in Table 8.

Table 8. Drift measurements for two continuous water quality monitoring events in Santa Clara Valley urban creeks during WY 2020. Bold and highlighted values exceeded measurement quality objectives.

Parameter	**Measurement Quality Objectives**	**205COY182**		**205COY183**			**205COY195**	
		Event 1	**Event 2**	**Event 1**	**Event 2**	**Event 3**	**Event 1**	**Event 3**
Dissolved Oxygen (mg/L or %)[1]	± 0.5 mg/L or 10%	-5%	-0.50%	0.9%	2.7%	0.3%	0.02	0.1%
pH 7.0	± 0.2	0.01	-0.09	-0.01	0.02	-0.02	NC	0.04
pH 10.0	± 0.2	0.04	-0.1	-0.02	-0.14	-0.17	NC	-0.13
Specific Conductance	± 10%	0.7%	-0.8%	0.7%	NR	-1.63%	1.1%	-4.2%

[1] Due to difference in sonde manufactures' specifications, some oxygen calibrations were performed on saturation (%), while others were on the concentration (mg/L).

NR – Not Recorded; calibration record could not be found

NC – Drift could not be calculated due to sensor failure

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 2020 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. One logger was missing during the mid-deployment field check and was replaced with a new logger. Similarly, two loggers were moved due to dry conditions at their original site. During the field check, staff also downloaded the existing data and redeployed the loggers. The eight original temperature loggers and one replacement logger 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 2020. None of the deployed loggers exceeded the 0.2 °C mean difference threshold for either the room temperature bath or the ice bath.

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 22, 2020 Samples were analyzed by Caltest for inorganic compounds, synthetic organic compounds, and grain size distribution . 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 A-7 through A-11.

3.9.1. Completeness

The MRP requires a sediment chemistry sample to be collected at two locations each year. In WY 2020, SCVURPPP collected the sediment chemistry sample at 205STE021 and 205STQ010. The laboratory analyzed samples well 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

For sediment chemistry analysis conducted in WY 2020, laboratory RLs were higher than RMC QAPP target RLs for metals, pyrethroid pesticides, fipronil and its degradates, carbaryl, and total organic carbon. A comparison of target and actual reporting limits for those parameters is shown in Table 9. 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 caused these exceedances. Additionally, the pyrethroid and fipronil samples required a dilution. As a result of this dilution, the RL for these analytes (1.1 ng/g) was greater than the target RL (0.33 ng/g) listed in the RMC QAPP. If dilutions had not been necessary, the analytical RLs would have met the target RL.

Table 9. Comparison of target and actual reporting limits (RLs) for sediment analytes where analytical reporting limits exceeded target limits. Sediment samples were collected in Santa Clara County creeks in WY 2020.

Analyte	Target RL	Actual RL	Unit
Arsenic	0.3	0.53-0.54	mg/Kg
Cadmium	0.01	0.08-0.09	mg/Kg
Chromium	0.1	1.1	mg/Kg
Copper	0.01	0.42-0.43	mg/Kg
Lead	0.01	0.08-0.9	mg/Kg
Nickel	0.02	0.08-0.09	mg/Kg
Zinc	0.1	0.84-0.9	mg/Kg
Bifenthrin	0.33 [a]	1.1 [b]	ng/g
Cyfluthrin	0.33 [a]	1.1 [b]	ng/g
Total Lambda-cyhalothrin	0.33 [a]	1.1 [b]	ng/g
Total Cypermethrin	0.33 [a]	1.1 [b]	ng/g
Total Deltamethrin	0.33 [a]	1.1 [b]	ng/g
Total Esfenvalerate/Fenvalerate	0.33 [a]	1.1 [b]	ng/g
Permethrin	0.33 [a]	1.1 [b]	ng/g
Fipronil	0.33 [a]	1.1 [b]	ng/g
Fipronil Desulfinyl	0.33 [a]	1.1 [b]	ng/g
Fipronil Sulfide	0.33 [a]	1.1 [b]	ng/g
Fipronil Sulfone	0.33 [a]	1.1 [b]	ng/g
Carbaryl	30	32-33	ng/g
Total Organic Carbon	0.01	0.053-0.055	% dw

[a] There is no appropriate SWAMP targets for pyrethroids or for fipronil and its degredates. For these analytes, the RMC target RLs are based on current lab capabilities.

[b] These samples were diluted, which raised the RL. If dilutions had not been necessary, the samples' RL would have been less than the target RL.

3.9.3. Accuracy

Inorganic Analytes

In the RMC QAPP, the PR MQO for LCS and MS samples is 75-125% for inorganic analytes. None of the LCSs exceeded the QAPP MQO, but the MS samples for lead exceeded the PR MQO. Additionally, the zinc MS sample was non-calculable because the measured concentration was less than the native concentration. The zinc and lead samples were flagged for matrix spike samples exceeded their recovery MQOs, but the samples were not rejected.

Synthetic Organic Compounds

The MQO specified in the RMC QAPP for the recovery of synthetic organic compounds (excluding pyrethroid pesticides) in sediment is 50-150% for both LCS and MS samples. None of the LCS or MS PRs exceeded the RMC MQO range.

The RMC QAPP lists pyrethroid pesticides separately from other synthetic organic compounds, but they have the same MQO of 50-150% for both LCS and MS/MSD samples. All LCS samples analyzed for pyrethroid pesticides were well within the prescribed MQO for recovery. However, one matrix spike analyzed for permethrin slightly exceeded the MQO. The two permethrin samples were subsequently flagged, but not rejected.

3.9.4. Precision

Inorganic Analytes
The RMC QAPP lists the maximum RPD for inorganic analytes (metals) as 25%. All MS/MSD pairs for metals were below the RMC RPD MQO of 25%. The RMC QAPP does not require the analysis of LCS duplicates for inorganic compounds.

Synthetic Organic Compounds
The maximum RPD for synthetic organics listed in the sediment laboratory report 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 exceeded the RPD MQO.

Field Duplicates
A sediment sample field duplicate was collected in Santa Clara County on July 22, 2020 and evaluated for precision. The field duplicate sample and corresponding RPDs are shown in Table 10. Due to 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. Analytes that exceeded their corresponding RPD MQO and were flagged were small pebbles (4 to <8 mm), lead, and three polycyclic aromatic hydrocarbons (PAHs; fluoranthene, phenanthrene, and pyrene).

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 10. Sediment chemistry duplicate field results for site 205STQ010, collected on July 22, 2020 in Santa Clara 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	%	9.02	8.82	2%	No
	Silt: 0.0039 to <0.0625 mm	%	16.96	17.05	1%	No
	Sand: V. Fine 0.0625 to <0.125 mm	%	10.41	11.31	8%	No
	Sand: Fine 0.125 to <0.25 mm	%	18.93	18.1	4%	No
	Sand: Medium 0.25 to <0.5 mm	%	25.7	25.49	1%	No
	Sand: Coarse 0.5 to <1.0 mm	%	11.04	10.97	1%	No
	Sand: V. Coarse 1.0 to <2.0 mm	%	7.94	8.27	4%	No
	Granule: 2.0 to <4.0 mm	%	5.23	4.74	10%	No
	Pebble: Small 4 to <8 mm	%	3.89	0.56	150%	Yes
	Pebble: Medium 8 to <16 mm	%	ND	ND	NA	NA
	Pebble: Large 16 to <32 mm	%	ND	ND	NA	NA
	Pebble: V. Large 32 to <64 mm	%	ND	ND	NA	NA
Metals	Arsenic	mg/Kg dw	2.8	2.7	4%	No
	Cadmium	mg/Kg dw	0.19	0.17	11%	No
	Chromium	mg/Kg dw	47	46	2%	No
	Copper	mg/Kg dw	35	34	3%	No
	Lead	mg/Kg dw	19	10	62%	Yes
	Nickel	mg/Kg dw	47	41	14%	No
	Zinc	mg/Kg dw	130	130	0%	No
	Total Organic Carbon	%	2.8	3.2	13%	No
Pyrethroids (MQO <35%)	Bifenthrin	ng/g dw	7.8	6.6	17%	No
	Cyfluthrin	ng/g dw	2.5	2.2	13%	No
	Lambda-Cyhalothrin	ng/g dw	J0.72	J0.7	NA	NA
	Cypermethrin	ng/g dw	J0.75	J0.78	NA	NA
	Deltamethrin/Tralomethrin	ng/g dw	ND	ND	NA	NA
	Esfenvalerate/Fenvalerate	ng/g dw	ND	ND	NA	NA
	Permethrin	ng/g dw	3.1	2.6	18%	No
	Carbaryl	mg/Kg dw	ND	ND	NA	NA
Fipronil	Fipronil	ng/g dw	ND	ND	NA	NA
	Fipronil Desulfinyl	ng/g dw	ND	ND	NA	NA
	Fipronil Sulfide	ng/g dw	ND	ND	NA	NA
	Fipronil Sulfone	ng/g dw	J0.53	J0.57	NA	NA
Polycyclic Aromatic Hydrocarbons	Acenaphthene	ng/g dw	ND	ND	NA	NA
	Acenaphthylene	ng/g dw	ND	ND	NA	NA
	Anthracene	ng/g dw	ND	ND	NA	NA
	Benz(a)anthracene	ng/g dw	ND	ND	NA	NA
	Benzo(a)pyrene	ng/g dw	ND	ND	NA	NA
	Benzo(b)fluoranthene	ng/g dw	ND	ND	NA	NA
	Benzo(e)pyrene	ng/g dw	ND	ND	NA	NA
	Benzo(g,h,i)perylene	ng/g dw	ND	ND	NA	NA
	Benzo(k)fluoranthene	ng/g dw	ND	ND	NA	NA
	Biphenyl	ng/g dw	ND	ND	NA	NA
	Chrysene	ng/g dw	ND	ND	NA	NA

Table 10. Sediment chemistry duplicate field results for site 205STQ010, collected on July 22, 2020 in Santa Clara 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	NA	NA
	Dibenzothiophene	ng/g dw	ND	ND	NA	NA
	Dimethylnaphthalene, 2,6-	ng/g dw	55	65	17%	No
	Fluoranthene	ng/g dw	55	76	32%	Yes
	Fluorene	ng/g dw	ND	ND	NA	NA
	Indeno(1,2,3-c,d)pyrene	ng/g dw	ND	ND	NA	NA
	Methylnaphthalene, 1-	ng/g dw	ND	ND	NA	NA
	Methylnaphthalene, 2-	ng/g dw	ND	ND	NA	NA
	Methylphenanthrene, 1-	ng/g dw	ND	ND	NA	NA
	Naphthalene	ng/g dw	ND	ND	NA	NA
	Perylene	ng/g dw	ND	ND	NA	NA
	Phenanthrene	ng/g dw	33	43	26%	Yes
	Pyrene	ng/g dw	66	87	27%	Yes

[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

J concentrations are below the RL that are "detected, not quantified"

Laboratory Duplicates

Laboratory duplicates were collected and analyzed for grain sizes and total organic carbon. All RPDs were below the MQO limits.

3.9.5. Contamination

The RMC QAPP requires all blanks (laboratory and field) to be less than the analyte reporting limits. All laboratory blanks were below their analytes' MDL except for the sample analyzed for lead. Since this QA sample was below the RL, the lead samples were flagged, but no corrective action was necessary.

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 22, 2020. 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 water sediment toxicity are not required by the RMC QAPP. Subsequently, precision could not be evaluated.

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. SUMMARY

In WY 2020, sample collection and analysis followed MRP and RMC QAPP requirements. A summary of the QA/QC analysis is provided below.

Data Discrepancies

- Ammonia concentrations are potentially biased high, but data were not flagged or rejected until this finding can be confirmed and the source identified.
- Free chlorine measurements were greater than total chlorine measurements at three sites.

Rejected Data

- Continuous pH data were rejected for site 205COY195 for the first deployment.

Flagged Data

- Chlorine between 0.02 and 0.1 mg/L flagged as “detected, not quantified.”
- Ash free dry mass, chlorophyll a, and TKN data were flagged due to the field duplicates exceeding the RPD MQO.
- Five silica samples flagged for potential contamination, but no corrective action needed because the concentration in the blank sample was less than the RL.
- The zinc, lead, and permethrin sediment samples were flagged for matrix spike samples exceeding their recovery MQOs, but the samples were not rejected.
- Small pebbles (4 to <8 mm), lead, fluoranthene, phenanthrene, and pyrene sediment samples were flagged due to the field duplicate exceeding the RPD MQO.
- Lead sediment samples were flagged for potential contamination.

5. REFERENCES

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Attachment 2

SCVURPPP Bioassessment Data, WY 2020

SCVURPPP Bioassessment Data, WY 2020

Site Information					Water Quality						Water Chemistry (Nutrients)														Biological and Physical Habitat Indicator Scores					Physical Habitat									Land Use Variables		
Station Code	Creek Name	Latitude	Longitude	Sample Date	Dissolved Oxygen (mg/L)	Temperature (Deg C)	Spec Conductance (uS/cm)	pH	Chloride (mg/L)	Silica (mg/L)	Ash Free Dry Mass (g/m2)	Chlorophyll a (mg/m2)	Ammonia (mg/L)	UIA (mg/L)	Nitrate as N (mg/L)	QA Flag	Nitrite as N (mg/L)	QA Flag	TKN as N (mg/L)	QA Flag	Total Nitrogen(mg/L)	Ortho Phosphate as P (mg/L)	QA Flag	Total Phosphorus (mg/L)	CSCI	ASCI_Diatom	ASCI_Soft Algae	ASCI_Hybrid	IPI	Channel Alteration	Epifaunal Substrate	Sediment Deposition	Human Disturbance Index	Evenness Flow Habitat	% Substrate <2 mm	Shannon Diversity Habitat	SumRiparianCover	Shannon Diversity Substrate	% Impervious (wat)	% Urban (wat)	Road Density (wat)
205COY200	Thompson Creek	37.3263	-121.8086	06/03/20	8.5	24.3	1154	7.8	99	27	302	68	0.18	0.005	4.40	=	0.017	=	-0.08	ND	4.5	0.032	=	0.041	0.44	0.48	0.48	0.37	0.44	7	6	4	4.0	0.5	84	0.9	38	1.0	18%	34%	4.9
205R00026	Los Gatos Creek	37.2307	-121.9732	05/04/20	11.6	11.4	413	7.9	12	15	37	30	0.13	0.002	0.14	=	0.003	DNQ	-0.08	ND	0.2	0.01	=	0.02	0.64	0.74	1.34	0.95	1.15	14	14	13	1.4	1.0	61	1.8	175	1.6	5%	11%	2.9
205R00227	Matadero Creek	37.4098	-122.1383	05/05/20	7.7	13	1281	7.8	140	15	147	48	0.13	0.002	1.00	=	0.018	=	-0.08	ND	1.1	0.18	=	0.02	0.43	0.55	0.96	0.50	0.86	6	7	11	1.6	0.3	50	1.5	144	1.5	17%	51%	5.0
205R00282	Guadalupe Creek	37.2374	-121.8887	05/11/20	8.8	14.4	506	7.7	18	15	118	51	0.13	0.001	0.08	DNQ	0.002	DNQ	-0.08	ND	0.1	0.018	=	0.026	0.78	0.81	1.10	0.75	1.13	19	17	9	2.0	0.8	49	1.8	169	1.5	4%	8%	2.4
205R00419	Stevens Creek	37.3199	-122.0617	05/14/20	10.5	12.9	569	7.9	25	13	230	61	0.51	0.008	0.20	=	0.004	DNQ	-0.08	ND	0.2	0.029	=	0.043	0.67	0.44	0.94	0.50	1.08	15	15	8	1.8	0.7	51	1.7	176	1.5	3%	4%	1.4
205R00602	Alamitos Creek	37.2302	-121.8659	05/13/20	11.9	15.1	502	8.2	40	17	149	114	0.64	0.023	0.18	=	0.002	DNQ	0.28	=	0.5	0.049	=	0.061	0.64	0.64	0.58	0.55	1.01	NR	NR	NR	2.1	0.9	50	1.4	122	1.6	7%	15%	2.6
205R00714	Los Gatos Creek	37.2342	-121.9736	06/01/20	9.3	14	4321	7.5	14	13	105	42	0.12	0.001	0.12	=	0.002	DNQ	0.083	DNQ	0.2	0.02	=	0.023	0.73	0.66	1.07	0.72	1.13	14	14	11	1.5	0.7	43	1.8	193	1.5	5%	11%	2.9
205R00787	Upper Penitencia Creek	37.4012	-121.7952	06/04/20	10.9	14.8	703	8.2	18	15	67	59	0.49	0.016	0.17	=	-0.001	ND	-0.08	ND	0.2	0.027	=	0.028	1.30	0.77	0.89	0.74	1	19	19	16	0.5	0.5	7	0.9	140	1.6	1%	2%	0.4
205R00979	Lower Silver Creek	37.3542	-121.8469	06/02/20	6.1	20.1	1354	8.2	120	24	735	213	0.24	0.012	2.40	=	0.030	=	0.41	=	2.8	0.057	=	0.087	0.49	0.39	1.26	0.27	0.75	5	6	14	3.7	0.5	32	1.4	82	1.6	24%	47%	6.8
205R03795	Lower Silver Creek	37.3580	-121.8561	06/02/20	14.5	25.5	1250	8.5	120	20	575	305	0.16	0.022	2.40	=	0.030	=	0.5	=	2.9	0.045	=	0.058	0.39	0.39	0.64	0.25	0.81	7	6	14	3.2	1.0	37	1.4	66	1.4	25%	49%	7.1
205R04523	Lower Penitencia Creek	37.4132	-121.9041	05/07/20	11.9	22.7	1474	8.0	120	21	725	92	0.19	0.007	1.30	=	0.015	=	0.33	=	1.6	0.032	=	0.051	0.19	0.48	1.06	0.55	0.74	3	3	2	2.7	0.5	81	1.6	112	1.2	69%	96%	12.6
205R04866	Canoas Creek	37.2332	-121.8350	05/12/20	5.5	17	1242	7.6	73	27	292	164	0.14	0.002	2.70	=	0.069	=	0.19	=	3.0	0.014	=	0.027	0.43	0.53	0.79	0.40	0.43	1	4	13	2.5	0.0	54	1.0	106	0.8	35%	61%	8.8
205R04967	Upper Penitencia Creek	37.3972	-121.8257	05/06/20	10.7	17.5	1241	8.5	110	9.8	119	132	0.23	0.017	0.19	=	0.002	DNQ	0.22	=	0.4	-0.006	ND	0.015	1.08	0.60	1.06	0.61	1.12	16	15	16	0.4	0.8	34	1.7	169	1.8	2%	6%	0.7
205R05142	Thompson Creek	37.2906	-121.7664	06/03/20	6.3	17.6	1297	8.0	150	27	33	167	0.13	0.004	0.08	DNQ	0.002	DNQ	0.3	=	0.4	0.13	=	0.13	0.56	0.52	0.89	0.58	0.9	18	13	8	2.2	0.5	30	1.4	129	1.8	9%	19%	3.0
205R05155	Berryessa Creek	37.4165	-121.8556	05/07/20	10.2	13.6	657	8.4	24	28	162	12	0.31	0.016	-0.02	ND	0.003	DNQ	0.22	=	0.2	0.16	=	0.16	1.03	0.79	1.20	0.78	1	10	9	10	3.1	0.9	36	1.9	132	1.3	3%	5%	1.0
205R05183	Upper Penitencia Creek	37.4050	-121.7898	05/06/20	10.0	10.8	771	8.3	22	18	44	13	0.15	0.006	0.10	DNQ	0.001	DNQ	0.33	=	0.4	0.063	=	0.09	1.18	0.84	1.41	0.97	1.02	20	18	17	0.2	0.8	13	1.6	108	1.8	1%	1%	0.9
205R05198	Canoas Creek	37.2628	-121.8488	05/12/20	8.5	20.1	1016	7.9	66	18	500	245	0.53	0.015	1.50	=	0.098	=	3.2	=	4.8	0.086	=	0.17	0.28	0.48	0.86	0.44	0.47	1	3	15	2.4	0.0	49	0.8	136	0.6	43%	71%	10.7
205R05327	Hale Creek	37.3604	-122.0998	05/05/20	9.6	15.4	1886	7.9	210	43	271	32	0.16	0.003	1.90	=	0.010	=	0.63	=	2.5	0.2	=	0.22	0.41	0.50	1.10	0.41	0.68	9	9	7	2.5	0.3	70	1.4	115	1.3	21%	80%	7.7
205R05587	Stevens Creek	37.3053	-122.0743	05/28/20	8.8	12.9	545	7.7	20	16	52	85	0.23	0.002	0.09	=	0.007	=	0.17	=	0.3	0.027	=	0.054	0.53	0.70	1.26	0.71	1.1	17	17	13	1.1	0.7	36	1.9	154	1.6	2%	2%	1.2
205R05650	Alamitos Creek	37.2023	-121.8297	05/13/20	11.0	12.2	405	8.0	8.2	19	32	52	0.13	0.003	0.08	DNQ	0.001	DNQ	0.22	=	0.3	0.035	=	0.046	0.67	0.74	1.01	0.65	1.13	15	16	16	2.7	0.7	36	1.9	152	1.7	2%	3%	1.3

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_SA - Algae Stream Condition Index (Soft Algae)

IPI - Index Physical Habitat Integrity