
Watershed Monitoring and Assessment Program



Creek Status Monitoring Report

Water Year 2016 (October 2015 – September 2016)

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

March 31, 2017

PREFACE

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

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

This Creek Status Monitoring Report complies with provision C.8.h.iii of the MRP for reporting of all data in Water Year 2016 (October 1, 2015 through September 30, 2016). Data were collected pursuant to provisions C.8.d (Creek Status Monitoring) and C.8.g (Pesticides & Toxicity Monitoring) of the MRP. Data presented in this report were produced under the direction of the RMC and the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP or Program) using probabilistic and targeted monitoring designs as described herein.

Consistent with the Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012), monitoring data were collected in accordance with the most recent versions of the BASMAA RMC Quality Assurance Program Plan (QAPP; BASMAA, 2016a) and the BASMAA RMC Standard Operating Procedures (SOPs; BASMAA, 2016b). Where applicable, monitoring data were derived using methods comparable with methods specified by the California Surface Water Ambient Monitoring Program (SWAMP) QAPP². Data presented in this report were submitted in electronic SWAMP-comparable formats by SCVURPPP to the Regional Water Board on behalf of SCVURPPP Co-permittees and pursuant to provision C.8.h.ii of the MRP.

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

² The current SWAMP QAPP is available at:
http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/qapp/swamp_qapp_master090108a.pdf

LIST OF ACRONYMS

ACCWP	Alameda Countywide Clean Water Program
AFDM	Ash Free Dry Mass
AFS	American Fisheries Society
BASMAA	Bay Area Stormwater Management Agency Association
BMI	Benthic Macroinvertebrate
CAP	Conservation Action Planning
CCCWP	Contra Costa Clean Water Program
CEDEN	California Environmental Data Exchange Network
COLD	Cold Freshwater Habitat
CSCI	California Stream Condition Index
DO	Dissolved Oxygen
DPS	Distinct Population Segment
EPA	Environmental Protection Agency
FSURMP	Fairfield Suisun Urban Runoff Management Program
GIS	Geographic Information Systems
GRTS	Generalized Random Tessellation Stratified
HDI	Human Disturbance Index
IBI	Indices of Biotic Integrity
IWRMP	Integrated Water Resources Management Plan
LID	Low Impact Development
MPC	Monitoring and Pollutants of Concern Committee
MRP	Municipal Regional Permit
MWAT	Maximum Weekly Average Temperature
MWMT	Maximum Weekly Maximum Temperature
NMFS	National Marine and Fisheries Services
NPDES	National Pollution Discharge Elimination System
O/E	Observed to Expected
PAH	Polycyclic Aromatic Hydrocarbons
PEC	Probable Effects Concentrations
PHAB	Physical habitat assessments
pMMI	Predictive Multi-Metric Index
PSA	Perennial Streams Assessment
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RMC	Regional Monitoring Coalition
RMP	Regional Monitoring Program
RWB	Reachwide Benthos
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
SMCWPPP	San Mateo County Water Pollution Prevention Program
SOP	Standard Operating Protocol
SSID	Stressor/Source Identification
SWAMP	Surface Water Ambient Monitoring Program
TEC	Threshold Effects Concentrations

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TMDL	Total Maximum Daily Load
TNS	Target Non-Sampleable
TOC	Total Organic Carbon
TS	Target Sampleable
TST	Test of Significant Toxicity
TU	Toxicity Unit
WARM	Warm Freshwater Habitat
USEPA	Environmental Protection Agency
WQ	Water Quality
WQO	Water Quality Objective
WY	Water Year

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LIST OF ATTACHMENTS

- Attachment 1.** QA/QC Report
- Attachment 2.** Biological Indicator Metric Scores

1.0 INTRODUCTION

This Creek Status Monitoring Report 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) 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). On November 19, 2015, the SFRWQCB updated and reissued the MRP as Order R2-2015-0049 (SFRWQCB 2015). This report fulfills the requirements of provision C.8.h.iii of the MRP for comprehensively interpreting and reporting all Creek Status and Pesticides & Toxicity monitoring data collected during the foregoing October 1 – September 30 (i.e., Water Year 2016).³ Data 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. Monitoring data presented in this report were submitted electronically to the SFRWQCB by SCVURPPP and may be obtained via the San Francisco Bay Area Regional Data Center of the California Environmental Data Exchange Network (CEDEN) (<http://water100.waterboards.ca.gov/ceden/sfei.shtml>).

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** – General water quality monitoring (continuous temperature, continuous general water quality, and pathogen indicators) at targeted sites
- **Section 4.0** – Chlorine monitoring at probabilistic sites
- **Section 5.0** – Pesticides & Toxicity monitoring
- **Section 6.0** – Conclusions and recommendations

1.1 Monitoring Goals

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?*

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 the 2015 MRP are similar to the 2009 MRP 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 Regional Monitoring Coalition (RMC). Monitoring results are evaluated to determine whether triggers are met and further investigation is warranted as a potential Stressor/Source Identification (SSID) Project, as described in provision C.8.e of the MRP. Results of Creek Status Monitoring conducted in Water Years 2012 through 2015 were submitted in prior reports (SCVURPPP 2016, SCVURPPP 2015, SCVURPPP 2014, SCVURPPP 2013).

³ Monitoring data collected pursuant to other C.8 provisions (e.g., Pollutants of Concern Monitoring, Stressor/Source Identification Monitoring Projects) are reported in the SCVURPPP Urban Creeks Monitoring Report (UCMR) for WY 2016 to which this Creek Status Monitoring Report is appended.

1.2 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 Bay Area Stormwater Management Agencies Association (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.

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 Jose, 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 Sanitation and Flood Control 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

⁴ The San Francisco Bay Regional Water Quality Control Board (SFRWQCB) 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 (SFRWQCB 2009). The BASMAA programs supporting MRP Regional Projects include all MRP Permittees as well as the cities of Antioch, Brentwood, and Oakley which are not named as Permittees under the MRP but have voluntarily elected to participate in MRP-related regional activities.

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). Table 1.2 provides a list of which 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. Creek Status Monitoring parameters in compliance with MRP 2.0 provision 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)	
<i>Creek Status Monitoring (C.8.d)</i>			
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	3.0
Chlorine	X	(X) ²	4.0
<i>Pesticides & Toxicity Monitoring (C.8.g)</i>			
Water Toxicity		X	5.0
Sediment Toxicity		X	5.0
Sediment Chemistry		X	5.0

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

1.3 Monitoring and Data Assessment Methods

1.3.1 Monitoring Methods

Water quality data were collected in accordance with SWAMP-comparable methods and procedures described in the BASMAA RMC Standard Operating Procedures (SOPs; BASMAA 2016b) and associated Quality Assurance Project Plan (QAPP; BASMAA 2016a). These documents and the RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012) are updated as needed to maintain their currency and optimal applicability. Where applicable, monitoring data were collected using methods comparable to those specified by the California Surface Water Ambient Monitoring Program (SWAMP) QAPP⁵, and were submitted in SWAMP-compatible format to the SFRWQCB. The SOPs were developed using a standard format that describes health and safety cautions and considerations, relevant training, site selection, and sampling methods/procedures, including pre-fieldwork mobilization activities to prepare equipment, sample collection, and de-mobilization activities to preserve and transport samples.

1.3.2 Laboratory Analysis Methods

RMC participants, including SCVURPPP, agreed to use the same laboratories for individual parameters (excepting pathogen indicators), developed standards for contracting with the labs, and coordinated quality assurance samples. All samples collected by RMC participants that were sent to laboratories for

⁵ The current SWAMP QAPP is available at:

http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/qapp/qappr082209.pdf

analysis were analyzed and reported per SWAMP-comparable methods as described in the RMC QAPP (BASMAA 2016a). Analytical laboratory methods, reporting limits and holding times for chemical water quality parameters are also described in BASMAA (2016a). Analytical laboratory contractors 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
- San Jose-Santa Clara Regional Wastewater Facility – Pathogen indicators

1.3.3 Data Analysis Methods

Water and sediment chemistry and toxicity data generated during WY 2016 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 and Toxicity Monitoring data must be evaluated with respect to numeric thresholds, specified in the “Followup” sections in Provision C.8.d and C.8.g of the MRP (SFRWQCB 2015) that, if not met, require consideration for further evaluation as part of a Stressor/Source Identification (SSID) 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.

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. Followup SSID projects will be selected from this list.

1.4 Setting

1.4.1 Watersheds Monitored by SCVURPPP

There are 13 major watersheds within the SCVURPPP jurisdictional boundaries and these watersheds comprise most of the Santa Clara Basin. The watersheds are mapped in Figure 1.1 and their major characteristics are listed in Table 1.3. The Santa Clara Basin, San Francisco Bay south of the Dumbarton Bridge, and the 840 square miles that drain to it, are 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 threshold, an urbanized landscape dominates. Most watersheds have their headwaters in the undeveloped mountains and drain north through urbanized areas to the Bay. Flows in the lower reaches of most watersheds are controlled by the presence of water supply reservoirs that are managed by the Santa Clara Valley Water District (SCVWD) and other agencies. Many of the reservoirs are constructed at the transition between the Santa Clara Valley and the surrounding foothills. Water is captured during the winter rainy season and released in the spring at managed rates to allow for percolation through the stream bed and to protect fish habitat downstream of the reservoirs. To varying degrees, portions of all watersheds within the urban zone have been engineered or placed within underground culverts. The Sunnyvale East and West Channel watersheds contain no natural creek bed at all; they were constructed in the 1960s to manage flooding.

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Table 1.3. Characteristics of major watersheds within SCVURPPP boundary.

Watershed	Area (square miles)	Number 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	44.7%	46.5%	11.8%	36.3%	2.7%	2.7%
Barron	15.6	5	15.1	7.9	28.6	60.3%	60.5%	20.1%	7.3%	7.0%	5.1%
Calabazas	20.3	6	12.9	14.1	55.5	NA	54.5%	29.4%	8.8%	5.2%	2.1%
Coyote	321	53	670	36.4	146	11.1%	8.6%	3.7%	49.9%	29.6%	8.2%
Guadalupe	171	50	207	45.5	265	37.1%	29.6%	13.6%	34.7%	15.5%	6.6%
Lower Penitencia	28.6	13	29.2	20.8	61.6	42.9%	30.7%	19.0%	1.1%	38.7%	10.5%
Matadero	14.0	3	18	NA	NA	60.3%	57.1%	5.8%	8.9%	8.2%	20%
Permanente	17.3	7	NA	NA	NA	43.9%	46.3%	13.1%	35.0%	2.8%	2.8%
San Francisquito	42.8	25	90.6	4.8	15.3	20.8%	29.6%	5.2%	44.7%	15.0%	5.5%
San Tomas Aquino	44.8	15	50.5	15.5	79.3	60.1%	53.9%	18.8%	23.7%	0.8%	2.8%
Stevens	29.2	12	54.2	1.1	30.0	28.6%	24.5%	9.0%	49.2%	12.5%	4.8%
Sunnyvale East	7.1	0	0	6.2	26.6	82.2%	65.3%	31.8%	0%	0%	2.9%
Sunnyvale West	7.6	0	0	6.7	18.7	72.4%	20.9%	65.2%	0%	0%	13.9%

Source: <http://www.scvurppp-w2k.com/watersheds.shtml>

NA – not available

WY 2016 Creek Status and Pesticides and Toxicity Monitoring Stations

The complete list of probabilistic and targeted monitoring sites samples by SCVURPPP in WY 2016 in compliance with Provisions C.8.d (Creek Status Monitoring) and C.8.g (Pesticides and Toxicity Monitoring) is presented in Table 1.4. Monitoring locations with monitoring parameter(s) are mapped in Figure 1.2. Probabilistic station numbers, generated from the RMC Sample Frame, are provided for all bioassessment locations. Targeted stations numbers, based on SWAMP station numbering methods (BASMAA 2016b), are provided for all targeted monitoring sites. In some cases, targeted sites occurred within the probabilistic site (150 meter reach), and both station numbers are provided.

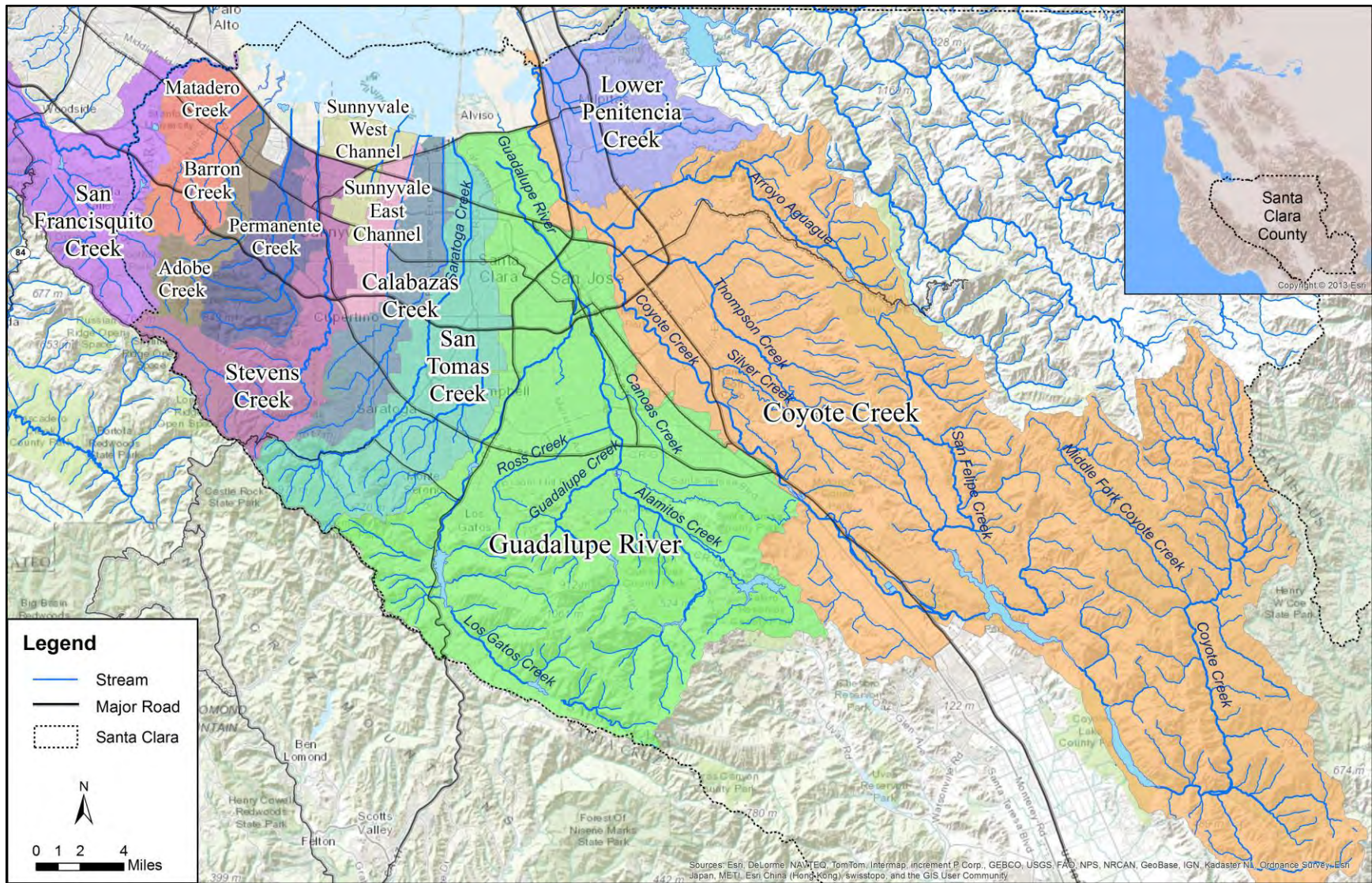


Figure 1.1. Watersheds within SCVURPPP jurisdictional boundaries.

SCVURPPP WY 2016 Creek Status Monitoring Report

Table 1.4. Sites and parameters monitored in WY 2016 in Santa Clara County. In cases where targeted sites occurred within a bioassessment sample reach, the geographic coordinates for the bioassessment site is indicated. Coordinates for all targeted sites are provided in method section for those parameters.

Map ID	Probabilistic Station Number	Targeted Station Number	Watershed	Creek Name	Land Use	Latitude	Longitude	Probabilistic Monitoring		Targeted Monitoring		
								Bioassess, Nutrients, Chlorine, General WQ	Toxicity, Sediment Chemistry	Temp	Cont WQ	Pathogen Indicators
213	205R00213		Coyote Creek	Cow Creek	NU	37.264449	-121.650393	x				
305	205R00305		Coyote Creek	San Felipe Creek	NU	37.256256	-121.66266	x				
578	205R00578		Coyote Creek	Arroyo Aguague	NU	37.349247	-121.71812	x				
1114	205R01114		Guadalupe River	Guadalupe River	U	37.2845	-122.88231	x				
1731	205R01731	205COY117	Coyote Creek	Upper Penitencia Creek	U	37.392645	-121.834768	x		x	x	x
2330	205R02330		Guadalupe River	Ross Creek	U	37.2552	-121.90656	x				
2422	205R02422	205GUA329	Guadalupe River	Arroyo Calero	U	37.21059	-121.82717	x				x
2458	205R02458	205GUA262	Guadalupe River	Alamitos Creek	U	37.218965	-121.843211	x				x
2474	205R02474	205SAR075	San Tomas Aquino	Saratoga Creek	U	37.25819	-122.03437	x				x
2538	205R02538		San Tomas Aquino	Calabazas Creek	U	37.275375	-122.042246	x				
2547	205R02547		Stevens Creek	Stevens Creek	U	37.31243	-122.16309	x				
2563	205R02563		Guadalupe River	Los Gatos Creek	U	37.329237	-121.899601	x				
2602	205R02602		San Tomas Aquino	Tributary to San Tomas	U	37.23547	-122.00528	x				
2618	205R02618		Guadalupe River	Aldercroft Creek	U	37.17623	-121.98942	x				
2650	205R02650		Guadalupe River	Alamitos Creek	U	37.2215	-121.847003	x				
2659	205R02659		Stevens Creek	Stevens Creek	U	37.344735	-122.064166	x				
2730	205R02730		San Tomas Aquino	Saratoga Creek	U	37.28141	-122.00642	x				
2762	205R02762		Guadalupe River	Ross Creek	U	37.23593	-121.95184	x				
2771	205R02771		Coyote Creek	Lower Silver Creek	U	37.352282	-121.835429	x				
2835	205R02835	205COY135	Coyote Creek	Upper Penitencia Creek	U	37.396581	-121.803899	x		x		x
021		205STE021	Stevens Creek	Stevens Creek	U	37.41096	-122.06893		x			
010		205STQ010	San Tomas Aquino	San Thomas Aquino	U	37.38895	-121.96858		x			
025		205AAG025	Coyote Creek	Arroyo Aguague	NU	37.39711	-121.78570			x		
114		205COY114	Coyote Creek	Upper Penitencia Creek	U	37.39007	-121.84361			x	x	
121		205COY121	Coyote Creek	Upper Penitencia Creek	U	37.39530	-121.82668			x	x	
130		205COY130	Coyote Creek	Upper Penitencia Creek	U	37.39362	-121.81783			x	x	
140		205COY140	Coyote Creek	Upper Penitencia Creek	U	37.40113	-121.79541			x		
142		205COY142	Coyote Creek	Upper Penitencia Creek	U	37.40418	-121.79317			x		
145		205COY145	Coyote Creek	Upper Penitencia Creek	NU	37.40469	-121.79165			x		

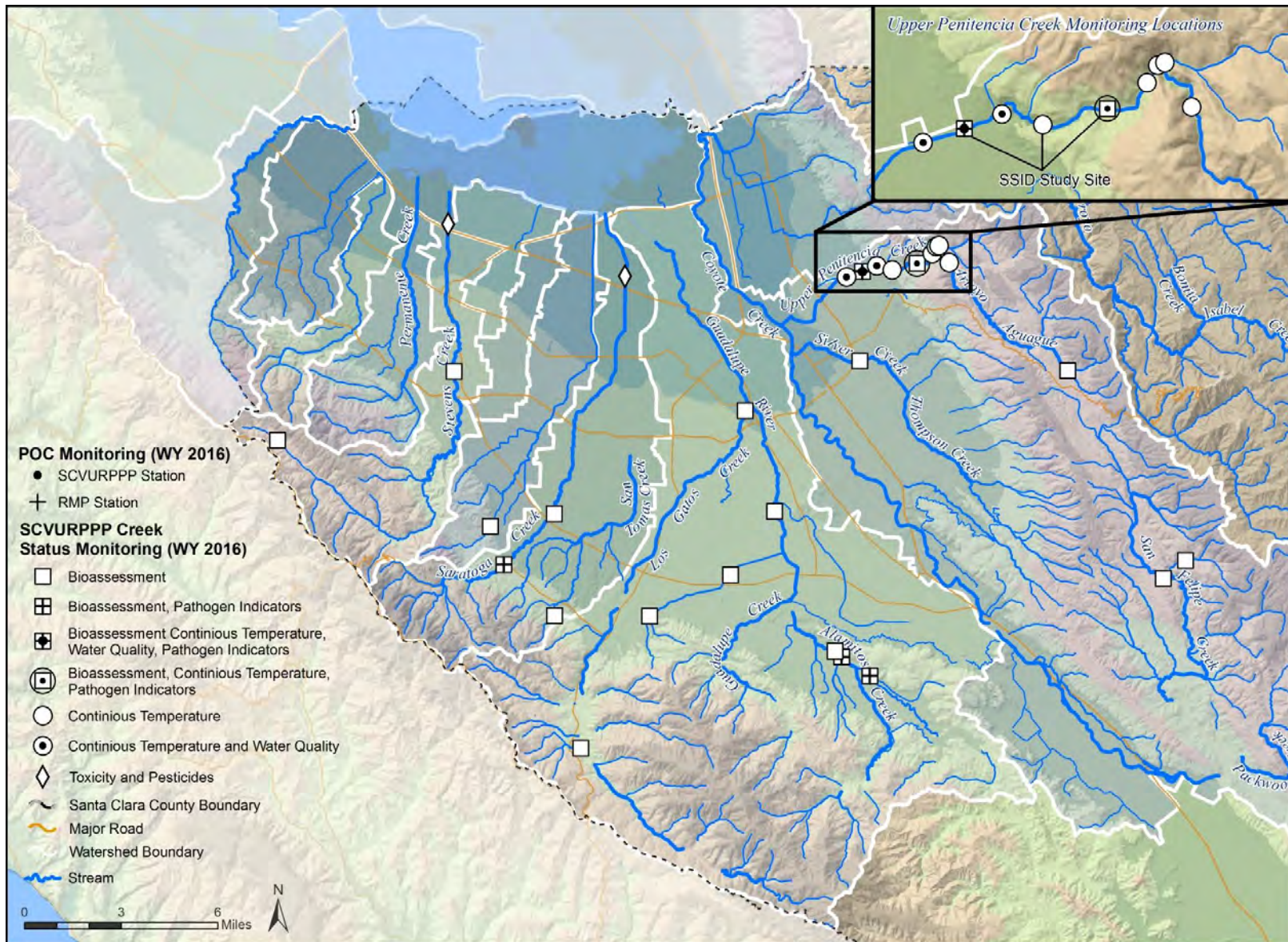


Figure 1.2. Map of SCVURPPP Program Area, major creeks, and sites monitored in WY 2016.

1.4.2 Designated Beneficial Uses

Beneficial Uses in Santa Clara Valley creeks are designated by the SFRWQCB for specific water bodies. Uses include aquatic life, recreation, human consumption, and habitat. Table 1.5 lists Beneficial Uses designated by the SFRWQCB (2013) for water bodies monitored by SCVURPPP in WY 2016.

Table 1.5. Creeks monitored by SCVURPPP in WY 2016 and their Beneficial Uses (SFRWQCB 2013).

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	
Aldercroft Creek ¹																			
Arroyo Aguague									E			E	E	E	E	E	E	E	
Arroyo Calero			E						E			E	E	E	E	E	E	E	
Calabazas Creek	E			E					E						E	E	E	E	
Cow Creek ¹																			
Guadalupe River				E					E			E	E	E	E	E	E	E	
Los Gatos Creek		E	E	E					E			E	E	E	E	E	E	E	
Lower Silver Creek															E	E	E	E	
Ross Creek				E											E	E	E	E	
San Felipe Creek			E						E					E	E	E	E	E	
San Tomas Aquino									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	
Tributary to San Tomas Aquino Creek ¹									E				E		E	E	E	E	
Upper Penitencia Creek			E	E					E			E	E	E	E	E	E	E	

¹ No Beneficial Uses listed specifically for waterbody.

Notes:

COLD = Cold Fresh Water Habitat
 FRSH = Freshwater Replenishment
 GWR - Groundwater Recharge
 MIGR = Fish Migration
 MUN = Municipal and Domestic Water

EST = Estuarine (the Basin Plan assigns this beneficial use to slough portions of Plummer Creek; for this evaluation WARM is presumed applicable to freshwater portions)

NAV = Navigation
 RARE= Preservation of Rare and Endangered Species
 REC-1 = Water Contact Recreation
 REC-2 = Non-contact Recreation

WARM = Warm Freshwater Habitat
 WILD = Wildlife Habitat
 P = Potential Use
 E = Existing Use
 L = Limited Use.

* = "Water quality objectives apply; water contact recreation is prohibited or limited to protect public health" (SFRWQCB 2013).

1.4.3 Climate

The Santa Clara Valley experiences a Mediterranean-type climate with cool, wet winters and hot, dry summers. The wet season typically extends from November through March 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, 1981-2010⁶). Figure 1.3 illustrates the geographic variability of mean annual precipitation in the area. It is important to understand that mean annual precipitation depths are statistically calculated or modeled; actual measured precipitation in a given year rarely equals the statistical average. Extended periods of drought and wet conditions are

⁶ <http://www.prism.oregonstate.edu/normals/>

common with episodic events exerting a great influence on hydrology and ecology. Figure 1.4 illustrates the temporal variability in annual precipitation measured at the Mineta San Jose International Airport. Creek Status Monitoring in compliance with the MRP began in WY 2012 which was the first year of an ongoing severe drought on a statewide and local basis. Some climate scientists suggest the current drought began as early as WY 2006, punctuated by two slightly above average years in WY 2009 and WY 2010 (UCLA Water Resources Group⁷). Although measured precipitation in WY 2015 and WY 2016 at the San Jose Airport was near or above average, it did not necessarily signal the end of the drought for the region.

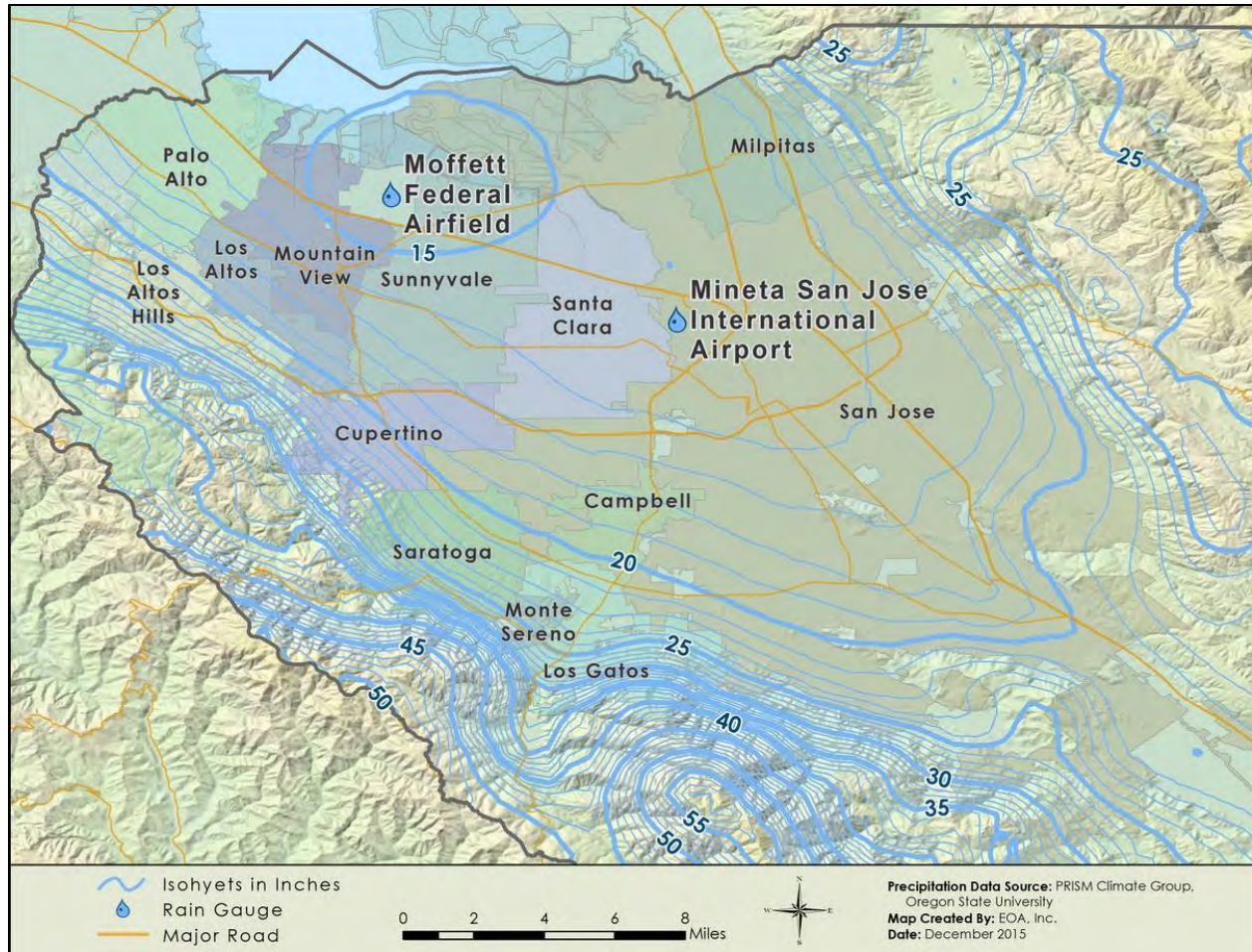


Figure 1.3. Average annual precipitation in Santa Clara Valley, modeled by the PRISM Climate Group for the period of 1981-2010.

⁷ <http://www.environment.ucla.edu/water/drought>

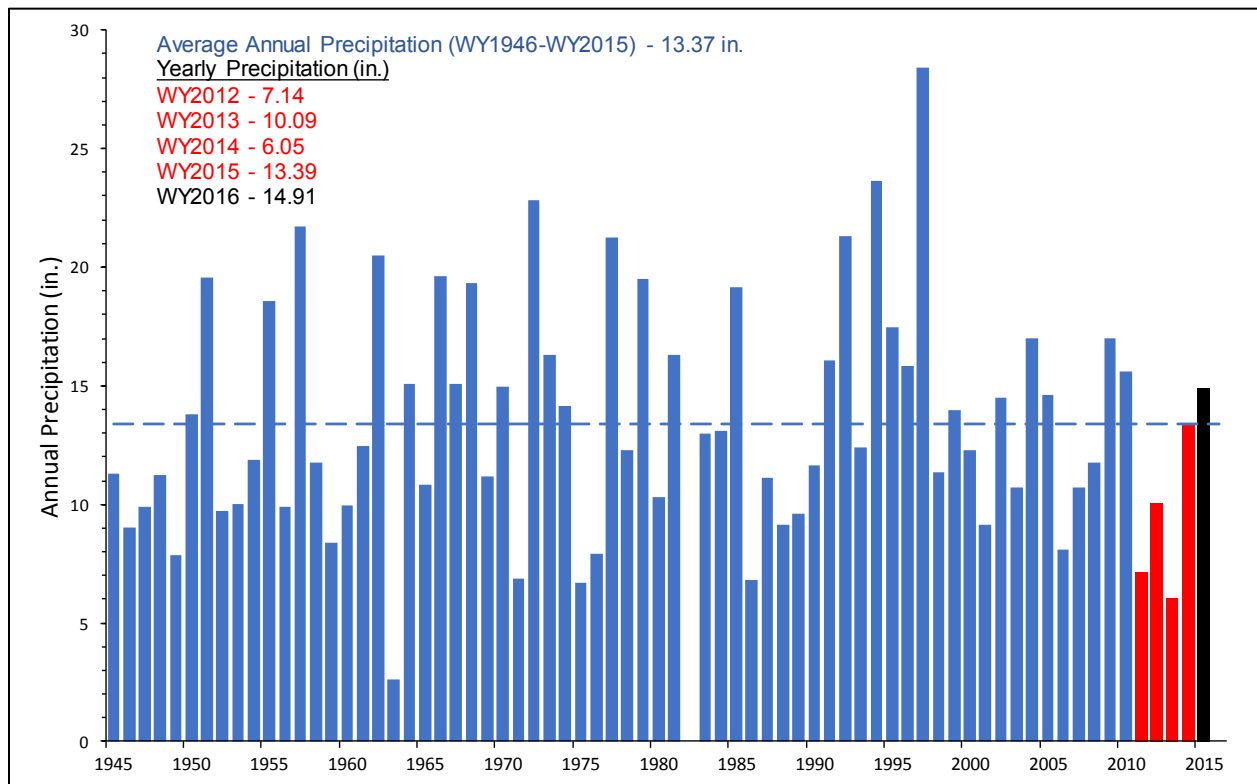


Figure 1.4. Annual rainfall recorded at the San Jose Airport, WY1946 – WY2016.

Individual dry years often result in decreased summer stream flows or earlier than normal desiccation. The cumulative effect of sustained dry conditions can exasperate low flow conditions as ground water tables begin to fall. During severe droughts, water management agencies (such as the Santa Clara Valley Water District) may also decrease the magnitude and duration of reservoir releases. For these reasons, climate should be considered when evaluating water temperature and general water quality data as these parameters are influenced by water depth and stream flows. Periods of drought (rather than individual dry years) can also result in changes in riparian and upland vegetation communities and 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. Therefore, periods of drought can influence the physical habitat parameters measured by the Creek Status Monitoring program.

There is still some uncertainty regarding the impact of periods of drought on overall stream condition as assessed through the calculation of stream condition indices based on benthic macroinvertebrate data (USEPA 2012a). 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 of biotic integrity (IBIs) 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 *periods* of extended drought on IBIs 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 is currently exploring how changing climate affects Sierra Nevada stream ecosystems.

1.5 Statement of Data Quality

A comprehensive Quality Assurance/Quality Control (QA/QC) program was implemented by SCVURPPP covering all aspects of the probabilistic and targeted monitoring. In general QA/QC procedures were implemented as specified in the BASMAA RMC QAPP (BASMAA, 2016a), and monitoring was performed according to protocols specified in the BASMAA RMC SOPs (BASMAA, 2016b), and in conformity with methods specified by the SWAMP QAPP⁸. A detailed QA/QC report is included as Attachment 1. Overall, the results of the QA/QC review suggest that the Creek Status Monitoring data generated during WY 2016 was of sufficient quality. Some data were flagged in the project database based on exceedances of measurement and/or data quality objectives; however, only a small percent of continuous dissolved oxygen data were rejected.

⁸ The current SWAMP QAPP 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

In compliance with Creek Status Monitoring Provision C.8.d.i, SCVURPPP conducted bioassessment monitoring in WY 2016. All bioassessment monitoring was performed at sites selected randomly using the probabilistic monitoring design. The probabilistic monitoring design allows each individual RMC participating program to objectively assess stream ecosystem conditions within its program area (e.g., County boundary) while contributing data to answer regional management questions about water quality and beneficial use condition in San Francisco Bay Area creeks. The survey design provides an unbiased framework for data evaluation that will allow a condition assessment of ambient aquatic life uses within known estimates of precision. The monitoring design was developed to address the management questions for both RMC participating county and overall RMC area described below:

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 scale. Over the past five years, the SCVURPPP and Regional Water Board have sampled 112 probabilistic sites in Santa Clara County, providing a sufficient sample size to estimate ambient biological condition for urban streams countywide. There are still an insufficient number of samples to accurately assess the biological condition of non-urban streams in the county, as well as all streams within smaller areas of interest (e.g., watershed or jurisdictional areas).⁹

The second question (i.e., *What are major stressors to aquatic life in the RMC area?*) is addressed by the collection and evaluation of physical habitat and water chemistry data collected at the probabilistic sites, as potential stressors to biological health. The extent and magnitude of these stressors above certain thresholds can also be assessed for streams in Santa Clara County. In addition, the stressor levels can be compared to biological indicator data through correlation and relative risk analysis. Assessing the extent and relative risk of stressors can help prioritize stressors at a regional scale and inform local management decisions.

The last question (i.e., *What are the long-term trends in water quality in creeks over time?*) is addressed by assessing the change in biological condition over several years. Changes in biological condition over time can help evaluate the effectiveness of management actions. Although, long-term trend analysis for the RMC probabilistic survey will require more than five years of data collection, preliminary trend analysis

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).

of biological condition may be possible for some stream reaches using a combination of historical targeted data with the probabilistic data.

The sections below present bioassessment data collected at twenty sites in WY 2016. A preliminary analysis of biological indicator and stressor data collected in Santa Clara County over the past five years (WY 2012 – WY 2016) is also presented. It is anticipated that the BASMAA RMC will conduct a *regional* analysis of biological condition using the five-year data set (WY 2012 – WY 2016) in Fiscal Year 2017/18.

2.2 Methods

2.2.1 Probabilistic Survey Design

The RMC probabilistic design was developed using the Generalized Random Tessellation Stratified (GRTS) approach developed by the United States Environmental Protection Agency (USEPA) and Oregon State University (Stevens and Olson 2004). GRTS offers multiple benefits for coordinating amongst 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 recently in California by several agencies including the statewide Perennial Streams Assessment (PSA) conducted by Surface Water Ambient Monitoring Program (SWAMP) (Ode et al. 2011) and the Southern California Stormwater Monitoring Coalition's (SMC) regional monitoring program conducted by municipal stormwater programs in Southern California (SCCWRP 2007).

Sample sites were selected and attributed 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 storm water programs associated with the RMC (listed in Table 1.1). 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.

The RMC sample frame 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 areas within 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 weight 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 probabilistic sites selected from the sample frame, including 12 sites in Santa Clara County.¹⁰ Bioassessment data collected by SWAMP from the Santa Clara County sites are included in this report.

2.2.2 Site Evaluations

Sites identified in the regional sample draw are evaluated by each RMC participant in chronological order using a two-step process described in RMC Standard Operating Procedure FS-12 (BASMAA 2016b), consistent with the procedure described by Southern California Coastal Water Research Project (SCCWRP) (2012). Each site is evaluated to determine if it meets the following RMC sampling location criteria:

¹⁰ As of WY 2016, the SFRWQCB SWAMP is no longer conducting RMC-related bioassessment monitoring at probabilistic sites.

1. The location (latitude/longitude) provided for a site is located on or is within 300 meters of a non-impounded receiving water body;¹¹
2. Site is not tidally influenced;
3. Site is wadeable during the sampling index period;
4. Site has sufficient flow during the sampling index period to support standard operation procedures for biological and nutrient sampling.
5. Site is physically accessible and can be entered safely at the time of sampling;
6. Site may be physically accessed and sampled within a single day;
7. Landowner(s) grant permission to access the site.¹²

In the first step, these criteria were evaluated to the extent possible using a “desktop analysis.” Site evaluations were completed during the second step via field reconnaissance visits. Based on the outcome of site evaluations, sites were classified into one of three categories:

- **Target** – Target sites were grouped into two subcategories:
 - **Target Sampleable (TS)** - Sites that met all seven criteria and were successfully sampled.
 - **Target Non-Sampleable (TNS)** - Sites that met criteria 1 through 4, but did not meet at least one of criteria 5 through 7 were classified as TNS.
- **Non-Target (NT)** - Sites that did not meet at least one of criteria 1 through 4 were classified as non-target status.
- **Unknown (U)** - Sites were classified with unknown status when it could be reasonably inferred either via desktop analysis or a field visit that the site was a valid receiving water body and information for any of the seven criteria was unconfirmed.

All site evaluation information was documented on field forms and entered into a standardized database. The overall percent of sites classified into the three categories will eventually be evaluated to determine the statistical significance of local and regional average ambient conditions calculated from the multi-year dataset.

2.2.3 Field Sampling Methods

Biological sample collection and processing was consistent with the BASMAA RMC QAPP (BASMAA 2016a) and SOPs (BASMAA 2016b).

In accordance with the RMC QAPP (BASMAA 2016a) 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). A 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. During WY 2016, one storm occurred over April 8-9, 2016 (0.56 inches in 24-hour period). In WY 2016, due to antecedent dry conditions and concerns that many sites would desiccate before the end of the 30-day grace period, bioassessments were initiated on April 26th at sites exhibiting low flow conditions. Visual observations at these sites indicated that the April storm event did not generate high flows. Presumably, antecedent dry ground conditions absorbed much of the runoff from the precipitation event. Bioassessments were conducted at the more urbanized sites after the 30-day grace period.

¹¹ The evaluation procedure permits certain adjustments of actual site coordinates within a maximum of 300 meters.

¹² If landowners did not respond to at least two attempts to contact them either by written letter, email, or phone call, permission to access the respective site was effectively considered to be denied.

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

Immediately prior to biological and physical habitat data collection, water samples were collected at 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 2016b). Water samples were also collected and analyzed for free and total chlorine using a Pocket Colorimeter™ II and DPD Powder Pillows according to SOP FS-3 (BASMAAS 2016b) (see Section 4.0 for chlorine monitoring results). In addition, general water quality parameters (DO, pH, specific conductivity and temperature) were measured at or near the centroid of the stream flow using pre-calibrated multi-parameter probes.

Biological and water samples were sent to laboratories for analysis. The laboratory analytical methods used for BMIs followed Woodward 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. Taxa that were not on the SWAMP list were flagged and identified for future potential harmonization work.

2.2.4 Data Analysis

BMI and algae data were analyzed to assess the biological condition of the sampled reaches using condition index scores. The physical habitat and water chemistry data were evaluated as potential stressors to biological health using thresholds from published sources and regulatory criteria/guidance, as well as correlations with condition index scores. Data analysis methods are described below.

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. Different BMIs respond differently to changes in water chemistry and physical habitat. Some are relatively sensitive; others more tolerant of poor habitat and pollution. Therefore, the abundance and variety of BMIs in a stream indicates the biological condition of the stream.

The California Stream Condition Index (CSCI) is a biological index that was developed by the State Water Resources Control Board (State Board) and is used to score the condition of BMI communities in perennial wadeable rivers and streams. The CSCI translates benthic macroinvertebrate data into an overall measure of stream health. The CSCI was developed using a large reference data set that is intended to represent the full range of natural conditions in California (Rehn et al. 2015). It 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 multi-metric index (pMMI) that is based on reference conditions. The CSCI score is computed as the average of the sum of O/E and pMMI.

The CSCI is calculated using a combination of biological and environmental data following methods described in Rehn et al. (2015). Biological data include benthic macroinvertebrate data collected and

analyzed using protocols described in the previous section. The 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).

The State Board is continuing to evaluate the performance of CSCI in a regulatory context. In the current MRP, the Regional Water Board defined a CSCI score of 0.795 as a threshold for identifying sites with degraded biological condition that may be considered as candidates for a Stressor Source Identification (SSID) project.

Benthic Algae

Similar to BMI's, the abundance and type of benthic algae species living on a streambed can indicate stream health. Biological indices based on benthic algae can provide a more complete picture of the streams biological condition because algae respond most directly to nutrients and water chemistry; whereas, BMIs are more responsive to physical habitat.

The State Board and Southern California Coastal Water Research Project (SCCWRP) are currently developing and testing a statewide index using benthic algae data as a measure of biological condition for streams in California. The statewide algae IBI is expected to be completed in 2017. The statewide algae index will build upon studies by Fetscher et al. (2014) that developed and tested algal indices of biological integrity (IBIs) for streams in Southern California (SoCal Algae IBI). The SoCal Algae IBIs were developed from data comprised of either single-assemblage metrics (i.e., either diatoms or soft algae) or combinations of metrics presenting both assemblages (i.e., "hybrid" IBI).

Algae data collected in Santa Clara County were evaluated using the existing SWAMP Algae Reporting Module, (Algae RM) which was developed in 2012 using the SoCal Algae IBI as the basis for metric and IBI calculations (Marco Sigala, personal communication). Three algal IBIs that performed well against stressor gradients at sites in Southern California were calculated using the algae data collected in Santa Clara County. These include a soft algae index (S2), a diatom index (D18) and a soft algae-diatom hybrid index (H20). The interpretation of algae data collected in Santa Clara County is considered preliminary since the IBIs were developed and tested on data collected in Southern California.

New taxa (i.e., not on the SWAMP master list) are typically identified by SWAMP laboratory each year. Additional new taxa are identified by contracting labs for stormwater projects and, depending on available resources, may be "harmonized" with taxa on the SWAMP master list. Each year, SWAMP updates the taxa list used to calculate metrics in the Algae RM. The trait attributes table, used to associate taxa response to environmental stressors, has not been updated since May 2013 (Marco Sigala, personal communication). As a result, some of the taxa identified in samples collected since 2013 are not included in the IBI calculations. Thus, the SoCal Algae IBI scores should be considered preliminary until all possible taxa and their trait attributes are incorporated into the Algae RM.

Biological Condition Thresholds

Existing thresholds for biological indicators defined in Mazor (2015) were used to evaluate the bioassessment data collected in Santa Clara County and analyzed in this report (Table 2.1). The thresholds for each index were based on the distribution of scores for data collected at reference calibration sites in California (CSCI) or in Southern California (algae). Four condition categories are defined by these thresholds: "likely intact" (greater than 30th percentile of reference site scores); "possibly intact" (between the 10th and the 30th percentiles); "likely altered" (between the 1st and 10th percentiles; and "very likely altered" (less than the 1st percentile).

Table 2.1. Condition categories used to evaluate CSCI and Algae IBI scores.

Index	Likely Intact (>30 th Percentile)	Possibly Intact (10 th – 30 th Percentile)	Likely Altered (1 st – 10 th Percentile)	Very Likely Altered (< 1 st Percentile)
<i>Benthic Macroinvertebrates (BMI)</i>				
CSCI Score	≥ 0.92	0.79 – 0.92	0.63 – 0.79	< 0.63
<i>Benthic Algae</i>				
S2 Score	≥ 60	47 - 60	29 - 47	< 29
D18 Score	≥ 72	62 - 72	49 - 62	< 49
H20 Score	≥ 70	63 - 70	54 - 63	< 54

A CSCI score below 0.795 is referenced in the MRP as a threshold below which indicates a potentially degraded biological community, and thus should be considered for a SSID Project. The MRP threshold is the division between “possibly intact” and “likely altered” condition category 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.

Stressor Variables

Physical habitat, general water quality, and water chemistry data collected at the bioassessment sites were compiled and evaluated as potential stressor variables for biological condition. Some of the data required conversion to other analytes or units of measurement:

- Conversion of measured total ammonia to the more toxic form of unionized ammonia was calculated to compare with the 0.025 mg/L standard provided in the San Francisco Basin Water Quality Control Plan (Basin Plan) (SFRWQCB 2013). The conversion was based on a formula provided by the American Fisheries Society (AFS, internet source). The calculation requires total ammonia and field-measured parameters of pH, temperature, and specific conductance.
- The 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.

Physical habitat variables consisted of reachwide endpoints of quantitative and qualitative habitat measurements. Quantitative measurements included percent canopy cover, percent sands & fines and percent micro- and macro-algae cover (both derived from pebble count data). Qualitative measurements included human disturbance index and three physical habitat (PHAB) scores (epifaunal substrate complexity, sediment deposition and channel alteration). Additional environmental variables were calculated in GIS by overlaying the drainage area for sample locations with land use and road data. The variables included percent urbanization, percent impervious, and road density at three different spatial scales (1000 km², 5000 km² and entire watershed).

Another potential stressor is the lower than average precipitation and stream flow during the five years of probabilistic bioassessment sampling. In addition to low rainfall, low base flow conditions during the dry season were further impacted by minimal or complete absence of water releases from upstream reservoirs and diversion pipes bringing imported water from other parts of the State. Future sampling during wetter years will provide useful information to evaluate the impacts of drought on biological integrity of the streams.

Stressor Thresholds

In compliance with Provision C.8.h.iii.(4), water chemistry data collected at the bioassessment sites during WY 2016 were compared to stressor thresholds and applicable water quality standards (Table 2.2). Thresholds for pH, specific conductance, dissolved oxygen, and temperature (for waters with COLD Beneficial Use only) are listed in Provision C.8.d.iv of the MRP. With the exception of temperature, these conform to Water Quality Objectives (WQOs) in the Basin Plan (SFRWQCB 2013). 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). Los Gatos Creek is the only creek sampled in WY 2016 with MUN designated (see Table 1.4).

Table 2.2. Thresholds for nutrient and general water quality variables.

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

Stressor Association with Biological Conditions

Statistical tests were conducted to evaluate which potential stressors (i.e., physical habitat measurements, water chemistry) have the most significant relationships with biological indicator data (i.e., CSCI scores, algae IBIs). The tests were conducted using all probabilistic data collected in Santa Clara County over the past 5 years (n=112) which is considered sufficient sample size to estimate ambient biological condition. Two statistical methods were used:

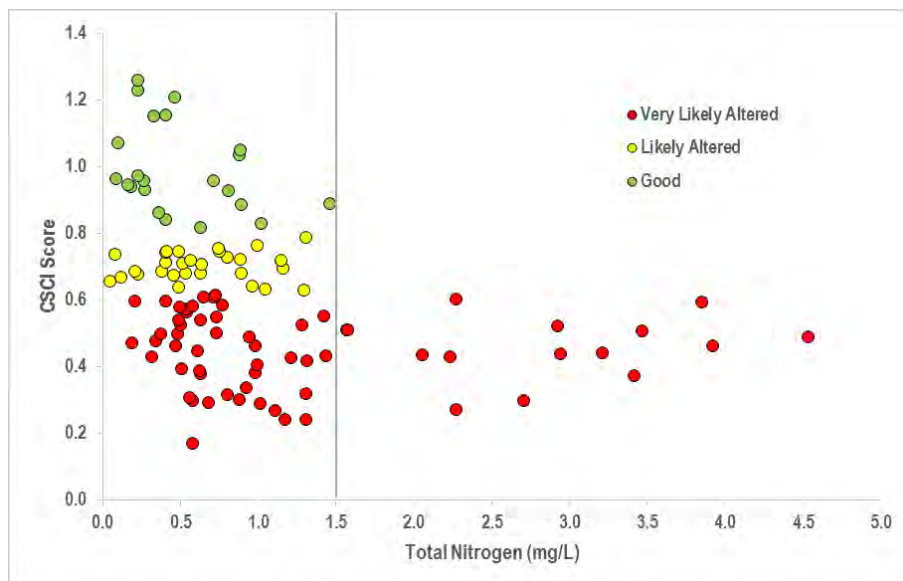
- Correlations between biological indicator data and potential stressors were evaluated using the Spearman rank method in Sigma Plot statistical software. The Spearman rank method was selected for its suitability of evaluating data that are not normally distributed. Coefficients values greater than ±0.5 indicate a strong relationship between variables. If the p-value is ≤0.05, the correlation is considered statistically significant.
- The random forest method was applied to assess which potential stressors are most important in explaining variability in CSCI scores. Random forest is a bootstrap method that combines many regression trees. It is able to discover more complex dependencies and works well with non-linear data, many variables, outliers, and small datasets (Cutler et al. 2007). We used the randomForest package in R. The random forest script did not run with missing data; the five-year dataset was culled to remove sites with missing data. Many of the culled sites were those provided by SWAMP which generally did not include laboratory results.

The extent and relative risk of stressors at a regional scale can be assessed using probabilistic datasets. This is one of the benefits of the probabilistic component of the Creek Status Monitoring design that was initiated in WY 2012. Ode et al (2011) identifies several approaches for evaluating stressor and biological indicator data collected for probability surveys, including: 1) relative risk and attributable risk estimates; 2) continuous risk relationships; and 3) biology-based stressor thresholds. These approaches will be explored for regional analyses of probabilistic data for Santa Clara County and entire RMC area during FY 2017/18.

Establishing Stressor Thresholds

In general, stressor thresholds can be derived a number of ways

- One approach is to apply existing regulatory standards (e.g., Basin Plan Water Quality Objectives, TMDL targets); however, these thresholds may not have any association with biological condition.
- **Another approach is to establish stressor thresholds using data collected at “reference sites.”** Reference sites are identified by evaluating environmental variables in a GIS to identify areas that have little or no human disturbance (e.g., road density, impervious area). Reference-based thresholds are based on a statistical function (e.g., 90th percentile) of the data collected at reference sites. Reference-based thresholds, however, may be too stringent to evaluate sites in more urban areas.
- A third approach to evaluate stressor data is to use biologically-based thresholds. Biological indicators (i.e., CSCI scores) can demonstrate thresholds of response to stressors, where sites in good biological condition are not observed to exceed a certain stressor concentrations. In the case below, total nitrogen concentration is plotted with CSCI scores for 112 sites sampled in Santa Clara County. **All sites classified as “good” and “likely altered” CSCI scores plot below the “indicated threshold” for total nitrogen concentration of 1.5 mg/L.**



2.3 Results and Discussion

2.3.1 Site Evaluations

During WY 2016, the SCVURPPP conducted site evaluations at a total of 76 potential probabilistic sites in Santa Clara County drawn from the Master List. Of these sites, a total of twenty were sampled in WY 2016 (rejection rate of 74%). Three of the twenty sites (15%) were classified as non-urban land use. Land use classification, sampling location, and date for each site sampled during WY 2016 are listed in Table 2.3.

Table 2.3. Bioassessment sampling date and locations in Santa Clara County in WY 2016.

Station Code	Creek	Program	Land Use	Sample Date	Latitude	Longitude
205R00213	Cow Creek	SCVURPPP	NU	4/27/2016	37.26445	-121.65039
205R00305	San Felipe Creek	SCVURPPP	NU	4/27/2016	37.25626	-121.66266
205R00578	Arroyo Aguague	SCVURPPP	NU	4/26/2016	37.34925	-121.71812
205R01114	Guadalupe River	SCVURPPP	U	5/3/2016	37.28450	-122.88231
205R01731	Upper Penitencia Creek	SCVURPPP	U	5/5/2016	37.39265	-121.83477
205R02330	Ross Creek	SCVURPPP	U	5/3/2016	37.25520	-121.90656
205R02422	Arroyo Calero	SCVURPPP	U	5/4/2016	37.21059	-121.82717
205R02458	Alamitos Creek	SCVURPPP	U	5/4/2016	37.21897	-121.84321
205R02474	Saratoga Creek	SCVURPPP	U	5/18/2016	37.25819	-122.03437
205R02538	Calabazas Creek	SCVURPPP	U	5/18/2016	37.27538	-122.04225
205R02547	Stevens Creek	SCVURPPP	U	6/1/2016	37.31243	-122.16309
205R02563	Los Gatos Creek	SCVURPPP	U	5/19/2016	37.32924	-121.89960
205R02602	Tributary to San Tomas	SCVURPPP	U	6/2/2016	37.23547	-122.00528
205R02618	Aldercroft Creek	SCVURPPP	U	5/2/2016	37.17623	-121.98942
205R02650	Alamitos Creek	SCVURPPP	U	5/31/2016	37.22150	-121.84700
205R02659	Stevens Creek	SCVURPPP	U	5/19/2016	37.34474	-122.06417
205R02730	Saratoga Creek	SCVURPPP	U	6/1/2016	37.28141	-122.00642
205R02762	Ross Creek	SCVURPPP	U	6/2/2016	37.23593	-121.95184
205R02771	Lower Silver Creek	SCVURPPP	U	6/3/2016	37.35228	-121.83543
205R02835	Upper Penitencia Creek	SCVURPPP	U	5/5/2016	37.39658	-121.80390

NU = non-urban, U = urban

Since WY 2012, a total of 112 probabilistic sites were sampled by SCVURPPP (n=100) and SWAMP (n=12) in Santa Clara County. During the five-year sampling period, SCVURPPP sampled 87 urban and 13 non-urban sites and SWAMP sampled 12 non-urban sites. A total of 403 total sites were evaluated to obtain the 112 samples, an overall rejection rate of 73%¹³. Refer to Section 2.2.2 for list of criteria used to reject sites. The number of sites (and percentage of total evaluated sites) rejected for each criterion are presented in Table 2.4. The location and site evaluation results for all sites evaluated are shown in Figure 2.1.

¹³ The rejection rate is an important factor in defining the confidence level of statistical data interpretations at countywide and regional scales.

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Table 2.4. Probabilistic site evaluation results in Santa Clara County, WY 2012 – WY 2016.

Subpopulation	Target Sampled Sites	Potential Target Not sampled due to access issues	Non-Target Rejected due to low or no flow	Non-Target Rejected for other reasons	Total Sites Evaluated
Urban	87 (32%)	22 (8%)	101 (37%)	62 (23%)	272
Non-Urban	25 (19%)	35 (27%)	67 (51%)	4 (3%)	131
Total	112 (28%)	57 (14%)	168 (42%)	66 (16%)	403

Low or no flow conditions were the most common reason for site rejection (42% of all sites). Low flow conditions were documented at more than half the non-urban sites evaluated. The inclusion of first order streams in the upper watershed areas in the Master List increases the potential for low flow conditions during the sample index period. In addition, the extended period of drought conditions during the five years of Creek Status Monitoring likely resulted in low flow conditions in reaches that would be perennial during normal years of rainfall.

Access issues (e.g., physical barriers, permission not granted) were another common reason for not sampling a site (14% of total sites). Access issues were more frequently encountered for non-urban sites due to high proportion of privately owned land, lack of road access to remote sites, and densely vegetated hill slopes adjacent to sites. The remaining sites (16% of total sites) were rejected for a variety of reasons, including site location not on a creek, site was tidally influenced, or site was not wadeable (e.g., too deep).

There are sufficient number of samples from probabilistic sites to develop estimates of biological condition and stressor assessment for urban streams in Santa Clara County (in development). More samples are needed to estimate biological condition at more local scales (e.g., watershed and jurisdictional areas).

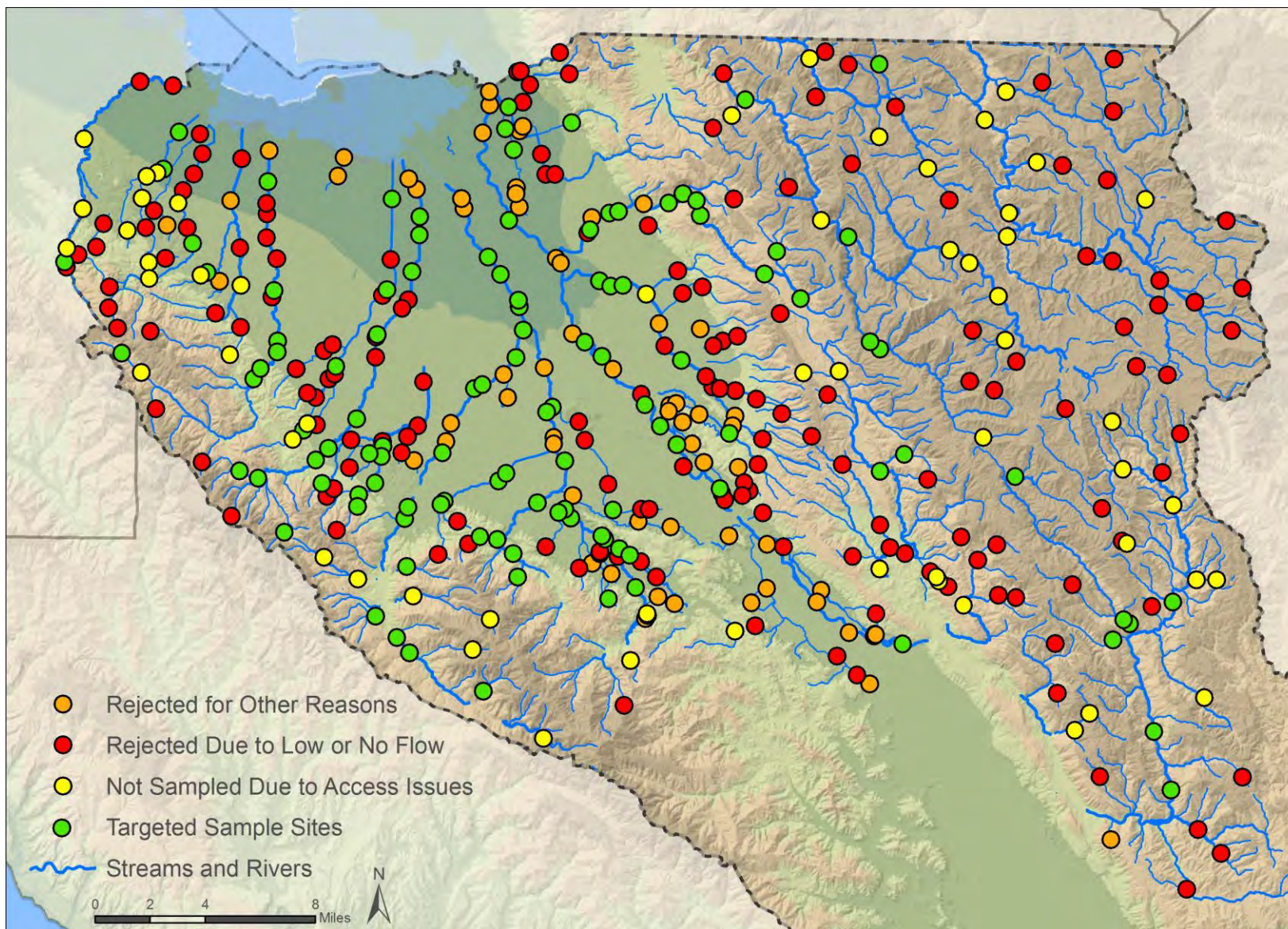


Figure 2.1. Site evaluation results for probabilistic sites (n=347) in Santa Clara County, WY 2012 – WY 2016.

2.3.2 Biological Condition Assessment

This section presents the results of the biological condition assessment conducted in WY 2016 and compiles those data with results from water years 2012 through 2015.

WY 2016 Results

A total of 152 unique BMI taxa were identified in samples collected at 20 bioassessment sites in Santa Clara County during WY 2016. A total of 244 benthic algae taxa were identified in samples collected at the same sites, including 205 diatom and 39 soft algae taxa. The total number of BMI, diatom, and soft algae taxa identified at each bioassessment location is presented in Table 2.5. BMIs and diatoms were relatively well represented across all sites, with BMIs ranging from 11 to 51 taxa, and diatoms ranging from 15 to 61 taxa. Soft algae taxa were less common across sites, ranging from 1 to 10 taxa. Seven of the sites (30%) had three or less soft algae taxa.

Table 2.5. The total number of unique BMI, diatom and soft algae taxa identified in samples collected at 20 bioassessment sites in Santa Clara County during WY 2016.

Station	Creek	Land Use	BMIs	Diatoms	Soft Algae
205R00213	Cow Creek	NU	25	16	5
205R00305	San Felipe Creek	NU	41	22	9
205R00578	Arroyo Aguague	NU	21	33	2
205R01114	Guadalupe River	U	11	48	8
205R01731	Upper Penitencia Creek	U	16	31	8
205R02330	Ross Creek	U	16	25	10
205R02422	Arroyo Calero	U	36	61	7
205R02458	Alamitos Creek	U	40	36	7
205R02474	Saratoga Creek	U	31	21	1
205R02538	Calabazas Creek	U	26	22	5
205R02547	Stevens Creek	U	51	22	4
205R02563	Los Gatos Creek	U	14	30	3
205R02602	Tributary to San Tomas	U	36	15	2
205R02618	Aldercroft Creek	U	30	34	3
205R02650	Alamitos Creek	U	32	53	7
205R02659	Stevens Creek	U	18	45	1
205R02730	Saratoga Creek	U	24	42	7
205R02762	Ross Creek	U	19	28	4
205R02771	Lower Silver Creek	U	18	46	5
205R02835	Upper Penitencia Creek	U	27	43	3

NU = non-urban, U = urban

Biological condition, as represented by CSCI scores and algae IBI scores (S2, D18 and H20), for the 20 probabilistic sites sampled by SCVURPPP during WY 2016 is presented in Table 2.6. Scores for each indicator that were in the two higher condition categories are indicated in bold. The condition categories for three of the biological indicator scores (CSCI, D18 and H20), as defined in Table 2.1, are illustrated in Figure 2.2 for the 20 sites sampled in WY 2016.

The CSCI scores ranged from 0.29 to 0.96 across the 20 bioassessment sites sampled in WY 2016. The two main components of the CSCI score, O over E and MMI scores, are listed for each site in Attachment 2. Five of the 20 bioassessment sites (25%) had CSCI scores in the two higher condition categories - "possibly intact" and "likely intact" condition. The combined classifications are above the MRP trigger threshold value of 0.795 and are herein referred to as "good" biological condition in this report. All but one of these sites were classified as urban (Table 2.6). Five sites ranked "likely altered"; two of these sites were classified as non-urban land use. Ten of the urban sites were ranked "very likely altered" (CSCI < 0.63), indicating highly degraded condition. Four of these sites had non-perennial flow status and two were in modified channels. Sites with CSCI scores below 0.795 will be considered as candidates for SSID projects.

Benthic algae taxa identified in the twenty samples collected in Santa Clara County were used to calculate scores for three SoCal Algae IBIs (S2, D18 and H20) (Table 2.6). Of the 244 total taxa identified in samples collected in WY 2016, six taxa (all diatoms) that did not match the SWAMP master taxa list. These were excluded from the IBI calculations. The individual metrics and scores for all three algae IBIs are presented in Attachment 2.

- **S2.** There were insufficient algae data to calculate a S2 IBI score at site 205R02618. For the remaining sites, the S2 IBI scores were relatively low, with 17 sites receiving scores equal to or below 47, corresponding to "likely altered" or "very likely altered" biological condition category.
- **D18.** Eight of the twenty bioassessment sites (40%) had D18 scores that were classified as "possibly intact" or "likely intact" condition.
- **H20.** Only one site of the twenty sites (5%) had H20 scores that would rank in good condition.

Total PHAB scores at twenty bioassessment sites ranged from 21 to 53 (Table 2.6). Total PHAB scores were slightly better correlated with CSCI scores ($r^2=0.26$, p value = 0.008) compared to H20 scores ($r^2=0.16$, p value = 0.08).

The CSCI and SoCal Algae IBI scores were generally not well correlated at either urban or nonurban sites (Table 2.6). One explanation is that BMIs are responding to different stressors compared to algae. BMIs typically have much longer life cycles compared to algae and thus, may respond more to habitat fluctuations that may occur at different points over time. In contrast, algae have much shorter life cycles and would be expected to show response to more recent changes in flow or water quality (e.g., peak flow events, drops in dissolved oxygen). As discussed above, BMIs generally show negative correlation with stressors associated with physical habitat, whereas algae can produce high biological condition scores in poor habitats (e.g., concrete channels) (Rafael Mazor, SCCWRP, personal communication).

In summary, CSCI and Algae IBI scores should be evaluated using a weight-of-evidence approach, to determine if potential stressors may be impacting biological condition at a site. Individual metric scores for each index or trait based responses from individual taxa can also be evaluated to determine if stressors may be affecting biological integrity.

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Table 2.6. Biological condition scores, presented as CSCI and SoCal Algae IBIs (S2, D18 and H20) for 20 probabilistic sites sampled in WY 2016. Total PHAB scores for each site are also presented. Site characteristics related to channel modification and flow condition are also presented. **Bold values indicate “good” condition.**

Station Code	Creek	Elevation (ft)	Land Use	Modified Channel ²	Flow ³	CSCI Score	Soft Algae “S2” IBI Score	Diatom “D18” IBI Score	Hybrid “H20” IBI Score	Total PHAB Score
205R00213	Cow Creek	1135	NU	N	NP	0.66	80	80	80	53
205R00305	San Felipe Creek	1022	NU	N	P	0.89	45	56	56	28
205R00578	Arroyo Aguague	1564	NU	N	NP	0.74	90	40	62	37
205R01114	Guadalupe River	523	U	N	P	0.39	7	48	31	33
205R01731	Upper Penitencia Cr	151	U	N	NP	0.63	23	20	20	36
205R02330	Ross Creek	202	U	Y	NP	0.49	3	16	11	21
205R02422	Arroyo Calero	311	U	N	P	0.72	25	54	41	36
205R02458	Alamitos Creek	267	U	N	P	0.61	22	64	51	31
205R02474	Saratoga Creek	474	U	N	P	0.82	0	24	15	45
205R02538	Calabazas Creek	401	U	N	P	0.57	13	56	42	28
205R02547	Stevens Creek	1651	U	N	P	0.96	12	68	48	43
205R02563	Los Gatos Creek	87	U	N	NP	0.52	3	70	44	34
205R02602	Unnamed Tributary	634	U	N	NP	0.93	17	82	51	39
205R02618	Aldercroft Creek	660	U	N	P	0.83	NR	24	15	42
205R02650	Alamitos Creek	277	U	N	P	0.73	25	74	55	42
205R02659	Stevens Creek	230	U	N	P	0.62	0	70	44	31
205R02730	Saratoga Creek	306	U	N	NP	0.29	47	22	25	32
205R02762	Ross Creek	329	U	N	P	0.30	20	68	51	30
205R02771	Lower Silver Creek	111	U	Y	P	0.49	15	4	8	24
205R02835	Upper Penitencia Cr	521	U	N	P	0.79	17	46	38	37

WY 2012 through WY 2016 Results

Biological indicator data were compiled for all probabilistic sites sampled by SCVURPPP (n=100) and the Regional Water Board (n=12) over the past five years. Biological condition based on CSCI scores for the five-year dataset are illustrated in Figure 2.3. The proportion of urban and non-urban sites for each of the biological condition classes based on CSCI scores are shown in Figure 2.4. Good biological condition scores occurred at 11% of the urban sites and 52% of non-urban sites.

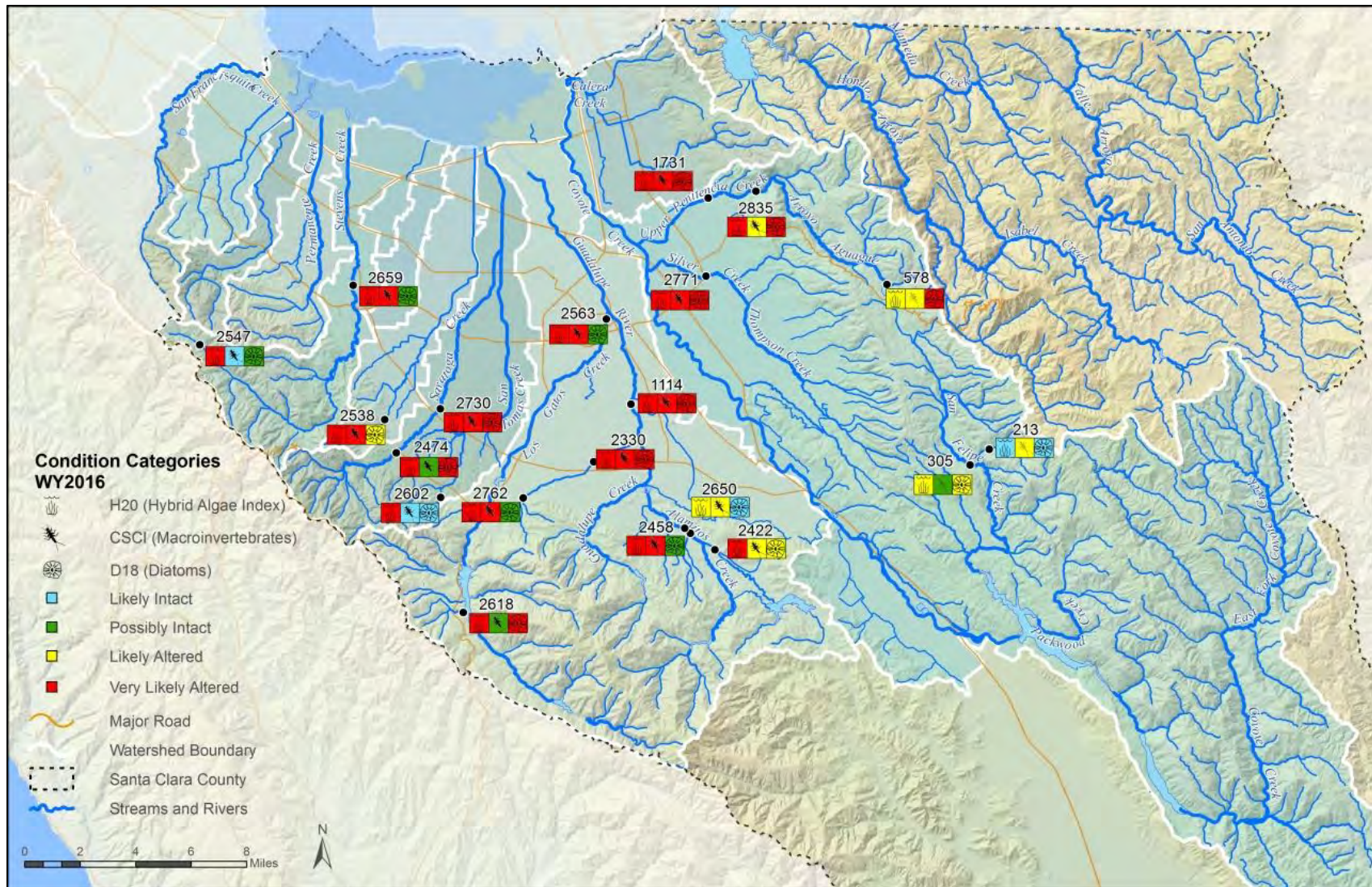


Figure 2.2. Condition category as represented by CSCI, D18 and H2O scores for 20 probabilistic sites sampled in Santa Clara County during WY 2016.

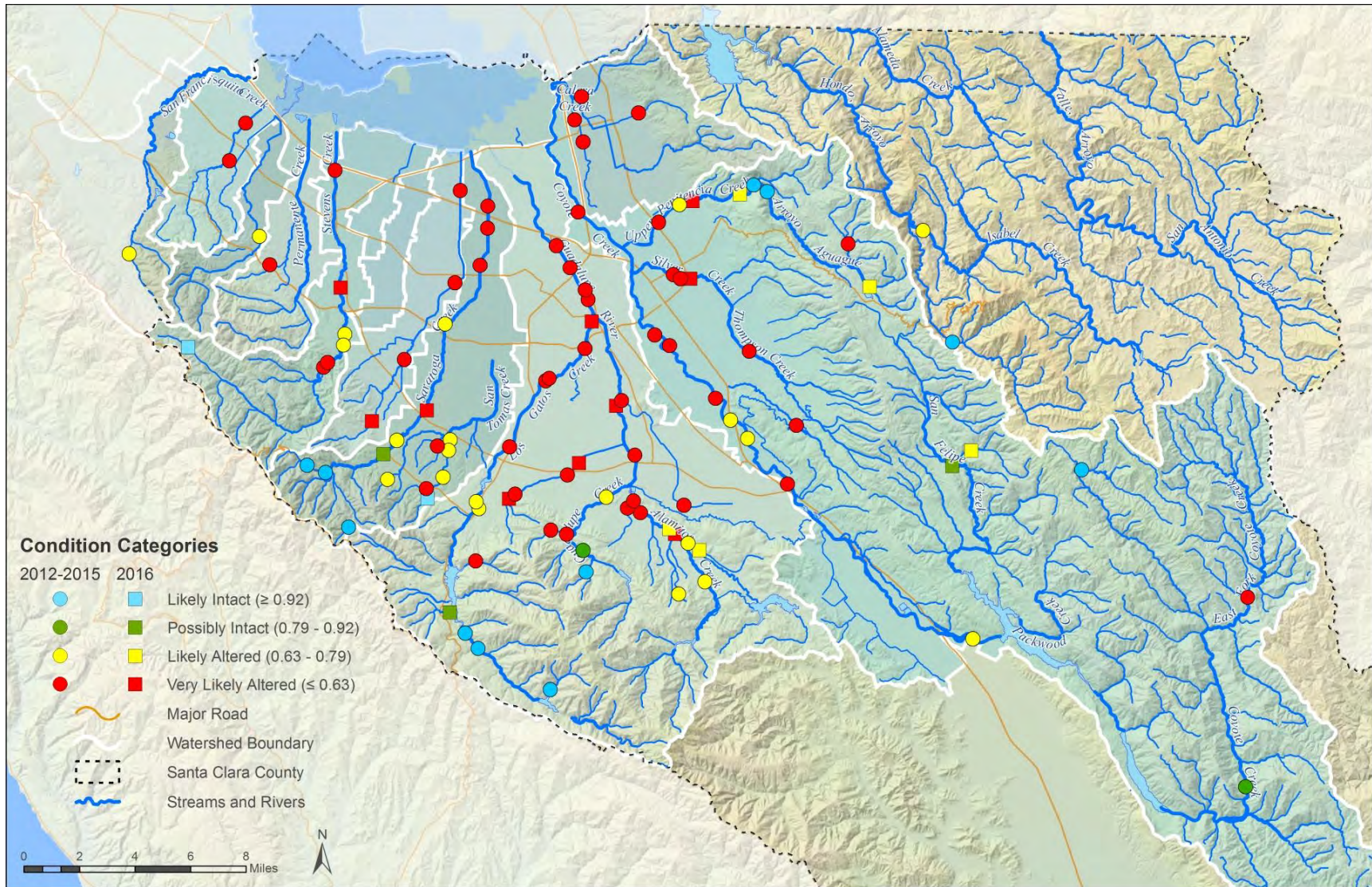


Figure 2.3. Biological condition based on CSCI scores for 112 sites sampled in Santa Clara County by SCVURPPP and SWAMP between WY 2012 and WY 2016.

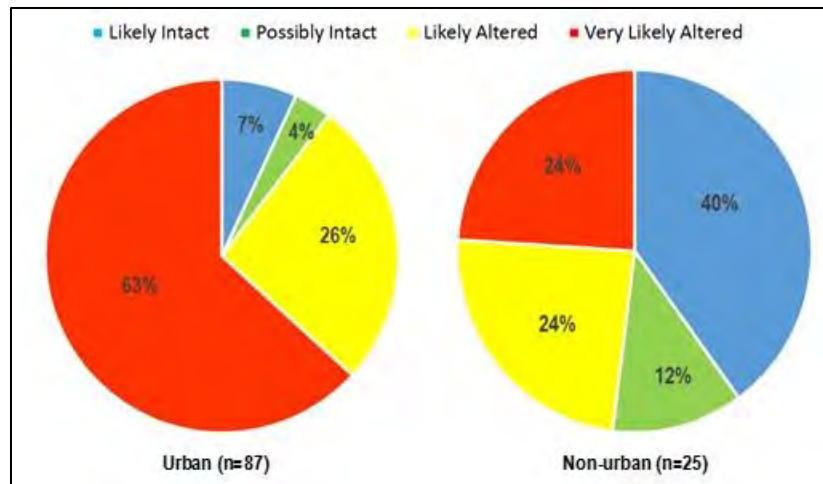


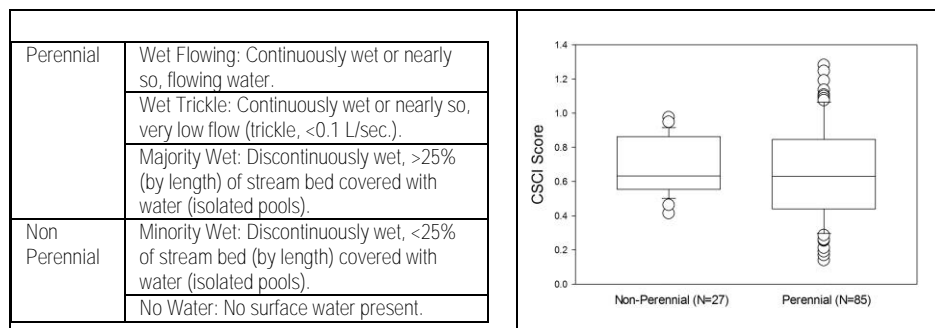
Figure 2.4. Proportion of bioassessment sites sampled over five years (WY 2012-WY 2016), grouped by land use classification, for each of the CSCI biological condition category.

Assessing Flow at Bioassessment Sites

The State Board's Perennial Stream Assessment (PSA) Program only assesses wadeable, perennial streams in California. In contrast, the RMC Creek Status Monitoring Program conducts bioassessments at both perennial and non-perennial sites. Perennial flow status is determined by visiting sampling locations during the fall season and assessing flow conditions using definitions for five potential flow scenarios.

Flow status at potential sites can be highly variable due to natural (e.g., low rainfall, ground water levels) and human factors (e.g., water diversions, reservoir releases). Drought conditions over the past five years in the San Francisco Bay Area have generally resulted in low flow conditions in creeks throughout Santa Clara Valley watersheds. Thus, many sites that were not sampled due to low or no flow, could potentially be sampled in subsequent, wetter years.

Although the CSCI tool was originally developed to assess biological condition for perennial creeks, CSCI scores for both perennial and non-perennial sites in Santa Clara County over five-year period (WY 2012-WY 2016) have similar central tendencies (median score = 0.63).



Biological condition scores, based on CSCI and three SoCal Algal IBI scores, for perennial (n=85) and non-perennial (n=27) sites sampled over the past five years in Santa Clara County are shown in Figure 2.5. Approximately 25% of the bioassessment sampling locations were non-perennial. There was no difference in median CSCI scores for perennial and non-perennial sites (0.63). The median algae IBI scores were consistently higher at non-perennial sites. Non-perennial sites tended to be either small non-urban creeks in the upper watershed area or sections of urban creeks in the Santa Clara Valley that stop flowing during the dry season.

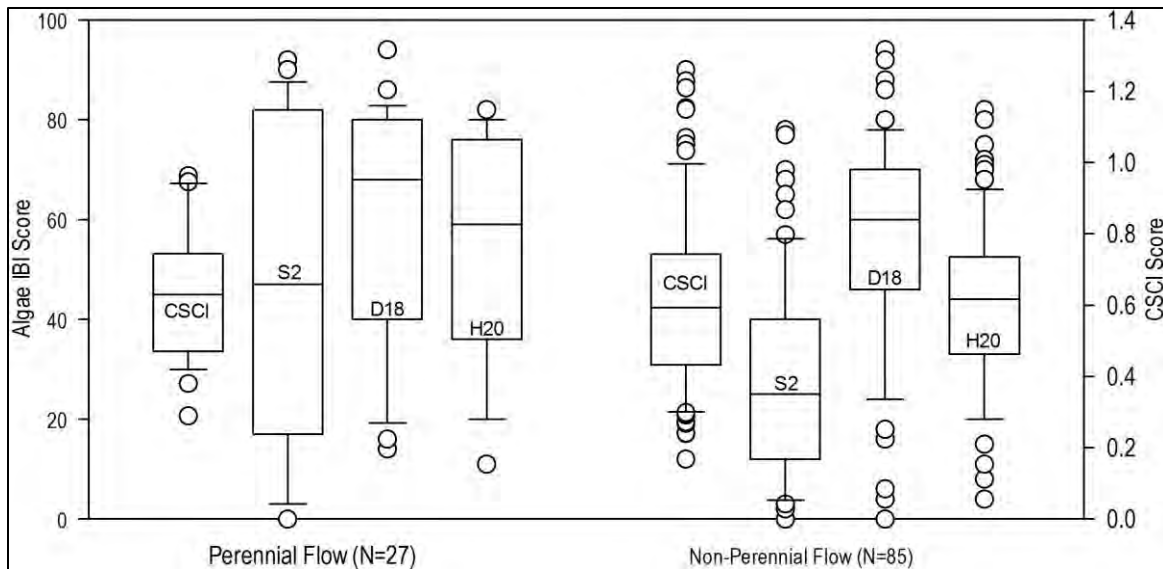


Figure 2.5. Box plots showing CSCI and algae IBI scores, grouped by flow classification, for 112 bioassessment sites sampled in Santa Clara County over the past 5 years (WY 2012 – WY 2016).

A beanplot is a variation of a box plot that shows the variable density of data and highlights the mean result, rather than the median shown in box plots. Figure 2.6 shows beanplot distributions of CSCI scores for perennial and non-perennial sites. The beanplots illustrate that, although mean values are similar, non-perennial sites have a somewhat bi-modal distribution of CSCI scores.

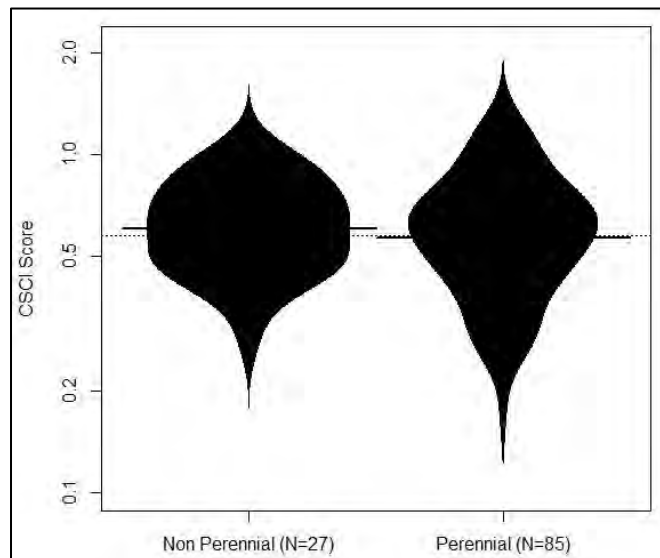


Figure 2.6. Beanplots showing CSCI, grouped by flow classification, for 112 bioassessment sites sampled in Santa Clara County over the past 5 years (WY 2012 – WY 2016). The cross bars are equal to the mean value.

The CSCI and three algae IBI tools showed relative consistency in their response across an urban gradient, with generally lower median scores associated with increasing urbanization (i.e., percent imperviousness) (Figure 2.7). The S2 IBI scores were especially variable at sites with low percent impervious area (< 3%), while the D18 IBI scores had more variability for sites with higher amount of impervious area. Beanplots of CSCI scores for the three different imperviousness groupings are shown in Figure 2.8.

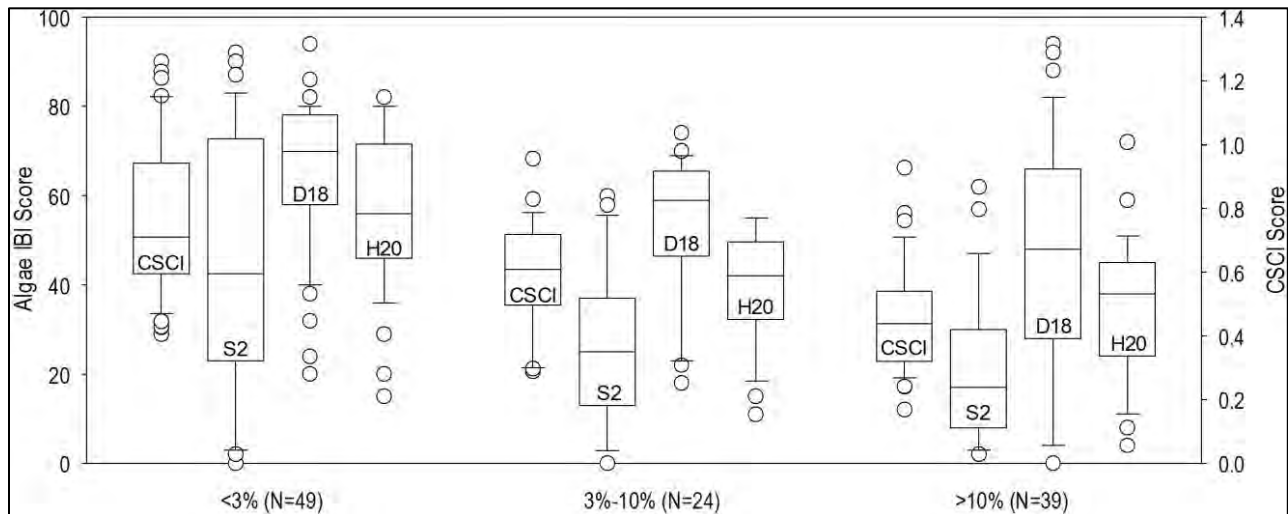


Figure 2.7. Box plots showing CSCI and algae IBI scores, grouped by percent impervious area, for 112 bioassessment sites sampled in Santa Clara County over the past 5 years (WY 2012 – WY 2016).

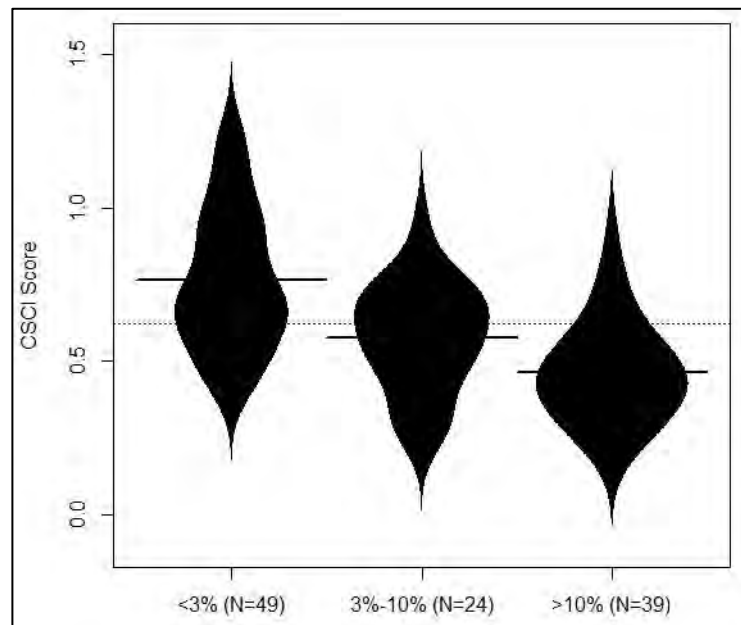


Figure 2.8. Beanplots showing CSCI scores, grouped by percent impervious area, for 112 bioassessment sites sampled in Santa Clara County over the past 5 years (WY 2012 – WY 2016).

CSCI scores were better correlated with site elevation ($r^2 = 0.34$, p value <0.001) compared to D18 scores ($r^2 = 0.18$, p value <0.001), suggesting that physical habitat variables associated with changing elevation (e.g., stream gradient, substrate size) have greater influence on the BMI community compared to diatom assemblages (Figure 2.9). For this reason, algae may provide useful data to assess water quality issues at urban sites with poor habitat.

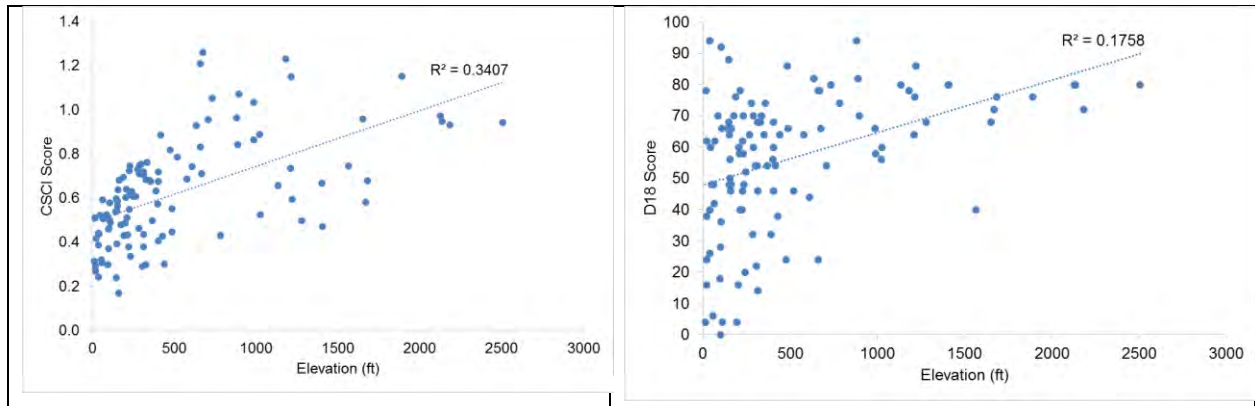


Figure 2.9. CSCI and D18 scores plotted with elevation for 112 bioassessment sites sampled in Santa Clara County over five-year period (WY 2012 – WY 2016).

Similar to site elevation, total PHAB scores had better correlation with CSCI scores ($r^2=0.37$, p value <0.001) compared to D18 scores ($r^2=0.19$, p value <0.001) (Figure 2.10)

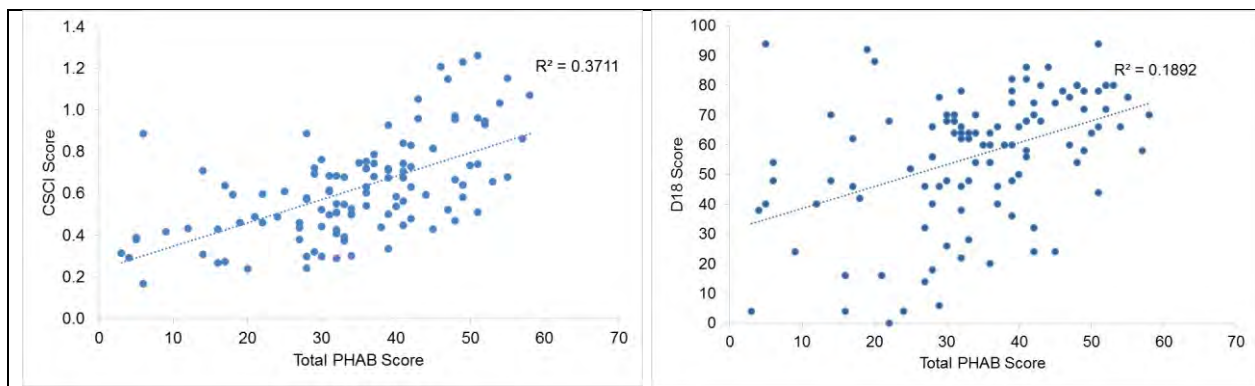


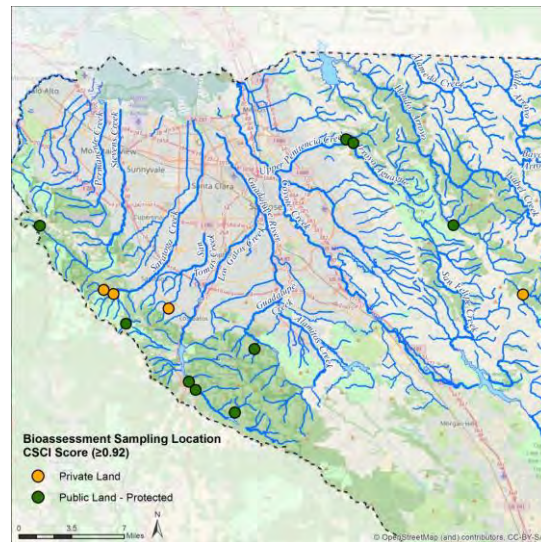
Figure 2.10. CSCI and D18 scores plotted with total PHAB scores for 112 bioassessment sites sampled in Santa Clara County over five-year period (WY 2012 – WY 2016).

Analyses of physical habitat related stressor data was limited to the data collected at each probabilistic site and environmental variables that were generated in GIS. Additional stressor data, not collected during the study that may also have important impacts to biological condition, include impacts from reservoirs (e.g., modified peaks flows and sediment transport processes), variability in channel form and flood plain access (e.g., channel incision), modifications to stream channel (e.g., hardened banks, earthen levees), and riparian habitat condition. These stressor data types however typically require detailed measurements that are not practical to collect during bioassessment sampling.

Are Good Condition Sites Protected?

Many of the RMC Creek Status Monitoring sites sampled by SCVURPPP and SWAMP are located in publicly protected lands that have limited urban development. These lands include State Parks, County Parks, Municipal Parks, Midpeninsula Open Space Regional District Preserves, and watersheds protected by public utility agencies that provide water supply (e.g., San Jose Water Company).

A majority of the bioassessment sites sampled in Santa Clara County that received the highest biological condition scores, based on BMI data, were in publicly protected lands. Sixteen of the 112 bioassessment sites sampled over the past 5 years had CSCI scores ≥ 92 . Twelve of these sites were in publicly owned land with minimal urban development. The other four sites were in either privately owned land or within an urban municipal park. Three of the “unprotected” sites were located on Saratoga Creek.



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Table 2.7. Nutrient and conventional constituent concentrations in water samples collected at 20 sites in Santa Clara County during WY 2016. Analyte concentrations that exceed water quality objectives are indicated in bold.

Station Code	Creek	Ammonia as N	Unionized Ammonia (as N)	Chloride	AFDM	Chlorophyll a	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen As N	Total Nitrogen	Ortho-Phosphate as P	Phosphorus as P	Total Phosphorus	Silica as SiO ₂
		mg/L	mg/L	mg/L	g/m ²	mg/m ²	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Water Quality Objective		NA	0.025	250 ^a	NA	NA	10 ^a	NA	NA	NA	NA	NA	NA	NA
205R00213	Cow Creek	0.01	0.000	13	13.9	1.24	0.01	0.0005	0.035	0.046	0.006	0.018	0.024	16
205R00305	San Felipe Creek	0.01	0.000	16	83.5	87.1	1.2	0.002	0.26	1.462	0.024	0.04	0.064	14
205R00578	Arroyo Aguague	0.01	0.000	18	72.4	8.89	0.01	0.0005	0.4	0.411	0.03	0.044	0.074	13
205R01114	Guadalupe River	0.02	0.000	15	304	64.3	0.025	0.002	0.48	0.507	0.016	0.086	0.102	8.8
205R01731	Upper Penitencia Cr	0.03	0.001	41	55.2	2.02	0.19	0.004	1.1	1.294	0.02	0.026	0.046	15
205R02330	Ross Creek ^b	0.03	0.009	670	22.2	66.2	0.15	0.001	0.79	0.941	0.06	0.084	0.144	16
205R02422	Arroyo Calero	0.02	0.000	37	421	75.4	0.26	0.004	0.88	1.144	0.039	0.049	0.088	17
205R02458	Alamitos Creek	0.03	0.001	28	34.4	34.6	0.14	0.003	0.57	0.713	0.03	0.037	0.067	18
205R02474	Saratoga Creek	0.01	0.003	50	30.0	14.2	0.059	0.0019	0.57	0.631	0.042	0.044	0.086	20
205R02538	Calabazas Creek	0.01	0.006	37	62.8	13.4	0.01	0.0014	0.53	0.541	0.032	0.019	0.051	16
205R02547	Stevens Creek	0.03	0.000	20	13.6	14.9	0.01	0.0005	0.7	0.711	0.025	0.024	0.049	18
205R02563	Los Gatos Creek	0.01	0.000	96	39.5	145	0.66	0.0031	0.62	1.283	0.021	0.033	0.054	10
205R02602	Unnamed Trib	0.03	0.001	43	195	11.7	0.41	0.0005	0.4	0.811	0.2	0.017	0.217	23
205R02618	Aldercroft Creek	0.02	0.022	17	9.89	3.80	0.54	0.001	0.48	1.021	0.081	0.087	0.168	23
205R02650	Alamitos Creek	0.02	0.000	38	186	71.0	0.18	0.002	0.62	0.802	0.034	0.037	0.071	18
205R02659	Stevens Creek	0.39	0.001	12	71.6	10.2	0.089	0.014	0.62	0.723	0.028	0.072	0.100	18
205R02730	Saratoga Creek	0.07	0.005	71	158	96.1	0.22	0.0005	0.79	1.011	0.098	0.11	0.208	10
205R02762	Ross Creek	0.04	0.000	18	62.5	223	1.6	0.009	1.1	2.709	0.036	0.2	0.236	35
205R02771	Lower Silver Creek	0.10	0.002	96	736	123	3.4	0.031	1.1	4.531	0.2	0.082	0.282	24
205R02835	Upper Penitencia Cr	0.17	0.004	120	248	74.3	0.3	0.035	0.97	1.305	0.03	0.042	0.072	15
Number of exceedances		NA	0	0	NA	NA	0	NA	NA	NA	NA	NA	NA	NA

NA = not applicable

^a Chloride and nitrate WQOs only apply to waters with MUN designated Beneficial Uses.

^b Ross Creek is not designated for MUN Use.

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Table 2.8. Selected physical habitat variables and general water quality measurements collected at 20 bioassessment sites in Santa Clara County during WY2016. Land use data calculated in GIS, is also provided. Measurements that exceed objectives or MRP thresholds are indicated in bold.

Station Code	Creek	% Micro Algae Cover	% Macro Algae Cover	% Canopy Cover	% Sands+ Fines	HDI Score	% Urban (watershed)	% Imperv (watershed)	Temp (C) Instan Maximum	DO (mg/L)	pH	Specific Cond (uS/cm)
<i>Water Quality Objective/Threshold</i>		NA	NA	NA	NA	NA	NA	NA	24	5 or 7	6.5 to 8.5	2000
205R00213	Cow Creek	0.00	0.95	85.70	5.71	0.00	0%	1%	10.7	10.49	8.2	492
205R00305	San Felipe Creek	2.86	8.57	90.37	18.10	0.09	0%	1%	13.4	10.67	8.4	555
205R00578	Arroyo Aguague	0.00	7.62	58.42	17.14	0.86	0%	1%	13.9	7.94	7.6	305
205R01114	Guadalupe River	0.00	20.95	1.07	28.57	1.72	38%	17%	18.9	9.41	8.3	547
205R01731	Upper Penitencia Cr	1.90	19.05	70.15	16.19	2.95	4%	2%	15.7	10.26	8.7	876
205R02330	Ross Creek	14.29	43.81	20.45	2.86	3.91	86%	37%	25.2	16	9.1	2848
205R02422	Arroyo Calero	8.57	13.33	93.16	51.43	1.98	37%	6%	15.8	8.77	7.7	489
205R02458	Alamitos Creek	0.95	27.62	82.35	37.14	2.15	9%	2%	16.7	10.36	8.1	4712
205R02474	Saratoga Creek	9.52	4.76	89.19	15.24	2.21	10%	3%	14.6	9.92	8	526
205R02538	Calabazas Creek	0.00	37.14	87.17	19.05	1.63	12%	4%	20.1	8.68	8	1108
205R02547	Stevens Creek	0.00	3.81	87.97	6.67	0.05	37%	6%	12.6	10.22	8.2	534
205R02563	Los Gatos Creek	12.38	71.43	64.04	25.71	2.85	2%	2%	21.4	12.13	8.8	498
205R02602	Unnamed Trib	2.86	0.95	94.25	7.62	2.40	32%	18%	15.8	8.86	7.6	468
205R02618	Aldercroft Creek	3.81	3.81	86.10	15.24	0.61	21%	4%	11.7	10.85	8	575
205R02650	Alamitos Creek	0.96	26.67	79.55	34.29	1.82	13%	4%	16.4	8.99	7.9	492
205R02659	Stevens Creek	0.95	5.71	78.74	21.90	1.12	13%	5%	15.7	9.6	8.4	467
205R02730	Saratoga Creek	0.00	0.00	82.35	22.86	1.97	16%	8%	20.1	10.3	8.4	501
205R02762	Ross Creek	6.67	54.29	89.97	32.38	3.01	80%	13%	18.7	11.65	8.3	1013
205R02771	Lower Silver Creek	0.00	34.29	5.08	39.05	3.07	24%	10%	20.9	8.95	8.1	1364
205R02835	Upper Penitencia Cr	7.62	10.48	85.83	27.62	2.01	76%	23%	13.8	9.95	8.2	794
Number of exceedances		NA	NA	NA	NA	NA	NA	NA	1	NA	3	1

Stressor Data (WY 2012 - 2016)

Nutrient data were compiled for all bioassessment sites sampled during the past five years (WY 2012 – WY 2016) in Santa Clara County. Total nitrogen and phosphorus concentrations, grouped by three classes of percent imperviousness of the area draining to monitoring site, are presented as box plots in Figure 2.11. In general, urban sites had slightly higher concentrations compared to less urban sites for both total nitrogen and total phosphorus.

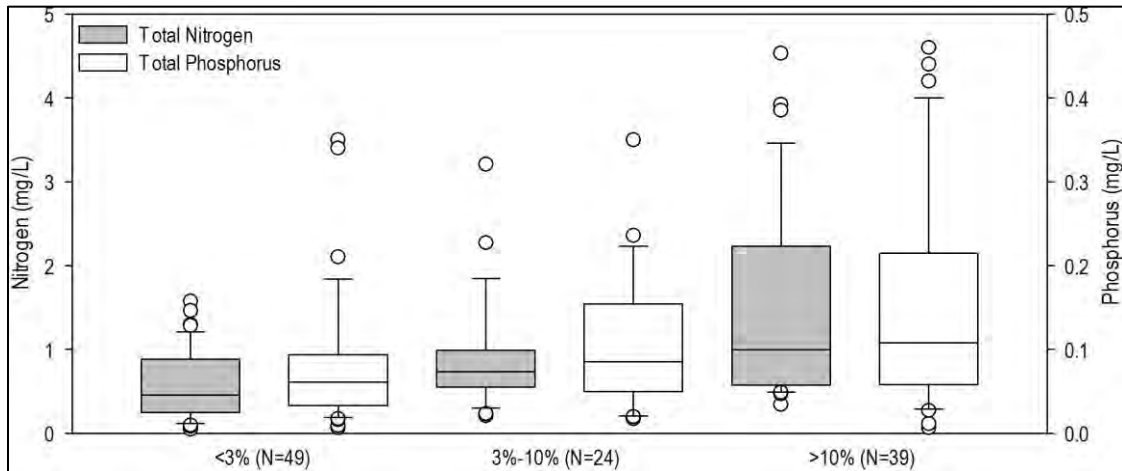


Figure 2.11. Total nitrogen and total phosphorus concentrations measured in water samples collected at bioassessment sites (n=112) by SCVURPPP and SWAMP between WY 2012 and WY 2016.

Box plots for total nitrogen and total phosphorus, grouped by subwatershed, are presented in Figures 2.12 through 2.14. See Figure 1.1 for a map of watersheds within SCVURPPP jurisdictional boundaries. In the Coyote Creek watershed, elevated¹⁴ total nitrogen concentrations were measured at all sites in Lower Silver/Thompson Creek and at the lowest elevation site in Coyote Creek (Figure 2.12). Elevated concentrations for total phosphorus were also observed at two sites in Lower Silver/Thompson Creek, one site in Upper Silver Creek and one site in Los Coches Creek (tributary to Lower Penitencia Creek).

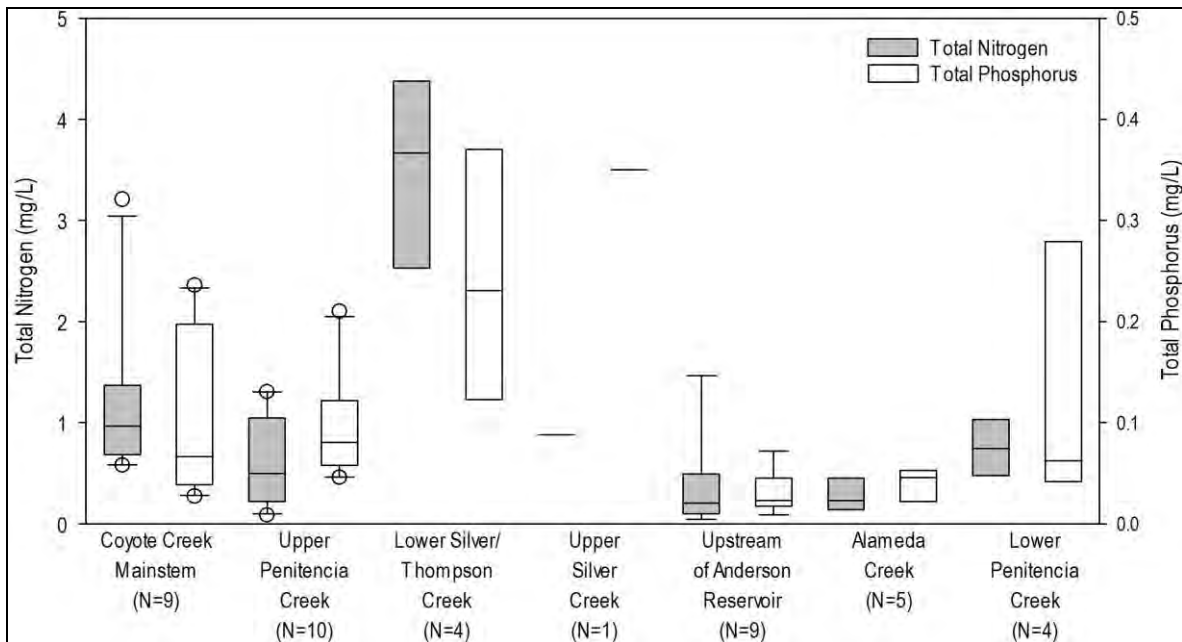


Figure 2.12. Total nitrogen and total phosphorus concentrations measured in water samples collected in Coyote Creek, Lower Penitencia Creek and Alameda Creek watersheds between WY 2012 and WY 2016.

¹⁴ In this analysis, samples are considered elevated if nutrient concentrations exceeded the 90th percentile of all data collected in Santa Clara and San Mateo Counties in the past five years.

In the Guadalupe River watershed, elevated total nitrogen concentrations occurred at three sites in Guadalupe River, two sites in Ross Creek and one site in Alamitos Creek (Figure 2.13). The highest concentration of total phosphorus (0.46 mg/L) for all stations sampled over the past five years occurred in water sample collected in 2015 at site 205R01738 in Ross Creek. In the western Santa Clara Valley watersheds, elevated total nitrogen concentrations occurred at two sites in Matadero Creek (Figure 2.14).

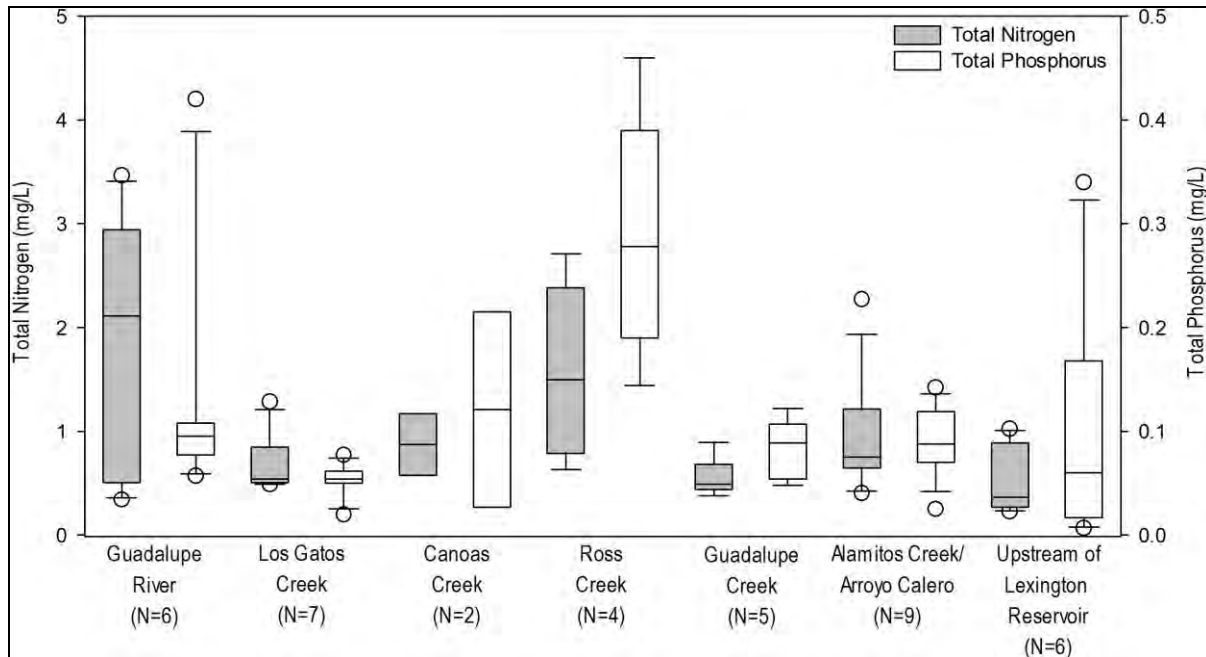


Figure 2.13. Total nitrogen and total phosphorus concentrations measured in water samples collected in the Guadalupe River watershed between WY 2012 and WY 2016.

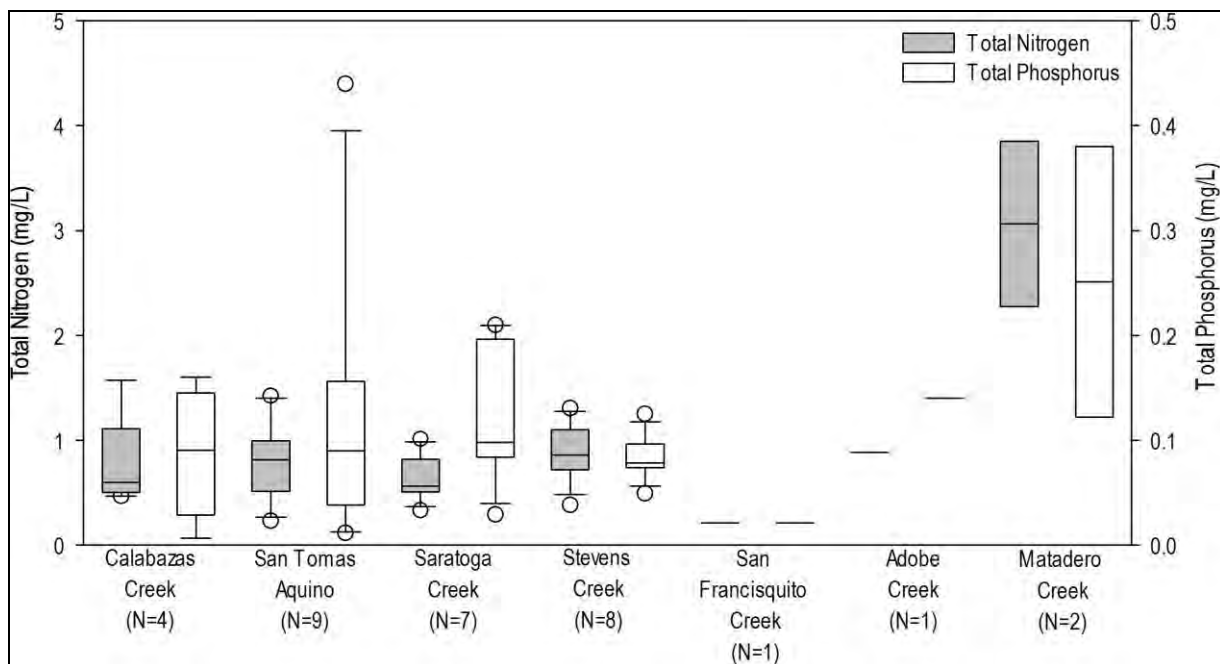


Figure 2.14. Total nitrogen and total phosphorus concentrations measured in water samples collected in Western Santa Clara Valley watersheds between WY 2012 and WY 2016.

In an effort to assess whether total nitrogen concentrations (measured during bioassessments) are affecting indicators of biomass (i.e., chlorophyll a, ash free dry mass, percent macro-algae cover), simple regression models were run. There was no correlation between total nitrogen concentration and chlorophyll a, ash free dry mass, or percent macro-algae cover in the Santa Clara County dataset (n=112). However, chlorophyll a and macro-algae cover were moderately correlated ($r^2 = 0.27$, p value <0.05) (Figure 2.15) indicating that estimating algae cover during pebble counts may provide a reasonable estimate for algae biomass at bioassessment sites.

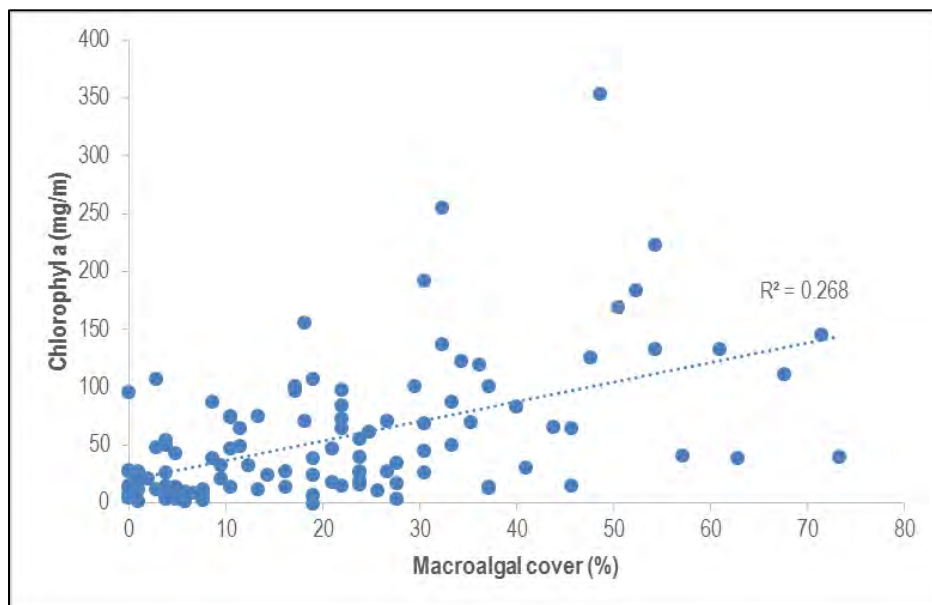


Figure 2.15. Plot of chlorophyll a concentrations with percent macro-algae cover measured at 112 bioassessments conducted WY 2012 through WY 2016 in Santa Clara County.

Stressor Association with Biological Condition

Spearman Correlations

Spearman Rank Correlations for environmental variables associated with CSCI and D18 scores are presented in Figures 2.16 and 2.17, respectively. Statistically significant variables (i.e., $p < 0.05$) are indicated as shaded columns. Coefficients values greater than ± 0.5 indicate a stronger relationship between the variable and the CSCI/D18 score.

- CSCI scores are negatively correlated with land use variables (percent impervious, percent urban), chloride, temperature, and specific conductivity. CSCI scores are positively correlated with two PHAB parameters (epifaunal substrate score and channel alteration score).
- D18 scores are negatively correlated with chloride and total nitrogen but are not well correlated with any other of the measured stressors.

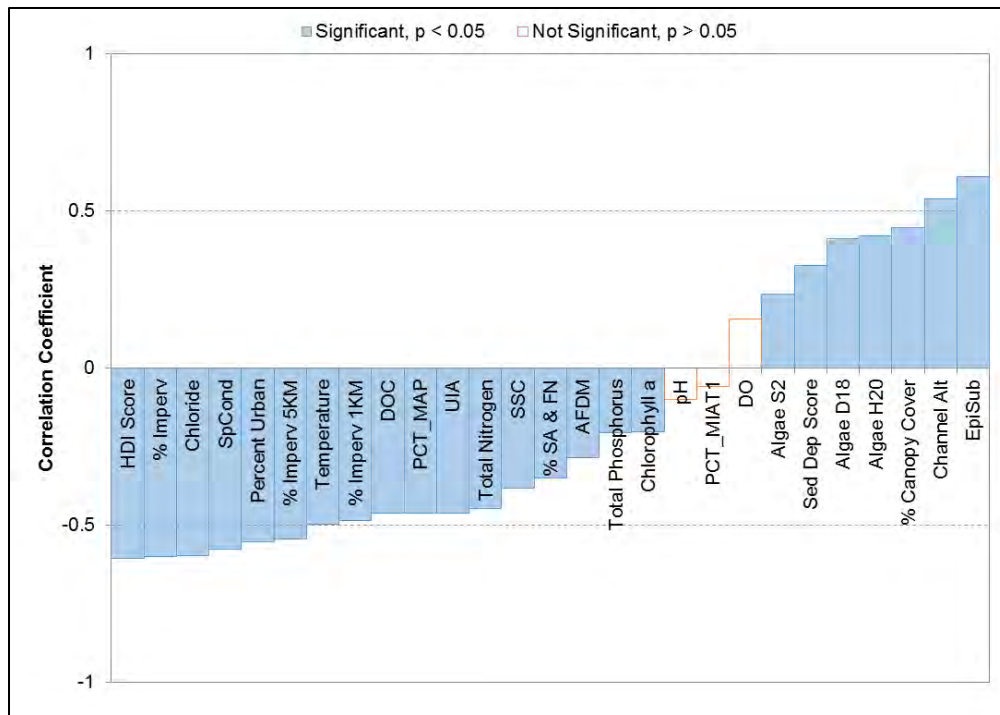


Figure 2.16. Spearman Rank Correlation for CSCI scores and stressor variable data collected at 20 bioassessment sites in Santa Clara County in WY2016.

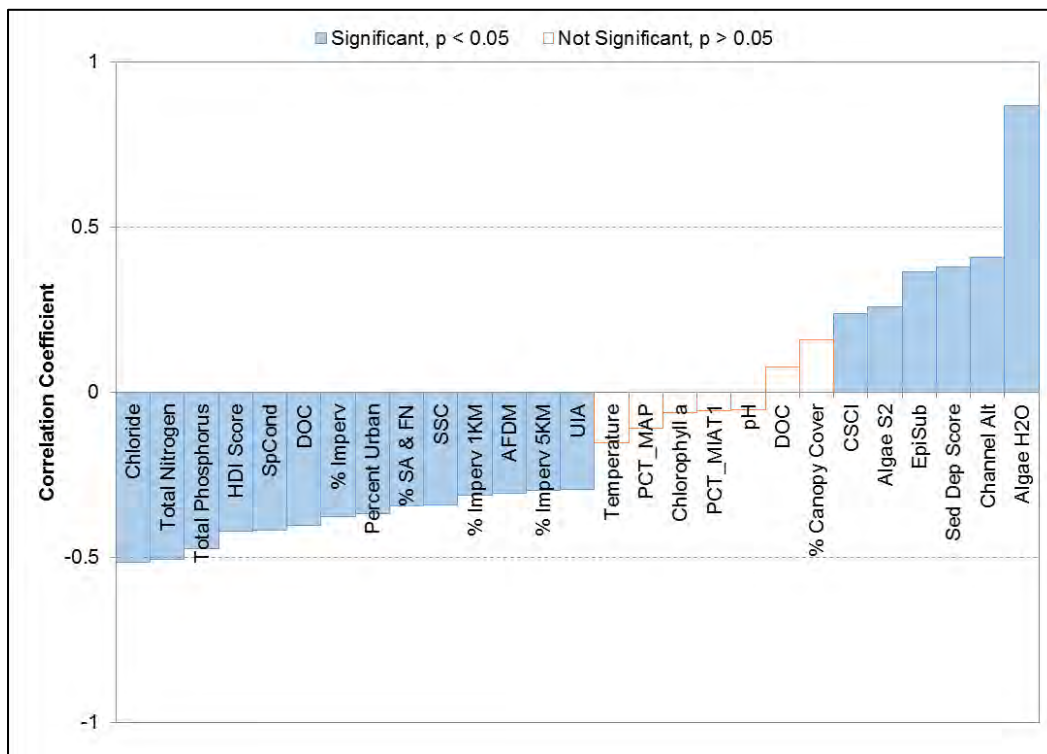


Figure 2.17. Spearman Rank Correlation for D18 scores and stressor variable data collected at 20 bioassessment sites in Santa Clara County in WY 2016

Random Forests

Figure 2.18 shows variable importance plots for potential stressors from the random forest analysis. Stressors with mean square error (%IncMSE) values are more important in explaining variability in CSCI scores. In this analysis, the five most important stressors are: elevation, specific conductance, epifaunal substrate, dissolved oxygen, and temperature. All of the stressors, except dissolved oxygen, were also identified through the Spearman Rank Correlation as statistically significant; albeit not as important as other variables. Dissolved oxygen was not found to be statistically significant though the Spearman Rank Correlation. The node purity (IncNodePurity) value relates to the loss function in the regression tree and is not as robust a measure of importance as %IncMSE. The random forest analysis was able to explain 59 percent of the variance in CSCI scores.

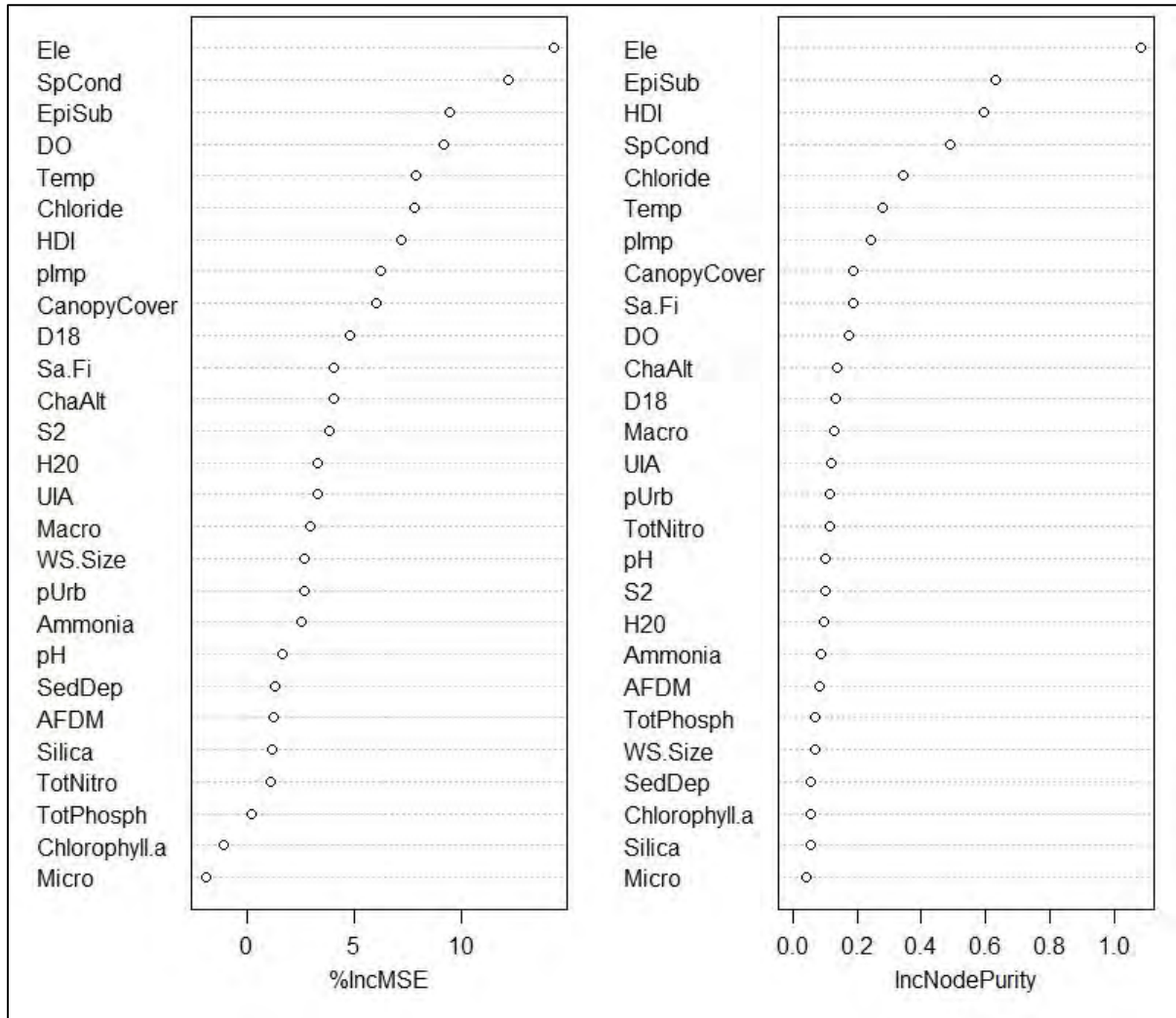


Figure 2.18. Variable importance for CSCI scores in Santa Clara County, WY 2012 – WY 2016.

2.4 Conclusions

Bioassessment monitoring in WY 2016 was conducted in compliance with provision C.8.d.i of the MRP. Twenty sites were sampled for BMIs, benthic algae, PHab observations, and nutrients. Stations were randomly selected using a probabilistic monitoring design. The following preliminary conclusions and recommendations are made based on these data.

Probabilistic Survey Design

- Site evaluations were conducted at a total of 76 potential probabilistic sites in Santa Clara County during WY 2016. Of these sites, a total of twenty were sampled in WY 2016 (rejection rate of 74%). Three of the twenty sites (15%) were classified as non-urban land use.
- Between WY 2012 and WY 2016, a total of 112 probabilistic sites were sampled by SCVURPPP (n=100) and SWAMP (n=12) in Santa Clara County, including 87 urban and 25 non-urban sites.
- There is a sufficient number of samples from probabilistic sites to develop estimates of biological condition and stressor assessment for urban streams in Santa Clara County (in development). More samples are needed to estimate biological condition at more local scales (e.g., watershed and jurisdictional areas).

Biological Condition Assessment (WY 2016)

- The California Stream Condition Index (CSCI) tool was used to assess the biological condition. The CSCI translates benthic macroinvertebrate data into an overall measure of stream health. Of the 20 sites monitored in WY 2016, five sites (25%) were rated in good condition (CSCI scores ≥ 0.795); five sites rated as likely altered condition (CSCI score 0.635 – 0.795), and ten sites rated as very likely altered condition (≤ 0.635).
- The 15 sites with CSCI scores less than the trigger threshold of 0.795 will be added to the list of candidate SSID projects.
- Diatoms were relatively well represented across all sites ranging from 15 to 61 taxa. Soft algae taxa were less common across sites, ranging from 1 to 10 taxa. Seven of the sites (30%) had three or less soft algae taxa.
- Three algae IBI metrics were used to evaluate stream condition using benthic algae data collected synoptically with BMIs. These include D18 (diatoms), S2 (soft algae), and H20 (combination of diatoms and algae). Eight sites were ranked in good condition based on D18 scores (D18 ≥ 62). Two sites were ranked in good condition based on S2 scores (S2 ≥ 47) and one site was ranked in good condition based on H20 scores (H20 ≥ 63).

Biological Condition Assessment (WY 2012-WY 2016)

- CSCI scores were calculated for the five-year Santa Clara County probabilistic data set (n=112). Good biological condition scores (CSCI score > 0.795) occurred at 11% of the urban sites and 52% of non-urban sites.
- There was no significant difference in median CSCI scores between perennial (n=85) and non-perennial (n=27) sites. Median algal IBI scores were slightly higher at non-perennial sites.
- The CSCI and three algae IBI tools showed were relatively consistent in their response across an urban gradient, with generally lower median scores associated with higher percent imperviousness.
- CSCI scores were better correlated with site elevation ($r^2 = 0.34$) compared to D18 scores ($r^2 = 0.18$), suggesting that physical habitat variables associated with changing elevation (e.g., stream gradient, substrate size) have greater influence on the BMI community compared to diatom assemblages.

Stressor Assessment

- Potential stressors (nutrients, algal biomass indicators, and conventional analytes) were measured in samples collected concurrently with bioassessments which are conducted in the spring season. Physical habitat parameters were also observed during bioassessments. Other potential stressors (e.g., percent urbanization/imperviousness in contributing catchments) were calculated in GIS.
- The association of potential stressors with biological condition scores collected over five years was assessed using the Spearman rank method and random forests. Land use variables (percent impervious and urban), chloride, temperature and specific conductivity showed significant negative correlations with CSCI scores. Two PHAB parameters (epifaunal substrate score and channel alteration score) were significantly positively correlated with CSCI scores.
- Water quality objectives were generally not exceeded in WY 2016.

Trend Assessment

- Trend analysis for the RMC probabilistic survey will require more than five years of data collection. Preliminary long-term trend analysis of biological condition may be possible for some stream reaches using a combination of historical targeted data with the probabilistic data.
- Targeted re-sampling at probabilistic sites can provide additional data to evaluate longer term trends at selected locations.

3.0 TARGETED MONITORING

3.1 Introduction

During WY 2016 water temperature, general water quality, and pathogen indicators were monitored in compliance with Creek Status Monitoring Provisions C.8.d.iii – v of the MRP. Monitoring was conducted at selected sites using a targeted design based on the directed principle¹⁵ 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?*
3. *What are the pathogen indicator concentrations at creek sites where there is potential for water contact recreation to occur?*

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

The second and third management questions are 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 for future evaluation of Stressor Source Identification projects.

3.2 Study Area

In compliance with MRP, temperature was monitored at a minimum of eight sites, general water quality was monitored at three sites, and pathogen indicator samples were collected at five sites. The targeted monitoring design focuses 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.

3.2.1 Temperature

From April through September 2016, Continuous (hourly) water temperature measurements were recorded at eight stations in the Upper Penitencia Creek watershed¹⁶ ranging from 200 to 900 feet in elevation (Figure 3.1). Eight of the nine locations were on Upper Penitencia Creek and one site was in Arroyo Aguague, approximately 0.75 mile upstream of its confluence with Upper Penitencia Creek. The highest elevation site in both creeks were just downstream of waterfalls that are migration barriers for anadromous fishes. Six of the upper elevation sites are in Alum Rock Park, which supports both rearing and spawning habitat for steelhead, as well as other native fishes. All six sites had flowing water throughout the study period.

The two lowest elevation sites were located on the eastern edge of the Santa Clara Valley (sites 121 and 114). Only one of these “valley reach” sites had flow throughout the study period. This was the uppermost site (site 121), located just upstream of the stream gage at Dorel Drive. The lowest elevation site in the valley reach (site 114) continued to flow through late July as the result of discharges from the Robert Gross Percolation Ponds near Piedmont Avenue. Releases from the ponds stopped during the month of

¹⁵ 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.”

¹⁶ SCVURPPP typically monitors water temperature at more stations than the MRP required minimum to mitigate for potential equipment loss.

August and resumed in early September. The majority of the water that is stored in the ponds is imported from the Central Valley for the purposes of groundwater recharge.

During WY 2016, the Program conducted a Stressor Source Identification (SSID) project in Upper Penitencia Creek, evaluating a range of potential stressors that may cause reduced biological condition previously observed at site 114. Water temperature data collected at sites 114 and 121 for Creek Status Monitoring were also used to evaluate potential effects of temperature on biological condition at the same sites. Results from this SSID study are presented in Appendix B of the UCMR.

3.2.2 General Water Quality

Continuous (15-minute) general water quality measurements (dissolved oxygen, specific conductance, pH, and temperature) were recorded at three locations (sites 114, 117 and 121) in the Upper Penitencia Creek watershed during two sampling events in WY 2016 (Figure 3.1). The first event was in April and the second event was in June. The middle elevation site (117) went dry soon after the June event. The lowest elevation site (114) had flowing conditions through late July due to augmented water supply from percolation ponds. Water quality data collected for at these sites were used to evaluate potential impacts to biological condition as part of the Upper Penitencia Creek SSID Project (Appendix X of the UCMR).

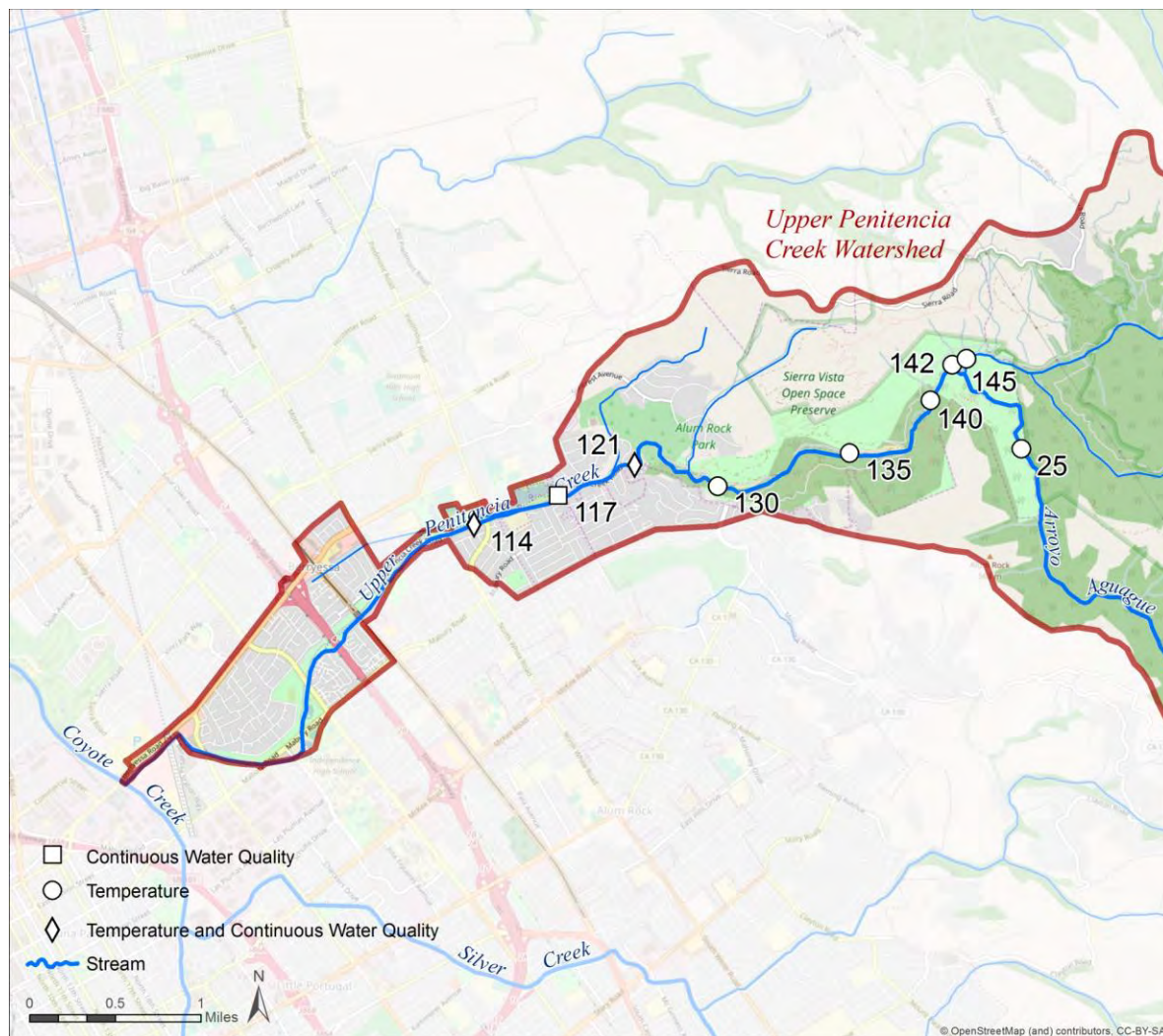


Figure 3.1. Continuous temperature and water quality monitoring stations deployed in Upper Penitencia Creek during WY 2016.

3.2.3 Pathogen Indicators

Pathogen indicator samples were collected at five sites located in municipal or county owned/operated parks in areas with good public access to creeks and potential for recreational water contact (Figure 3.2). Two of the five sites were in Upper Penitencia Creek; one site in Alum Rock Park (site 132) and one site adjacent to the Penitencia Creek Trail (site 117) at Noble Ave. One site was in Alamitos Creek adjacent to the Alamitos Creek Trail and another site was in Arroyo Calera Creek adjacent to the Calera Creek Trail. The last site was in Saratoga Creek at Wildwood Park, located in the Town of Saratoga. The five pathogen indicator sampling locations were also bioassessment monitoring sites in WY 2016.

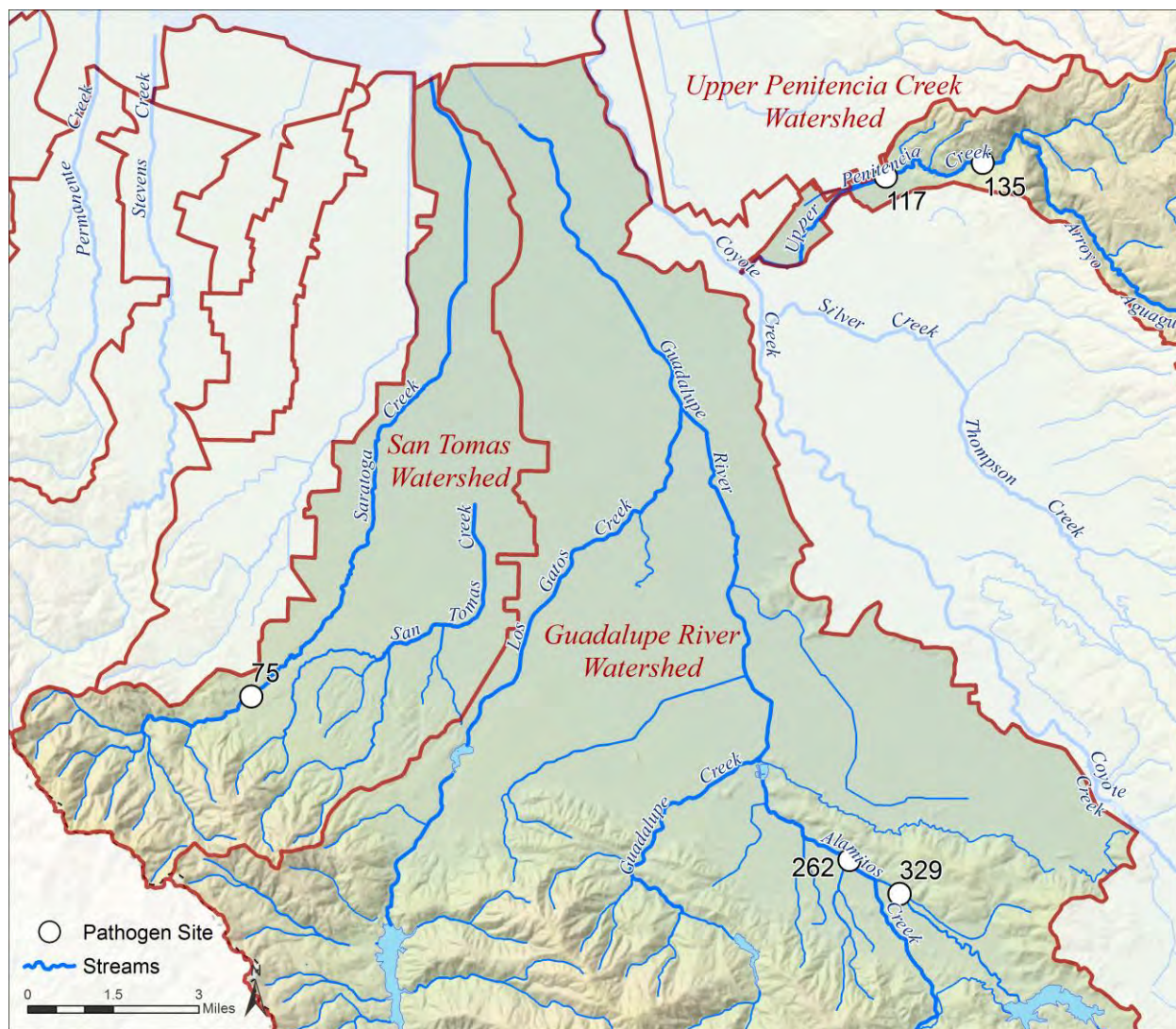


Figure 3.2. Pathogen indicator monitoring sites sampled in Santa Clara County during WY 2016.

3.3 Methods

Water quality data were collected in accordance with SWAMP-comparable methods and procedures described in the BASMAA RMC SOPs (BASMAA 2016b) and associated QAPP (BASMAA 2016a). Data were evaluated with respect to the MRP provision C.8.d “Followup” triggers for each parameter.

3.3.1 Continuous Temperature

Digital temperature loggers (Onset HOBO Water Temp Pro V2) were programmed to record data at 60-minute intervals and were deployed at targeted sites from April through September 2016. Procedures used for calibrating, deploying, programming and downloading data are described in RMC SOP FS-5 (BASMAA 2016b).

3.3.2 Continuous General Water Quality Measurements

Water quality monitoring equipment recording dissolved oxygen, temperature, conductivity, and pH at 15-minute intervals (YSI 6600 data sondes) was deployed at targeted sites for two 2-week periods: once during spring season and once during summer season in 2016. Procedures for calibrating, deploying, programming and downloading data are described in RMC SOP FS-4 (BASMAA 2016b).

3.3.3 Pathogen Indicators Sampling

Water samples were collected during the dry season. Sampling techniques for pathogen indicators (enterococcus and *E. coli*) include direct filling of sterile containers at targeted sites and transfer of samples to the analytical laboratory within specified holding time requirements. Procedures for sampling and transporting samples are described in RMC SOP FS-2 (BASMAA 2016b).

3.3.4 Data Evaluation

Trigger Comparison

Continuous temperature, water quality, and pathogen indicator data generated during WY 2016 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). Provision C.8.d of the MRP (SFRWQCB 2015), 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, continuous water quality, and pathogen indicator 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 MWAT of 17.0°C for a Steelhead stream, or when 20% of the results at one sampling station exceed the instantaneous maximum of 24°C.	°C	MRP 2.0 provision C.8.d.iii.
General Water Quality Parameters	20% of results at each monitoring site exceed one or more established standard or threshold - applies individually to each parameter		
Conductivity	2000	uS	MRP 2.0 provision C.8.d.iii.
Dissolved Oxygen	WARM < 5.0, COLD < 7.0	mg/L	SF Bay Basin Plan Ch. 3, p. 3-4
pH	> 6.5, < 8.5 ¹	pH	SF Bay Basin Plan Ch. 3, p. 3-4
Temperature	Same as Temperature (See Above)		
Pathogen Indicators			
Enterococcus	≥ 130	cfu/100ml	EPA's statistical threshold value for estimated illness rate of 36 per 1000 primary contact recreators
<i>E. coli</i>	≥ 410	cfu/100ml	EPA's statistical threshold value for estimated illness rate of 36 per 1000 primary contact recreators

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

Temperature Trigger Considerations

Sullivan et al. (2000) is referenced in MRP Provision C.8.iii.(4) as the published source for the given trigger threshold(s) to use for evaluating water temperature data, specifically for creeks that have salmonid fish communities. The report summarizes results from previous field and laboratory studies investigating the effects of water temperature on salmonids of the Pacific Northwest and lists acute and chronic thresholds that can potentially be used to define temperature criteria. The authors identified annual maximum temperature (acute) and maximum 7-day weekly average temperature (MWAT) chronic indices as biologically meaningful thresholds. They found the MWAT index to be most correlated with growth loss estimates for juvenile salmonids, which can be used as a threshold for evaluating the chronic effects of temperature on summer rearing life stage.

Previous studies conducted by EPA (1977) identified a MWAT of 19°C for steelhead and 18°C for coho salmon. Using risk assessment methods, Sullivan et al (2000) identified lower thresholds of 17°C and 14.8°C for steelhead and coho respectively. The risk assessment method applied growth curves for salmonids over a temperature gradient and calculated the percentage in growth reduction compared to the growth achieved at the optimum temperature. The risk assessment analysis estimated that temperatures exceeding a threshold of 17°C would potentially cause 10% reduction in average salmonid growth compared to optimal conditions. In contrast, exceedances of the 19°C threshold derived by EPA (1977) would result in a 20% reduction in average fish growth compared to optimal conditions.

The lower MWAT thresholds presented in Sullivan et al. (2000) are based on data collected from creeks in the Pacific Northwest region, which exhibits different patterns of temperature associated with climate, geography and watershed characteristics compared to creeks supporting steelhead and salmon in Central California. Furthermore, a single temperature threshold may not apply to all creeks in the San Francisco Bay Area due to high variability in climate and watershed characteristics within the region.

In October 2016, the National Marine Fisheries Service (NMFS) released the Coastal Multispecies Final Recovery Plan for California Coastal Chinook, Northern California Steelhead and Central California Coast Steelhead. The Recovery Plan addresses the Central California Coast Steelhead Distinct Population Unit, which includes steelhead populations in the Santa Clara Valley watersheds. The plan includes an assessment of physical habitat and water quality as well as natural and anthropogenic threats to their habitat and survival. The NMFS developed a Conservation Action Planning (CAP) Analysis for the major

watersheds supporting salmonid populations (e.g., Coyote Creek). Water temperature was one of the factors used to evaluate existing conditions for steelhead. The CAP utilized a threshold of 20°C for maximum weekly maximum temperature (MWMT), or 7-day maximum, to protect summer juvenile steelhead populations.

Previous studies evaluating the differences between MWMT and MWAT, have shown that MWMT better reflects transient water temperature peaks (Welsh et al. 2001) and any acute effects of the single point maximum temperature. The MWMT is suggested to be a more biologically meaningful parameter that can better predict the ability of a given waterbody to support cold-water adapted species. It is important to note however, that stream temperature affects rearing salmonids in interaction with many other factors, all of which vary with species and location. In cases where low flow conditions in concert with high temperatures during summer season are impacting steelhead populations, management actions that improve food availability (e.g., increase summer flow) may better address factors that are more critically limiting steelhead production. For monitoring, fish size thresholds at critical life stages such as smolting may be a much better indicator for understanding viability of steelhead populations (Atkinson et al. 2011).

In compliance with MRP Provision C.8.d, sites with temperature data exceeding the 17°C MWAT trigger threshold are added to the list of candidate SSID project. However, in an effort to develop a more meaningful understanding of the temperature data within the local context, SCVURPPP also compared the results to the 20°C MWMT threshold proposed by NMFS (2016) CAP.

3.4 Results and Discussion

3.4.1 Continuous Temperature

Summary statistics for continuous water temperature data collected at eight¹⁷ sites in Upper Penitencia Creek during WY 2016 are listed in Table 3.2. Hourly temperature data was collected at six of the eight sites from March/April through September 2016. At the lowest elevation site (114), no water temperature data was collected in September due to dry channel conditions beginning in late August (note: water releases from percolation ponds was re-initiated in mid-September). One hobo device was not recovered at site 135 during a field check in June. A new device was re-deployed and data was collected from June through September.

Table 3.2. Descriptive statistics for continuous water temperature measured in Upper Penitencia Creek at eight sites during WY2016.

Site	205COY114	205COY121	205COY130	205COY135	205COY140	205COY142	205COY145	205AAG025	
Start Date	3/24/2016	3/24/2016	4/5/2016	6/10/2016	4/5/2016	4/5/2016	4/5/2016	4/5/2016	
End Date	8/20/2016	9/20/2016	9/20/2016	9/20/2016	9/20/2016	9/20/2016	9/20/2016	9/20/2016	
Temperature (°C)	Min	8.2	8.2	9.9	13.5	9.6	9.2	8.9	9.0
	Median	19.5	17.2	17.3	18.2	15.3	15.0	14.8	15.6
	Mean	19.1	17.2	17.2	18.4	15.1	15.0	14.5	15.1
	Max	27.1	24.5	25.3	24.1	24.8	26.7	26.7	26.8
	Max 7-day mean	24.7	20.3	20.2	20.0	16.9	16.8	17.4	18.1
	N	3574	4321	4033	2450	4033	4033	4033	4033

Consistent with MRP requirements, MWAT was calculated for non-overlapping, 7-day periods. The number of 7-day periods ranged from 17 to 26. The total number and percent of weeks when the MWAT exceeded the 17°C trigger threshold are presented in Table 3.3. Five of the eight stations exceeded the MRP trigger threshold of having two or more 7 days periods where MWATs exceeded 17°C.

¹⁷ Hobos were originally deployed at nine sites, however, the hobo device at site 117 was not recovered. A new device was re-deployed in early June, but the creek went dry less than two weeks later. Thus, data collected at site 117 is too limited to compare with data collected at remaining sites for entire sampling period.

The MWAT values calculated from temperatures recorded at the four lowest elevation sites in Upper Penitencia Creek (sites 114, 121, 130, and 135) are plotted in Figure 3.3 (see Figure 3.1 for a map of their locations). MWAT values exceeded the MRP threshold at all four sites from the beginning of June to the end of August. The MWAT values were consistently higher at the lowermost site (114), with temperatures 3 to 4°C higher compared to site 121 during the months of June and July. Beginning in May, releases from the percolation ponds were augmenting flow at site 114 and are likely responsible for the relatively high temperatures.

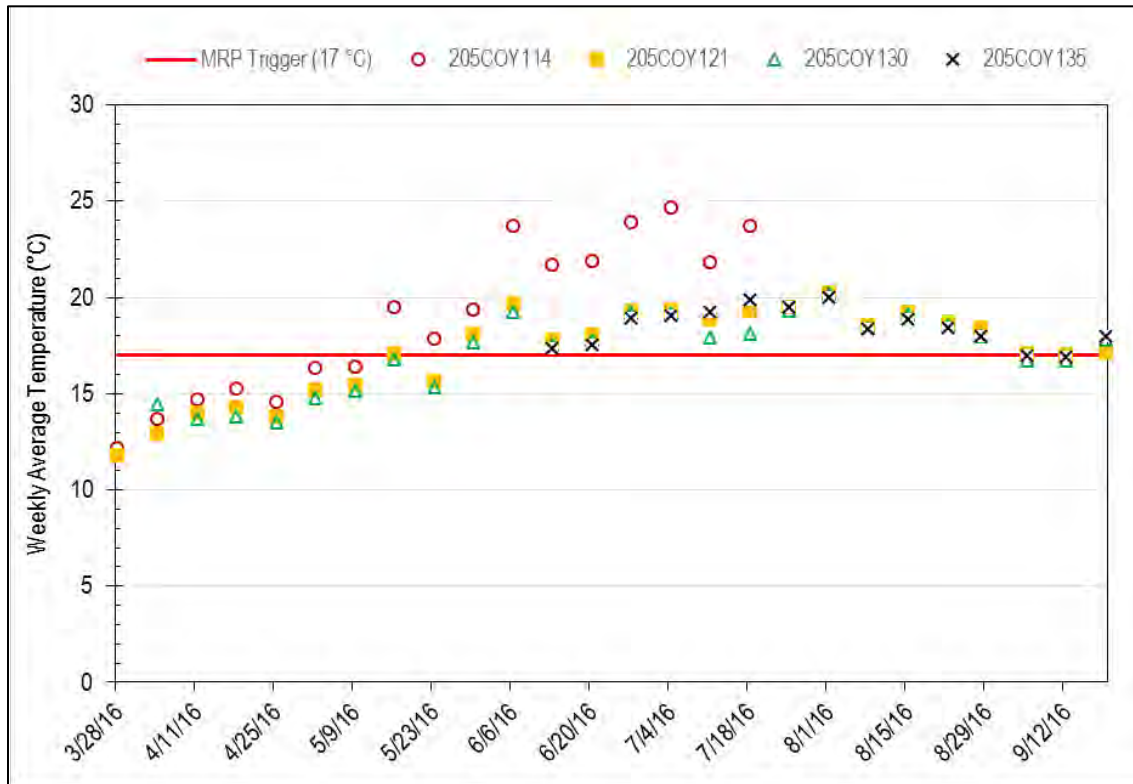


Figure 3.3. Plot of MWAT values calculated from temperatures collected at four lower elevation sites in Upper Penitencia Creek over 26 weeks of temperature monitoring. The MRP trigger (17°C) is shown for comparison.

The MWMT was calculated for each site by breaking the measurements into non-overlapping, 7-day periods. A threshold of 20°C for the MWMT was used to evaluate the data, similar to the temperature threshold for this criterion that was used by NMFS to evaluate the level of protection for summer juvenile steelhead populations in the Central Coastal Steelhead Recovery Plan. The total number and percent of weeks when the MWMT exceeded the 20°C threshold are presented in Table 3.3.

The MWAT threshold (17.0 °C) was exceeded more than three times more often compared to the MWMT temperature threshold (20.0 °C) at the four lower elevation sites, with the exception of site 114, which had the same number of exceedances. The four upper elevation sites had similar pattern for the two criteria (i.e., little or no exceedances occurred).

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Table 3.3. MWAT and MWMT values for water temperature data collected at eight sites monitored in Upper Penitencia Creek in Santa Clara County, WY 2016. MWAT values that exceed MRP trigger (17°C) and MWMT values that exceed threshold (20°C) are indicated in bold. Data were not collected due to dry channel “a” or device not recovered “b”.

Station Date	114		121		130		135		140		142		145		25	
	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT
3/28/2016	12.2	13.6	11.8	13.2	--	--	--	--	--	--	--	--	--	--	--	--
4/4/2016	13.7	15.8	13.0	14.7	14.5	14.8	b	b	12.8	12.9	12.7	12.7	12.2	12.3	12.7	12.7
4/11/2016	14.7	16.5	14.0	15.5	13.7	15.0	b	b	12.8	13.4	12.5	13.2	12.6	13.3	12.8	13.5
4/18/2016	15.3	16.8	14.3	15.6	13.9	15.2	b	b	12.4	13.4	12.0	13.0	11.9	13.2	12.2	13.4
4/25/2016	14.6	16.7	13.8	15.4	13.5	15.0	b	b	12.3	13.4	11.7	13.2	11.8	13.1	12.0	13.4
5/2/2016	16.4	17.3	15.2	16.1	14.8	15.7	b	b	13.0	13.9	12.4	13.5	12.5	13.8	12.8	13.9
5/9/2016	16.4	17.6	15.5	16.6	15.1	16.3	b	b	13.5	14.3	13.0	13.8	13.3	14.1	13.4	14.3
5/16/2016	19.5	21.0	17.1	18.9	16.8	18.5	b	b	14.4	15.2	13.9	15.0	14.2	15.1	14.4	15.5
5/23/2016	17.9	20.8	15.6	17.8	15.4	17.5	b	b	13.5	14.8	12.7	14.2	12.9	14.7	13.1	14.7
5/30/2016	19.4	21.5	18.1	19.6	17.7	19.1	b	b	14.8	15.7	14.3	15.5	14.6	16.0	14.9	16.1
6/6/2016	23.7	24.3	19.7	20.3	19.2	19.8	b	b	15.9	16.1	15.7	16.3	16.4	16.7	16.1	16.7
6/13/2016	21.7	22.8	17.8	18.8	17.6	18.4	17.3	18.4	15.0	15.6	14.4	15.2	15.3	16.2	14.6	15.6
6/20/2016	21.9	23.4	18.1	18.7	17.8	18.5	17.6	18.3	15.1	15.4	14.4	14.8	14.8	15.5	14.7	15.1
6/27/2016	23.9	25.2	19.3	20.4	19.2	20.2	18.9	20.0	15.9	16.5	15.5	16.5	16.0	16.8	15.9	16.8
7/4/2016	24.7	25.1	19.4	19.7	19.2	19.5	19.0	19.3	16.2	16.3	16.0	16.2	17.0	17.1	16.3	16.5
7/11/2016	21.9	23.5	18.9	19.6	17.9	18.7	19.3	19.8	15.9	16.3	15.6	15.9	16.3	16.7	17.0	18.3
7/18/2016	23.7	24.7	19.3	20.4	18.1	18.7	19.9	21.0	16.5	17.1	15.6	15.9	16.3	16.4	18.1	20.4
7/25/2016	a	a	19.5	21.0	19.3	20.8	19.5	20.8	16.3	16.9	15.8	16.8	16.3	16.8	16.2	17.2
8/1/2016	a	a	20.3	21.1	20.2	21.0	20.0	20.8	16.8	17.1	16.8	17.2	17.4	17.5	17.1	17.6
8/8/2016	a	a	18.5	19.0	18.4	18.9	18.4	18.8	16.2	16.4	15.6	16.0	16.9	17.3	15.9	16.2
8/15/2016	a	a	19.3	19.6	19.1	19.4	18.9	19.3	16.5	16.7	15.9	16.2	16.7	16.9	16.3	16.6
8/22/2016	a	a	18.8	19.3	18.5	19.1	18.5	18.9	16.4	16.6	15.9	16.2	16.9	17.0	16.2	16.5
8/28/2016	a	a	18.4	18.9	18.0	18.5	18.0	18.3	16.3	16.5	15.5	15.7	16.4	16.6	15.7	16.0
9/5/2016	a	a	17.1	17.9	16.7	17.5	17.0	17.7	15.8	16.1	14.7	15.3	15.5	16.0	14.9	15.5
9/12/2016	a	a	17.1	18.0	16.7	17.8	16.9	17.9	15.8	16.3	14.6	15.2	15.1	15.5	14.9	15.6
9/19/2016	a	a	17.2	18.6	17.8	18.2	18.0	18.2	16.9	16.3	16.2	15.4	16.3	15.1	16.5	15.9
Total Weeks	17		26		25		15		25		25		25		25	
MWMT >20	10	10	18	5	15	3	14	3	0	0	0	0	1	0	2	1
% Exceed	59	59	69	19	60	12	93	20	0	0	0	0	4	0	8	4
> MRP Trigger	Y	-	Y		Y		Y		N		N		N		Y	

The distribution of instantaneous temperature measured at the eight sites in Upper Penitencia Creek are shown in Figure 3.4. The acute temperature threshold (24.0 °C) is shown for comparison. Temperatures collected at all sites were generally below the acute threshold, with the exception site 114, which had approximately 12% of the data exceeding 24.0 °C. These exceedances coincided with period that discharge from percolation ponds were occurring during the months of June and July.

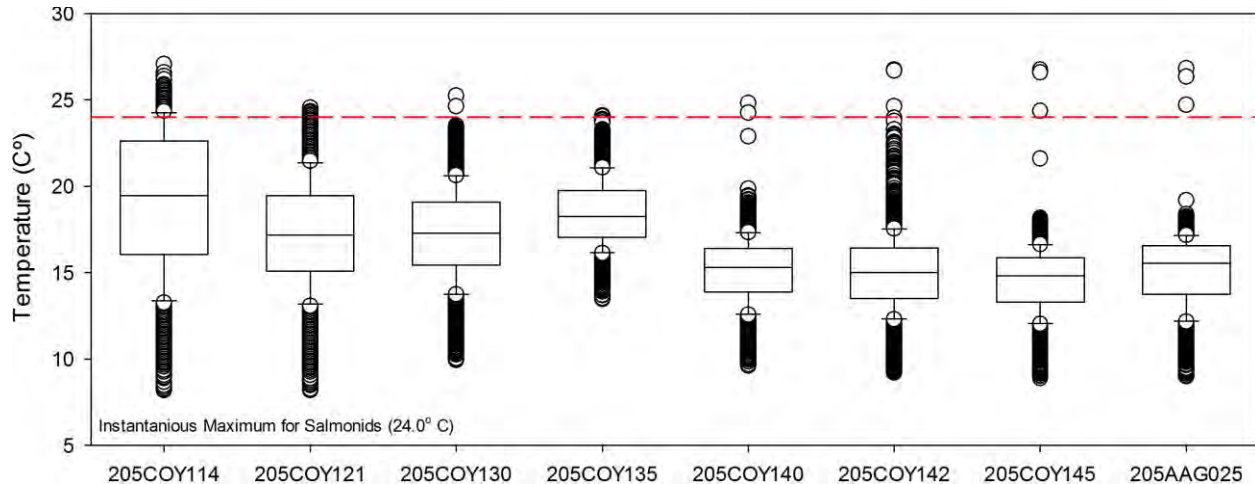


Figure 3.4. Box plots of water temperature data collected at eight stream locations in Upper Penitencia Creek, Santa Clara County, from April through September 2016.

The Basin Plan (SFRWQCB 2013) designates several Beneficial Uses for Upper Penitencia Creek that are associated with aquatic life uses, including COLD, WARM, MIGR, SPWN and RARE (Table 1.5). Furthermore, a limiting factors analysis study identified the reaches in Alum Rock Park as having the best quality steelhead spawning and juvenile rearing habitat within the Upper Penitencia Creek watershed (Stillwater 2006). The urban section of Upper Penitencia creek further downstream of Alum Rock Park is primarily a migrational corridor for steelhead. Stillwater (2006) identified potential low flow conditions reducing success of migrating steelhead smolts, especially in the urban reach, as the most important factor impacting success of migrating steelhead smolts.

Monitoring results from WY 2016 indicate that the upper reaches of Upper Penitencia Creek in Alum Rock Park have temperatures that support juvenile steelhead populations through the dry season. The MWAT (17 °C) threshold for steelhead was generally not exceeded at the four upper elevation sites (sites 140, 142, 145 and 25; Table 3.3). Site 25 exceeded the MWAT threshold for 2 of the 25 weeks of monitoring; however, one of those weeks was barely over the threshold (17.1 °C). The results were similar using the MWMT to evaluate temperature at the upper four sites; only one site (25) exceeded the MWMT threshold (20°C) for a single week.

Monitoring results indicate temperatures at the four lower elevation sites are not optimal for juvenile steelhead rearing habitat. However, with the exception of site 114, the remaining sites all had perennial flow that would allow juvenile steelhead to move further upstream in search of habitat with cooler temperatures. Longitudinal connectivity to areas where food is available can allow juvenile steelhead to increase feeding behavior and maintain optimal body weight to survive periods of warmer temperatures.

Site 114 is within an unconfined geological reach of Upper Penitencia Creek that contains alluvial deposits that percolates water into the underlying groundwater basin. As surface flows diminish during the late spring season, the creek typically dries up downstream Dorel Drive due to groundwater percolation. During WY 2016, stream flow at site 114 was present during spring and summer as the result of imported water getting released from the percolation ponds. The augmented water resulted in wetted channel for a short distance downstream (approximately Capital Expressway) until it percolated

into the groundwater basin. Due to antecedent drought conditions, the groundwater level was relatively low during WY 2016, resulting in majority of surface water percolating into the groundwater basin.

3.4.2 General Water Quality

Summary statistics for general water quality measurements collected at the three sites in Upper Penitencia Creek during two sampling events in W Y2016 are listed in Table 3.4. Sample Events 1 and 2 were conducted in April and June, respectively. Sampling locations are mapped in Figure 3.1. Plots for all water quality parameters collected during Event 1 are shown in Figure 3.5 and for Event 2 in Figure 3.6.

Some of the water quality data were not included in the analyses due to malfunction of one or more sensors. At site 114, the dissolved oxygen sensor malfunctioned during the first half of deployment in April, presumably due to fine sediment clogging the probe. All parameters measured during the June sampling event at site 117 were flagged and not used in the analysis due to dry channel conditions.

Table 3.4. Descriptive statistics for continuous water temperature, dissolved oxygen, pH, and specific conductance measured at sites in Upper Penitencia Creek, Santa Clara County during WY2016. Data were collected every 15 minutes over a two two-week time periods during April (Event 1) and June (Event 2).

Parameter	Data Type	114	117	121	114	117 ^b	121
		April WY2016			June WY2016		
Temperature (°C)	Min	10.3	9.9	9.9	19.2	11.9	13.3
	Median	14.5	14.0	13.6	21.6	16.8	17.5
	Mean	14.7	14.2	13.8	21.6	17.1	17.8
	Max	21.1	20.3	18.8	24.2	23.9	22.8
	% > 24 °C	0%	0%	0%	1%	0%	0%
Dissolved Oxygen (mg/L)	Min	8.0	8.9	9.0	8.0	0.5	7.2
	Median	9.9	10.4	10.4	8.8	9.8	8.8
	Mean	10.0	10.5	10.4	8.9	8.4	9.0
	Max	12.1	12.1	11.8	9.9	11.4	11.3
	% < 7 mg/L	0%	0%	0%	0%	0%	0%
pH	Min	7.9	8.4	8.2	7.7	7.3	8.2
	Median	8.1	8.5	8.5	8.0	8.2	8.3
	Mean	8.2	8.6	8.5	8.0	8.2	8.4
	Max	8.8	9.1	9.0	8.5	9.0	8.7
	% < 6.5 or 8.5	13%	50%	39%	0%	5%	28%
Specific Conductivity (uS/cm)	Min	240	65	507	286	485	977
	Median	722	630	721	305	583	1025
	Mean	705	626	699	305	600	1023
	Max	800	813	800	333	1028	1072
	% > 2000	0%	0%	0%	0%	0%	0%
Total number of data points (N)		1630 ^a	1621	1623	1252	1262	1261

^a Due to a sensor malfunction, the number of data points for dissolved oxygen was 1049.

^b Data collected at site 117 during Event 2 was affected by no or low flow conditions and were not used to assess exceedance of MRP trigger.

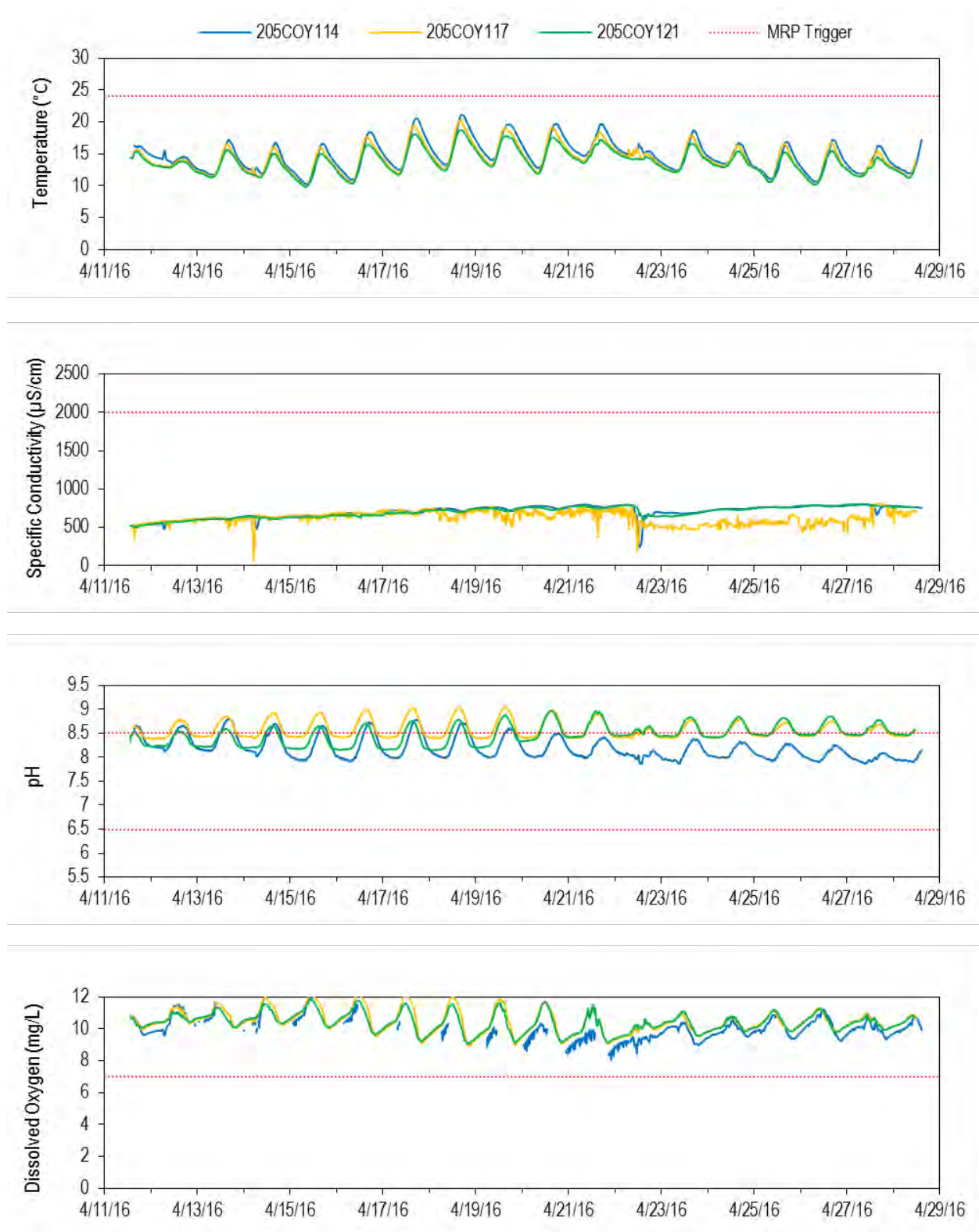


Figure 3.5 Continuous water quality data (temperature, specific conductance, pH, and dissolved oxygen) collected at three sites in Upper Penitencia Creek in April, 2016.

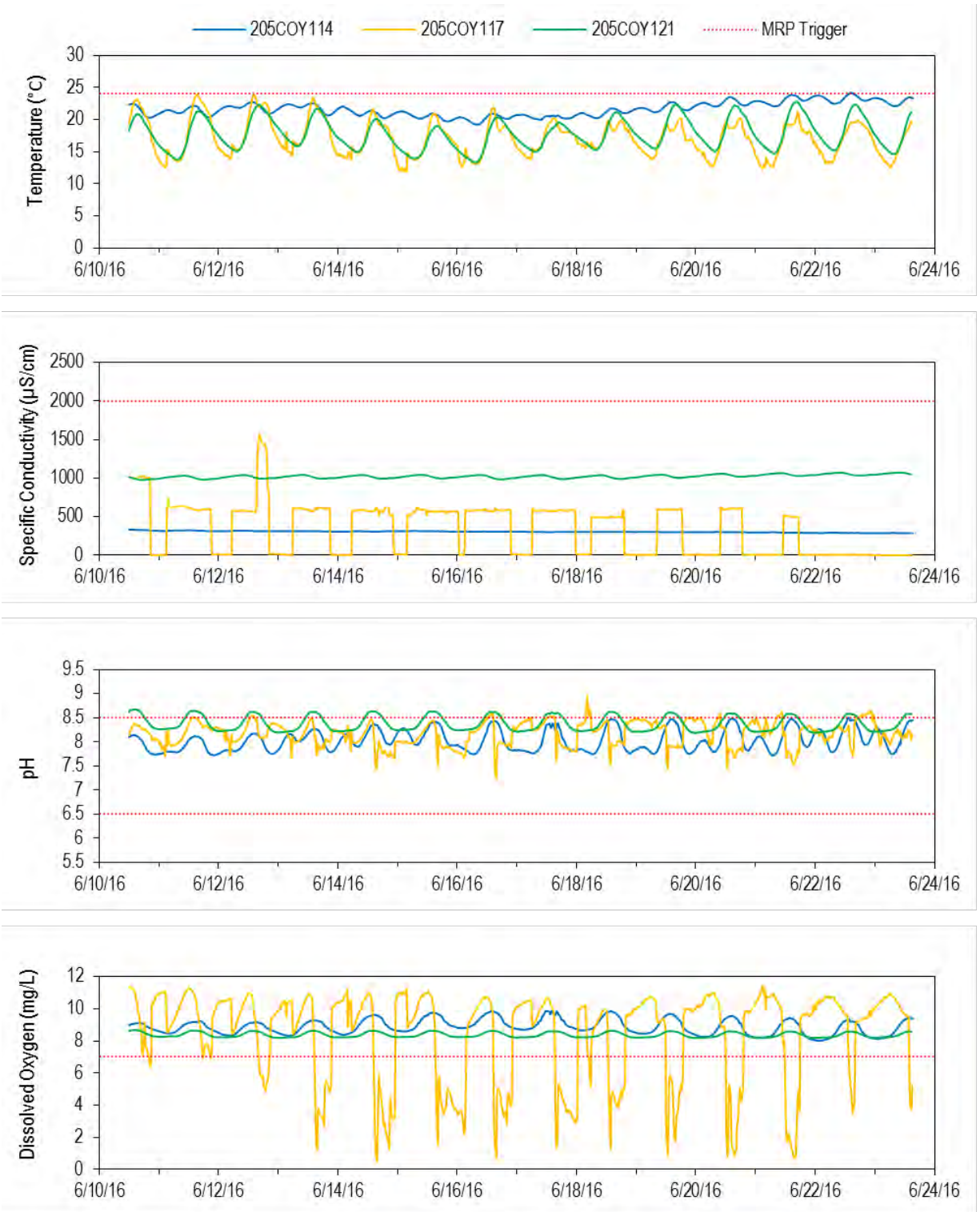


Figure 3.6 Continuous water quality data (temperature, specific conductance, pH, and dissolved oxygen) collected at three sites in Upper Penitencia Creek in June, 2016.

Temperature

Temperatures never exceeded the 24°C acute threshold for salmonids at any of the sites for either sampling event. MWAT was not calculated for temperature data collected by sondes due to limited number of data points (requires at least two 7 day periods to determine MRP trigger). However, MWAT was calculated for temperature data collected by hobos at sites 114 and 121 (see Section 3.4.1). The variability of temperatures at site 114 during Event 2 was much lower compared to other sites due to influence of water quality associated with the percolation pond discharge.

Dissolved Oxygen

Dissolved oxygen never dropped below WQOs for WARM or COLD Freshwater Habitat at any of the sites for both events, with the exception of site 117 in June. The DO sensor appeared to be affected by abrupt changes in flow and may have been periodically exposed to air and/or possible debris causing changes in flow. There was minimal flow at site 117 during sonde retrieval and the channel stopped flowing altogether by the end of June. As a result, this site will not be added to list of candidate SSID projects for DO.

pH

The MRP trigger for pH was exceeded at two monitoring locations. Site 121 (both events) and site 117 for April event had > 20% data greater than pH of 8.5. As a result, these two sites will be added to the list of candidate SSID projects. The pH was generally highest at the upper elevation site (121) for both events. The pH was reduced at site 114 midway through Event 1, possibly as a result of groundwater return flows associated with water diversion into the percolation ponds.

Specific Conductivity

Specific conductivity never exceeded the MRP trigger threshold (2000 µS) at the three sonde locations for either event.

Table 3.5. Exceedances of MRP water quality thresholds at three sites in Upper Penitencia Creek, Santa Clara County, WY 2016.

Site ID	Site Location	Monitoring Event	Temperature	Dissolved Oxygen	pH	Specific Conductivity
			Acute Trigger >20% results exceed 24°C	< 7 mg/L or < 5 mg/L	> 8.5 or < 6.5	> 2000 µS
114	Piedmont Av	April	No	No	No	No
		June	No	No	No	No
117	Noble Av	April	No	No	Yes	No
		June ¹	No	No	No	No
121	Dorel Dr	April	No	No	Yes	No
		June	No	No	Yes	No

¹ Data were flagged due to sensor readings getting impacted by dry channel conditions. The data were not used in the analysis.

3.4.3 Pathogen Indicators

Pathogen indicator densities measured in water samples in WY 2016 are listed in Table 3.6. Stations are mapped in Figure 3.3.

Table 3.6. Enterococcus and *E. coli* levels measured in Santa Clara County during WY 2016.

Site ID	Creek Name	Site Name	<i>Enterococcus</i> (cfu/100ml) (MPN/100ml) ¹	<i>E. Coli</i> (cfu/100ml) (MPN/100ml) ¹	Sample Date
<i>MRP Trigger Threshold (USEPA 2012b)</i>			130	410	
205R01731	Upper Penitencia Creek	Percolation Ponds	13	11	6/22/2016
205R02422	Arroyo Calero	Below Santa Therese Creek Confluence	110	340	6/22/2016
205R02458	Alamitos Creek	At Leland High School	140	280	6/22/2016
205R02474	Saratoga Creek	Wildwood Park	130	220	6/22/2016
205R02835	Upper Penitencia Creek	Alum Rock Park	140	110	6/22/2016

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

All five creeks monitored for pathogen indicators are designated for both contact (REC-1) and non-contact (REC-2) recreation Beneficial Uses. Although none of the stations could be considered “bathing beaches,” monitoring locations at each creek were selected at city parks or trails that were considered to exhibit high potential for public access. The MRP threshold for *E. coli* was not exceeded at any of the sites. The MRP threshold for enterococcus was exceeded at two sites. These will be added to the list of candidate SSID projects.

3.5 Conclusions and Recommendations

Targeted monitoring in WY 2016 was conducted in compliance with Provisions C.8.d.iii – v of the MRP. Hourly temperature measurements were recorded at eight sites in the Upper Penitencia Creek watershed from April through September. Continuous (15-minute) general water quality measurements (pH, DO, specific conductance, temperature) were recorded at two sites in the Upper Penitencia Creek watershed during two 2-week periods in May (Event 1) and September (Event 2). Pathogen indicator grab samples were collected during a sampling event in June at five probabilistic sites throughout Santa Clara County that coincide with public parks. Stations were deliberately selected using the Directed Monitoring Design Principle.

Conclusions and recommendations from targeted monitoring in WY 2016 are listed below. The sections below are organized on the basis of the management questions listed at the beginning of this section:

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

Spatial and Temporal Variability in Water Quality

- Median water temperatures continuously measured in the Upper Penitencia Creek watershed were generally coolest at the four upper elevation sites in Alum Rock Park. Temperatures became elevated at the four lower elevation sites between May and September 2016. Water temperatures were highest at site 114 when it was influenced by discharge from upstream percolation ponds.

Potential Impacts to Aquatic Life

- Potential impacts to aquatic life were assessed through analysis of continuous temperature data collected at eight targeted stations and continuous general water quality data (pH, dissolved oxygen, specific conductance, temperature) collected at three targeted stations.
- Five of the eight temperature stations in Upper Penitencia Creek exceeded the MRP trigger threshold of having two or more weeks where the maximum weekly average temperature (MWAT) exceeded 17°C. None of the stations exceeded the maximum instantaneous trigger threshold of 24°C.
- All stations with MWAT trigger exceedances will be added to the list of candidate SSID projects; however, review of the monitoring data in the context of the ongoing drought and locally-derived temperature thresholds developed by NMFS suggests that temperature is not a limiting factor for salmonid habitat (i.e., summer rearing juveniles) in the study reaches.
- The WQO for DO in waters designated as having cold freshwater habitat (COLD) beneficial uses (i.e., 7.0 mg/L) was met in all measurements recorded at the three water quality stations in Upper Penitencia Creek, with the exception of site 117, which had drops in DO that appeared to be related to significant drop in flow level during the dry season.
- Values for pH measured at the three sites in Upper Penitencia Creek during WY 2016 frequently exceeded the upper pH WQO of 8.5. As a result, all sites will be added to the list of potential SSID projects.
- Specific conductivity recorded at the three Upper Penitencia Creek sites in WY 2016 was consistently below the MRP trigger threshold of 2000 us/cm.

Potential Impacts to Water Contact Recreation

- Pathogen indicator densities were measured at five targeted sites during WY 2016. Although none of the stations could be considered “bathing beaches,” monitoring locations were selected at city parks or trails that were considered to have a relatively high potential for public access. MRP trigger thresholds for *E. coli* (410 cfu/100 ml) were not exceeded. MRP trigger thresholds for enterococcus (130 cfu/100 ml) were exceeded at two sites: one site on the Alamitos Creek at Leland High School and one on Upper Penitencia Creek at Alum Rock Park. These sites will be added to the list of candidate SSID projects.
- It is important to recognize that pathogen indicator thresholds are based on human recreation at beaches receiving bacteriological contamination from human wastewater, and may not be applicable to conditions found in urban creeks. Pathogen indicators observed at the WY 2016 stations may not be associated with human sources and therefore may not pose a threat to human health. As a result, the comparison of pathogen indicator results to water quality objectives and criteria for full body contact recreation, may not be appropriate and should be interpreted cautiously.

4.0 CHLORINE MONITORING

4.1 Introduction

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

In compliance with Creek Status Monitoring Provision C.8.d.ii and to assess whether the chlorine in receiving waters is potentially toxic to the aquatic life living there, SCVURPPP measured total and free chlorine residual in urban creeks. Total chlorine residual is comprised of combined and free chlorine, and is always 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.

4.2 Methods

In accordance with the MRP and the BASMAA RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012), WY 2016 field testing for free chlorine and total chlorine residual was conducted at all 20 probabilistic sites concurrent with spring bioassessment sampling (April-May). Probabilistic site selection methods are described in Section 2.0.

Field testing for free and total chlorine residual conformed to methods and procedures described in the BASMAA RMC SOPs (BASMAA 2016b), which are comparable to those specified in the SWAMP QAPP. Per SOP FS-3 (BASMAAS 2016b), water samples were collected and analyzed for free and total chlorine using a Pocket Colorimeter™ II and DPD Powder Pillows, which has a method detection limit of 0.02 mg/L. If concentrations exceed the trigger criteria of 0.1 mg/L, the site was immediately resampled. Per Provision C.8.d.ii(4) of the MRP, “if the resample is still greater than 0.1 mg/L, then Permittees report the observation to the appropriate Permittee central contact point for illicit discharges to that the illicit discharge staff can investigate and abate the associated discharge in accordance with its provision C.5.e – Spill and Dumping Complaint Response Program.”

4.3 Results

In WY 2016, SCVURPPP monitored the 20 probabilistic sites for free chlorine and total chlorine residual. These measurements were compared to the MRP trigger threshold of 0.1 mg/L.¹⁸ Results are listed in Table 4.1.

The Lower Silver Creek sample (and the resample) on June 3, 2016 exceeded the threshold of 0.1 mg/L for free chlorine and total chlorine residual. The field crew noted nearby active construction activities which may have been related to the chlorine observations. SCVURPPP staff immediately informed City of San Jose Watershed Protection Division staff and the Senior Environmental Inspector. City staff indicated that the report would be logged and an environmental inspector would be sent out to inspect the construction site. City staff reported that follow-up measurements were at or below the MRP trigger and determined that either the source of the higher readings had stopped, or that the original results were in error.

¹⁸ For reference, the Statewide General Permit for Drinking Water Discharges (Order WQ 2014-0194-DWQ) uses 0.1 mg/L as a reporting limit (minimum level) for field measurements of total residual chlorine.

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Table 4.1. Summary of SCVURPPP chlorine testing results compared to MRP trigger of 0.1 mg/L, WY 2016.

Station Code	Date	Creek	Free Chlorine (mg/L) ^{1, 2}	Total Chlorine Residual (mg/L) ^{1, 2}	Exceeds Trigger Threshold? ³ (0.1 mg/L)
205R00213	4/27/2016	Cow Creek	< 0.02	0.03	No
205R00305	4/27/2016	San Felipe Creek	< 0.02	0.05	No
205R00578	4/26/2016	Arroyo Aguague	0.09 / 0.07	0.05	No
205R01114	5/3/2016	Guadalupe River	0.02	0.05	No
205R01731	5/5/2016	Upper Penitencia Creek	0.03	0.03	No
205R02330	5/3/2016	Ross Creek	0.02	0.06	No
205R02422	5/4/2016	Arroyo Calero	0.02	0.02	No
205R02458	5/4/2016	Alamitos Creek	0.03	0.04	No
205R02474	5/18/2016	Saratoga Creek	0.03	0.05	No
205R02538	5/18/2016	Calabazas Creek	0.03	0.03	No
205R02547	6/1/2016	Stevens Creek	< 0.02	0.02	No
205R02563	5/19/2016	Los Gatos Creek	< 0.02	-	No
205R02602	6/2/2016	Unnamed Trib	0.02	0.02	No
205R02618	5/2/2016	Aldercroft Creek	< 0.02	0.04	No
205R02650	5/31/2016	Alamitos Creek	0.02	0.04	No
205R02659	5/19/2016	Stevens Creek	< 0.02	0.02	No
205R02730	6/1/2016	Saratoga Creek	0.06	0.05	No
205R02762	6/2/2016	Ross Creek	0.04	< 0.02	No
205R02771	6/3/2016	Lower Silver Creek	0.26 / 0.25	0.40 / 0.91	Yes
205R02835	5/5/2016	Upper Penitencia Creek	< 0.02	< 0.02	No

¹ The method detection limit is 0.02 mg/L.

² Original and repeat samples are reported where conducted. The first value is the original result.

³ The MRP trigger threshold applies to both free chlorine and total chlorine residual measurements.

4.4 Conclusions and Recommendations

While chlorine residual is generally not a concern in Santa Clara Valley urban creeks, WY 2016 and prior monitoring results suggest there are occasional free chlorine and total chlorine exceedances in the County. Exceedances are likely the result of one-time potable water discharges and it is generally very difficult to determine the source of elevated chlorine from such episodic discharges. The Program will continue to monitor chlorine in compliance with the MRP and will follow-up with illicit discharge staff as needed.

5.0 TOXICITY AND SEDIMENT CHEMISTRY MONITORING

5.1 Introduction

Toxicity testing provides a tool for assessing toxic effects (acute and chronic) of all the chemicals in samples of receiving waters or sediments and allows the cumulative effect of the pollutants present in the sample to be evaluated. Because different test organisms are sensitive to different classes of chemicals and pollutants, several different organisms are monitored. Sediment 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 they be found.

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

Dry Weather

The Program is required to conduct water toxicity and sediment chemistry and toxicity monitoring at two locations during the dry season, each year of the permit term beginning in WY 2016. The water and sediment samples do not necessarily need to be collected at the same locations. The permit provides examples of possible monitoring locations, including sites with suspected or past toxicity results, or existing bioassessment sites.

- Toxicity testing in water is required 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 in sediment is required using two species: *Hyella azteca* (survival) and *Chironomus dilutus* (survival).
- Sediment chemistry analytes include pyrethroids, fipronil, carbaryl, total Polycyclic aromatic hydrocarbons (PAHs), metals, Total Organic Carbon (TOC) and sediment grain size.

Wet Weather

The wet weather monitoring requirements include collection of water column samples for toxicity testing and analysis of pyrethroids, fipronil, imidacloprid and indoxacarb. The permit states that sample event(s) must occur during wet weather, but does not specify whether a “storm event” must be sampled. The permit states that monitoring locations should be representative of urban watersheds (i.e., bottom of watersheds).

The permit states that if the wet season monitoring is conducted by the RMC on behalf of all Permittees, a total of ten samples are required over the permit term, with at least six samples collected by WY 2018. At the RMC Monitoring Workgroup meeting on January 25, 2016, RMC members agreed to collaborate on implementation of the wet weather monitoring requirements. The first wet weather samples will occur in WY 2018. The RMC is still in the process of allocating sample sites and developing a monitoring approach. The assumption is that SCVURPPP will be responsible for collecting three wet weather samples during the permit term.

Toxicity and pesticides monitoring methods and results are described in the sections below.

5.2 Methods

5.2.1 Site Selection

In WY 2016, in compliance with MRP Provision C.8.g.i, water and sediment toxicity and sediment chemistry samples were collected from two sites during dry weather: Stevens Creek and San Thomas

Aquino (see Figure 1.2). Sites were selected to represent urban watersheds that are not already being monitored for toxicity or pesticides by other programs, such as the SWAMP Stream Pollution Trends (SPoT) program or the California Department of Pesticide Regulation (DPR) Surface Water Protection Program Monitoring (SWPP). Specific stations within the watersheds were identified based on the likelihood that they would contain fine depositional sediments during dry season sampling and would be safe to access during future wet weather sampling. It is anticipated that SCVURPPP will continue to sample the same two stations throughout the permit term with the goal of building a long-term dataset that compliments data being gathered through SWAMP SPoT and DPR SWPP.

5.2.2 Sample Collection

Before conducting sampling, field personnel surveyed the proposed sampling area for appropriate fine-sediment depositional areas. Personnel carefully entered the stream to avoid disturbing sediment at collection sub-sites.

Water samples were collected using standard grab sampling methods. The required number of 4-L 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 24-hour sample hold time. Procedures used for sampling and transporting water samples are described in SOP FS-2 (BASMAA 2016b).

Sediment samples were collected from the top 2 cm at each sub-site beginning at the downstream-most location and continuing upstream. Sediment samples were placed in a compositing container, thoroughly homogenized, and then aliquoted into separate jars for chemical or toxicological analysis using standard clean sampling techniques (see SOP FS-6, BASMAA 2016b).

Sample were submitted to respective laboratories and field data sheets were reviewed per SOP FS-13 (BASMAA 2016b).

5.2.3 Data Evaluation

Water and Sediment Toxicity

Data evaluation required by the MRP involves first determining whether the samples are toxic to the test organisms relative to the laboratory control treatment via statistical comparison using the Test of Significant Toxicity (TST) statistical approach. For samples with toxicity (i.e., those that “failed” the TST), the Percent Effect is evaluated. The Percent Effect compares sample endpoints (survival, reproduction, growth) to the laboratory control endpoints. Follow-up sampling is required if any test organism is reported as “fail” and the Percent Effect is $\geq 50\%$ Percent Effect. Both the TST result and the Percent Effect are determined by the laboratory.

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 was equal to or greater than 1.0 were identified and added to the list of candidate SSID projects.

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. Therefore, some of the calculated numbers for 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 they 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 and fipronil results, based on available literature values for pyrethroids in sediment LC50 values.^{19,20} Because organic carbon mitigates the toxicity of pyrethroid and fipronil 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.

5.3 Results and Discussion

5.3.1 Toxicity

Table 5.1 provides a summary of toxicity testing results for WY 2016 dry weather water and sediment samples. Based on the results, it is not necessary to add the sites to the list of potential SSID projects.

- **San Tomas Aquino (205STQ010).** The water sample collected from San Tomas Aquino was not significantly toxic to any of the test organisms. The sediment sample was found to be significantly toxic to *Chironomus dilutus* (survival); however, the Percent Effect did not exceed the 50% threshold for follow-up.
- **Stevens Creek (205STE021).** The water sample collected from Stevens Creek was found to be significantly toxic to *Chironomus dilutus* (survival) and *Pinephales promelas* (survival); however, the Percent Effect of both tests was less than the 50% threshold for follow-up. The sediment sample was not significantly toxic to any of the test organisms.

The cause of the water and sediment toxicity is unknown; however, the midge, *Chironomus dilutus*, has been shown to be the most sensitive species to newer classes of pesticides such as imidacloprid (a neonicotinoid) and fipronil and its degradates (SWAMP 2016). Imidacloprid is not included in the list of required dry weather analytical constituents but will be required in water samples collected during wet weather. Fipronil was analyzed in WY 2016 dry weather sediment samples. The concentration of fipronil was below the method detection limit in both the San Tomas Aquino and Stevens Creek samples.

¹⁹ The LC50 is the concentration of a given chemical that is lethal on average to 50% of test organisms.

²⁰ No LC50 is published for carbaryl.

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Table 5.1. Summary of SCVURPPP toxicity results for WY 2016.

Site	Organism	Test Type	Unit	Results		TST Result	% Effect	Follow up needed (TST "Fail" and $\geq 50\%$)
				Lab Control	Organism Test			
205STQ010 San Tomas Aquino	Water							
	<i>Ceriodaphnia dubia</i>	Survival	%	90	100	Pass ¹	-11.1%	No
		Reproduction	Num/Rep	34.7	32.1	Pass	7.49%	No
	<i>Pimephales promelas</i>	Survival	%	92.5	91.9	Pass	0.68%	No
		Growth	mg/ind	0.626	0.677	Pass	-8.12%	No
	<i>Chironomus dilutus</i>	Survival	%	100	95	Pass	5%	No
	<i>Hyalella azteca</i>	Survival	%	98	98	Pass	0%	No
	<i>Selenastrum capricornutum</i>	Growth	cells/ml	1620000	2700000	Pass	-66.7%	No
	Sediment							
	<i>Chironomus dilutus</i>	Survival	%	92.5	76.3	Fail	17.6%	No
<i>Hyalella azteca</i>	Survival	%	100	96.3	Pass	3.75%	No	
205STE021 Stevens Creek	Water							
	<i>Ceriodaphnia dubia</i>	Survival	%	90	100	Pass ¹	-11.1%	No
		Reproduction	Num/Rep	34.7	32.4	Pass	6.50%	No
	<i>Pimephales promelas</i>	Survival	%	92.5	67.5	Fail	27%	No
		Growth	mg/ind	0.626	0.605	Pass	3.35%	No
	<i>Chironomus dilutus</i>	Survival	%	100	70	Fail	30%	No
	<i>Hyalella azteca</i>	Survival	%	98	100	Pass	-2.04%	No
	<i>Selenastrum capricornutum</i>	Growth	cells/ml	1620000	3120000	Pass	-92.3%	No
	Sediment							
	<i>Chironomus dilutus</i>	Survival	%	92.5	81.3	Pass	12.2%	No
<i>Hyalella azteca</i>	Survival	%	100	98.8	Pass	1.25%	No	

¹ TST analysis is not performed for survival endpoint - a percent effect <25% is considered a "Pass", and a percent effect $\geq 25\%$ is considered a "Fail"

5.3.2 Sediment Chemistry

Sediment chemistry results are evaluated as potential stressors based on TEC quotients and PEC quotients according to criteria in provision C.8.g.iv of the MRP. SCVURPPP also evaluated TU equivalents of pyrethroids.

Table 5.2 lists TEC quotients for all non-pyrethroid, fipronil, and carbaryl sediment chemistry constituents, calculated as the measured concentration divided by the highly conservative TEC value, per MacDonald et al. (2000)²¹. TECs are extremely conservative and are intended to identify concentrations below which harmful effects on sediment-dwelling organisms are unlikely to be observed. Both of the sites exceeded the relevant trigger criterion from the MRP of having at least one result exceeding the TEC and will be added to the list of potential SSID projects. In both creeks, there were TEC exceedances of chromium and nickel as expected in watersheds draining hillsides underlain by serpentinite formations. In Stevens Creek (205STE021), the TEC for copper was also exceeded.

Table 5.3 provides PEC quotients for all non-pyrethroid, fipronil, and carbaryl sediment chemistry constituents, and calculated mean values of the PEC quotients for each site. PECs are intended to identify concentrations above which toxicity to benthic-dwelling organisms are predicted to be probable. Neither of the sites had any PEC quotient equal to or greater than 1.0.

Table 5.4 provides a summary of the calculated TU equivalents for the pesticides for which there are published LC50 values in the literature²². Because organic carbon mitigates the toxicity of pyrethroids and fipronil in sediments, the LC50 values were derived on the basis of TOC-normalized pyrethroid concentrations. Similarly, the constituent concentrations as reported by the lab were divided by the measured TOC concentration at each site, and the TOC-normalized concentrations were used to compute TU equivalents. Although no TU equivalents exceeded 1.0, the highest TU equivalent in both samples was calculated for bifenthrin (0.78). Bifenthrin is considered to be the leading cause of pyrethroid-related toxicity in urban areas (Ruby 2013).

In compliance with the MRP, a grain size analysis was conducted on both of the sediment samples (Table 5.5). The Stevens Creek (205STE021) sample was 8% fines (i.e., 4% clay and 4% silt); whereas the San Tomas Aquino (205STQ010) sample was 15% fines (i.e., 6% clay and 9% silt). It unknown whether these differences in percent fines influenced the toxicity tests or sediment chemistry analysis and evaluation.

²¹ MacDonald et al. (2000) does not provide TEC or PEC values for pyrethroids, fipronil, or carbaryl. Pyrethroids are compared to LC50 values in Table 5.4. However, LC50 values for fipronil and carbaryl in sediment have not been published.

²² Although an LC50 value has not been published for carbaryl, the carbaryl concentration is included in Table 5.4.

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Table 5.2. Threshold Effect Concentration (TEC) quotients for WY 2016 sediment chemistry constituents. Bolded and shaded values indicate TEC quotient ≥ 1.0 .

	Site ID Creek	TEC	WY 2016	
			205STE021	205STQ010
			Stevens Creek	San Tomas Aquino
Metals (mg/kg DW)				
Arsenic		9.79	0.30	0.26
Cadmium		0.99	0.21	0.14
Chromium		43.4	1.7	1.1
Copper		31.6	1.23	0.8
Lead		35.8	0.39	0.28
Nickel		22.7	3	2.1
Zinc		121	0.81	0.58
PAHs (ug/kg DW)				
Anthracene		57.2	0.09	0.03 ^a
Fluorene		77.4	0.04 ^b	0.02 ^a
Naphthalene		176	0.01 ^a	0.01 ^a
Phenanthrene		204	0.20	0.10
Benz(a)anthracene		108	0.09	0.04 ^b
Benzo(a)pyrene		150	0.05	0.01 ^a
Chrysene		166	0.31	0.12
Dibenz[a,h]anthracene		33.0	0.05 ^a	0.05 ^a
Fluoranthene		423	0.19	0.05
Pyrene		195	0.37	0.10
Total PAHs		1,610	0.21 ^c	0.08 ^c

a. Concentration was below the method detection limit (MDL). TEC quotient calculated using 1/2 MDL.

b. TEC quotient calculated from concentration below the reporting limit (DNO-flagged).

c. Total calculated using 1/2 MDLs.

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Table 5.3. Probable Effect Concentration (PEC) quotients for WY 2016 sediment chemistry constituents. No PEC quotients exceeded 1.0.

	Site ID	PEC	205STE021	205STQ010
	Creek		Stevens Creek	San Tomas Aquino
Metals (mg/kg DW)				
Arsenic		33.0	0.09	0.08
Cadmium		4.98	0.04	0.03
Chromium		111	0.6	0.41
Copper		149	0.26	0.17
Lead		128	0.11	0.08
Nickel		48.6	1.3	1.0
Zinc		459	0.21	0.15
PAHs (ug/kg DW)				
Anthracene		845	0.01	0.00 ^a
Fluorene		536	0.01 ^b	0.00 ^a
Naphthalene		561	0.00 ^a	0.00 ^a
Phenanthrene		1170	0.04	0.02
Benz(a)anthracene		1050	0.01	0.00 ^b
Benzo(a)pyrene		1450	0.01	0.00 ^a
Chrysene		1290	0.04	0.02
Fluoranthene		2230	0.04	0.01
Pyrene		1520	0.05	0.01
Total PAHs		22,800	0.01 ^c	0.01 ^c

a. Concentration was below the method detection limit (MDL). PEC quotient calculated using 1/2 MDL.

b. PEC quotient calculated from concentration below the reporting limit (DNQ-flagged).

c. Total calculated using 1/2 MDLs.

Table 5.4. Calculated pyrethroid toxic unit (TU) equivalents for WY 2016 pesticide concentrations.

Pyrethroid	Units	LC50	WY 2016	
			205STE021	205STQ010
			Stevens Creek	San Tomas Aquino
Bifenthrin	µg/g dw	0.52	0.78	0.39
Cyfluthrin	µg/g dw	1.08	0.13	0.15
Cypermethrin	µg/g dw	0.38	0.03 ^b	0.15 ^b
Deltamethrin	µg/g dw	0.79	0.19	0.11 ^b
Esfenvalerate	µg/g dw	1.54	0.02 ^b	0.02 ^a
Lambda-Cyhalothrin	µg/g dw	0.45	0.03 ^b	0.03 ^a
Permethrin	µg/g dw	10.83	0.03	0.03
Other MRP Pesticides of Concern				
Carbaryl	mg/Kg dw	NA ^e	NA ^c	NA ^c
Fipronil	ng/g dw	410	0.01 ^b	0.01 ^b

^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 (DNO-flagged).

^c Currently there is no available LC50 value for Carbaryl, however the observed concentration was below the detection limit.

Table 5.5. Summary of grain size for the two locations sampled in Santa Clara during WY 2016.

Grain Size (%)		205STE021	205STQ010
		Stevens Creek	San Tomas Aquino
Clay	<0.0039 mm	4%	6%
Silt	0.0039 to <0.0625 mm	4%	9%
Sand	V. Fine 0.0625 to <0.125 mm	29%	20%
	Fine 0.125 to <0.25 mm	27%	25%
	Medium 0.25 to <0.5 mm	6%	13%
	Coarse 0.5 to <1.0 mm	11%	13%
	V. Coarse 1.0 to <2.0 mm	19%	15%
Granule	2.0 to <4.0 mm	13%	12%
Pebble	Small 4 to <8 mm	2%	0%
	Medium 8 to <16 mm	0%	4%
	Large 16 to <32 mm	0%	0%
	V. Large 32 to <64 mm	0%	25%

5.4 Conclusions and Recommendations

Statistically significant toxicity to *Chironomus dilutus* was observed either water or sediment samples collected from both sites during dry weather; however, the magnitude of the toxic effects in the samples compared to laboratory controls were not great and did not exceed MRP trigger criteria. Although the midge, *Chironomus dilutus*, has been observed to be sensitive to fipronil, fipronil concentrations measured in sediment samples collected concurrently with the water and sediment toxicity samples were below the method detection limit.

TEC and PEC quotients were calculated for all metals and PAHs measured in sediment samples. Both sites had at least one TEC or PEC quotient exceeding 1.0. In compliance with the MRP, both stations will therefore be placed on the list of candidate SSID projects. Decisions about which SSID projects to pursue should be informed by the fact that most of the TEC and PEC quotient exceedances are related to naturally occurring chromium and nickel.

6.0 CONCLUSIONS AND RECOMMENDATIONS

In WY 2016, 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 two-component monitoring design that was initiated in WY 2012. The strategy includes a regional ambient/"probabilistic" bioassessment monitoring component and a component based on local "targeted" monitoring for general water quality parameters and pesticides/toxicity. The combination of these monitoring designs allows each individual RMC participating program to assess the status of Beneficial Uses in local creeks within its Program (jurisdictional) area, while also contributing data to eventually answer management questions at the regional scale (e.g., differences between aquatic life condition in urban and non-urban creeks).

The following conclusions from the MRP Creek Status and Pesticides/Toxicity Monitoring conducted during WY 2016 in Santa Clara County are based on the management questions presented in Section 1.0 of this report:

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

The first management question is addressed primarily through the evaluation of probabilistic and targeted monitoring data with respect to the triggers defined in the MRP. A summary of trigger exceedances observed for each site is presented in Table 6.1. 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 (SSID) projects.

The second management question is addressed primarily by assessing indicators of aquatic biological health using benthic macroinvertebrate and algae data collected at probabilistic sites. Biological condition scores were compared to physical habitat and water quality data collected synoptically with bioassessments to evaluate whether any correlations exist that may explain the variation in biological condition scores.

6.1 Conclusions

6.1.1 Bioassessment Monitoring

Probabilistic Survey Design

- Site evaluations were conducted at a total of 76 potential probabilistic sites in Santa Clara County during WY 2016. Of these sites, a total of twenty were sampled in WY 2016 (rejection rate of 74%). Three of the twenty sites (15%) were classified as non-urban land use.
- Between WY 2012 and WY 2016, a total of 112 probabilistic sites were sampled by SCVURPPP (n=100) and SWAMP (n=12)²³ in Santa Clara County, including 87 urban and 25 non-urban sites.
- There is a sufficient number of samples from probabilistic sites to develop estimates of biological condition and stressor assessment for urban streams in Santa Clara County (in development). More samples are needed to estimate biological condition at more local scales (e.g., watershed and jurisdictional areas).

Biological Condition Assessment (WY 2016)

- The California Stream Condition Index (CSCI) tool was used to assess the biological condition. The CSCI translates benthic macroinvertebrate data into an overall measure of stream health. Of

²³ The data from three SWAMP samples collected in WY 2015 were not available for analyses in this report. Data results from nine probabilistic sites sampled by SWAMP are included in this report.

the 20 sites monitored in WY 2016, five sites (25%) were rated likely intact or possibly intact (CSCI scores ≥ 0.795); five sites rated as likely altered condition (CSCI score $0.635 - 0.795$), and ten sites rated as very likely altered condition (≤ 0.635).

- The 15 sites with CSCI scores less than the trigger threshold of 0.795 will be added to the list of candidate SSID projects.
- Diatoms were relatively well represented across all sites ranging from 15 to 61 taxa. Soft algae taxa were less common across sites, ranging from 1 to 10 taxa. Seven of the sites (30%) had three or less soft algae taxa.
- Three algae IBI metrics were used to evaluate stream condition using benthic algae data collected synoptically with BMIs. These include D18 (diatoms), S2 (soft algae), and H20 (combination of diatoms and algae). Eight sites were ranked likely intact or possibly intact based on D18 scores ($D18 \geq 62$). Two sites were ranked likely intact or possibly intact based on S2 scores ($S2 \geq 47$) and one site was ranked likely intact or possibly intact based on H20 scores ($H20 \geq 63$).

Biological Condition Assessment (WY 2012-WY 2016)

- CSCI scores were calculated for the five-year Santa Clara County probabilistic data set ($n=112$). Condition ranking of likely intact or possibly intact (CSCI score > 0.795) occurred at 11% of the urban sites and 52% of non-urban sites.
- There was no significant difference in median CSCI scores between perennial ($n=85$) and non-perennial ($n=27$) sites. Median algal IBI scores were slightly higher at non-perennial sites.
- The CSCI and three algae IBI tools were relatively consistent in their response across an urban gradient, with generally lower median scores associated with higher percent imperviousness.
- CSCI scores were better correlated with site elevation ($r^2 = 0.34$) compared to D18 scores ($r^2 = 0.18$), suggesting that physical habitat variables associated with changing elevation (e.g., stream gradient, substrate size) have greater influence on the BMI community compared to diatom assemblages.

Stressor Assessment

- Potential stressors (nutrients, algal biomass indicators, conventional analytes) were measured in samples collected concurrently with bioassessments which are conducted in the spring season. Physical habitat parameters were also observed during bioassessments. Other potential stressors (e.g., percent urbanization/imperviousness in contributing catchments) were calculated in GIS.
- The association of potential stressors with biological condition scores collected over five years was assessed using the Spearman rank method and random forests. Land use variables (percent impervious and urban), chloride, temperature and specific conductivity showed significant negative correlations with CSCI scores. Two PHAB parameters (epifaunal substrate score and channel alteration score) were significantly positively correlated with CSCI scores.
- Water quality objectives were generally not exceeded in WY 2016.

Trend Assessment

- Trend analysis for the RMC probabilistic survey will require more than five years of data collection. Preliminary long-term trend analysis of biological condition may be possible for some stream reaches using a combination of historical targeted data with the probabilistic data.
- Targeted re-sampling at probabilistic sites can provide additional data to evaluate longer term trends at selected locations.

6.1.2 Targeted Monitoring for Temperature and General Water Quality

Spatial and Temporal Variability in Water Quality

- Median water temperatures continuously measured in the Upper Penitencia Creek watershed were generally coolest at the four upper elevation sites in Alum Rock Park. Temperatures became elevated at the four lower elevation sites between May and September 2016. Water temperatures were highest at site 114 when it was influenced by discharge from upstream percolation ponds.

Potential Impacts to Aquatic Life

- Potential impacts to aquatic life were assessed through analysis of continuous temperature data collected at eight targeted stations and continuous general water quality data (pH, dissolved oxygen, specific conductance, temperature) collected at three targeted stations.
- Five of the eight temperature stations in Upper Penitencia Creek exceeded the MRP trigger threshold of having two or more weeks where the maximum weekly average temperature (MWAT) exceeded 17°C. None of the stations exceeded the maximum instantaneous trigger threshold of 24°C.
- All stations with MWAT trigger exceedances will be added to the list of candidate SSID projects; however, review of the monitoring data in the context of the ongoing drought and locally-derived temperature thresholds developed by NMFS suggests that temperature is not a limiting factor for salmonid habitat (i.e., summer rearing juveniles) in the study reaches.
- The WQO for DO in waters designated as having cold freshwater habitat (COLD) beneficial uses (i.e., 7.0 mg/L) was met in all measurements recorded at the three water quality stations in Upper Penitencia Creek, with the exception of site 117, which had drops in DO that appeared to be related to significant drop in flow level during the dry season.
- Values for pH measured at the three sites in Upper Penitencia Creek during WY 2016 frequently exceeded the upper pH WQO of 8.5. As a result, all sites will be added to the list of potential SSID projects.
- Specific conductivity recorded at the three Upper Penitencia Creek sites in WY 2016 was consistently below the MRP trigger threshold of 2000 us/cm.

Potential Impacts to Water Contact Recreation

- Pathogen indicator densities were measured at five targeted sites during WY 2016. Although none of the stations could be considered “bathing beaches,” monitoring locations were selected at city parks or trails that were considered to have a relatively high potential for public access. MRP trigger thresholds for *E. coli* (410 cfu/100 ml) were not exceeded. MRP trigger thresholds for enterococcus (130 cfu/100 ml) were exceeded at two sites: one site on the Alamitos Creek at Leland High School and one on Upper Penitencia Creek at Alum Rock Park. These sites will be added to the list of candidate SSID projects.
- It is important to recognize that pathogen indicator thresholds are based on human recreation at beaches receiving bacteriological contamination from human wastewater, and may not be applicable to conditions found in urban creeks. Pathogen indicators observed at the WY 2016 stations may not be associated with human sources and therefore may not pose a threat to human health. As a result, the comparison of pathogen indicator results to water quality objectives and criteria for full body contact recreation, may not be appropriate and should be interpreted cautiously.

6.1.3 Chlorine Monitoring

Monitoring of total and free chlorine residual at probabilistic stations was conducted in compliance with provision C.8.d.ii of the MRP.

While chlorine residual is generally not a concern in Santa Clara Valley urban creeks, WY 2016 and prior monitoring results suggest there are occasional free chlorine and total chlorine exceedances in the County. The Program will continue to monitor chlorine in compliance with the MRP and will follow-up with illicit discharge staff as needed.

6.1.4 Pesticides and Toxicity Monitoring

In WY 2016, SCVURPPP conducted dry weather pesticides and toxicity monitoring at two stations in compliance with provision C.8.g of the MRP.

Statistically significant toxicity to *Chironomus dilutus* was observed either water or sediment samples collected from both sites during dry weather; however, the magnitude of the toxic effects in the samples compared to laboratory controls were not great and did not exceed MRP trigger criteria. Although the midge, *Chironomus dilutus*, has been observed to be sensitive to fipronil, fipronil concentrations measured in sediment samples collected concurrently with the water and sediment toxicity samples were below the method detection limit.

TEC and PEC quotients were calculated for all metals and PAHs measured in sediment samples. Both sites had at least one TEC or PEC quotient exceeding 1.0. In compliance with the MRP, both stations will therefore be placed on the list of candidate SSID projects. Decisions about which SSID projects to pursue should be informed by the fact that most of the TEC and PEC quotient exceedances are related to naturally occurring chromium and nickel.

SCVURPPP will continue to sample the same two stations for dry weather pesticides and toxicity throughout the permit term. In WY 2018, SCVURPPP anticipates working with the BASMAA RMC partners on a regional approach to wet weather pesticides and toxicity monitoring.

6.2 Trigger Assessment

The MRP requires analysis of the monitoring data to identify candidate sites for SSID projects. Trigger thresholds against which to compare the data are provided for most monitoring parameters in the MRP and are described in the foregoing sections of this report. Stream condition was determined based on CSCI scores that were calculated using BMI data. Water and sediment chemistry and toxicity data were evaluated using numeric trigger thresholds specified in the MRP. Nutrient data were evaluated using applicable water quality standards from the Basin Plan. In compliance with provision C.8.e.i of the MRP, all monitoring results exceeding trigger thresholds are added to a list of candidate SSID projects that will be maintained throughout the permit term. Follow up SSID projects will be selected from this list. Table 6.1 lists candidate SSID projects based on WY 2016 Creek Status and Pesticides/Toxicity monitoring data.

Additional analysis of the data is provided in the foregoing 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.

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Table 6.1. Summary of SCVURPPP Trigger Threshold Exceedance Analysis, WY 2016. “No” indicates samples were collected but did not exceed the MRP trigger; “Yes” indicates an exceedance of the MRP trigger.

Probabilistic Station Number	Targeted Station Number	Creek	Bioassessment ¹	Nutrients ²	Chlorine	Water Toxicity	Sediment Toxicity	Sediment Chemistry	Continuous Temperature	Continuous WQ	Pathogen Indicators
205R00213		Cow Creek	Yes	No	No	--	--	--	--	--	--
205R00305		San Felipe Creek	No	No	No	--	--	--	--	--	--
205R00578		Arroyo Aguague	Yes	No	No	--	--	--	--	--	--
205R01114		Guadalupe River	Yes	No	No	--	--	--	--	--	--
205R01731	205COY117	Upper Penitencia Creek	Yes	No	No	--	--	--	--	Yes	No
205R02330		Ross Creek	Yes	No	No	--	--	--	--	--	--
205R02422	205GUA329	Arroyo Calero	Yes	No	No	--	--	--	--	--	No
205R02458	205GUA262	Alamitos Creek	Yes	No	No	--	--	--	--	--	Yes
205R02474	205SAR075	Saratoga Creek	No	No	No	--	--	--	--	--	No
205R02538		Calabazas Creek	Yes	No	No	--	--	--	--	--	--
205R02547		Stevens Creek	No	No	No	--	--	--	--	--	--
205R02563		Los Gatos Creek	Yes	No	No	--	--	--	--	--	--
205R02602		Tributary to San Tomas	No	No	No	--	--	--	--	--	--
205R02618		Aldercroft Creek	No	No	No	--	--	--	--	--	--
205R02650		Alamitos Creek	Yes	No	No	--	--	--	--	--	--
205R02659		Stevens Creek	Yes	No	No	--	--	--	--	--	--
205R02730		Saratoga Creek	Yes	No	No	--	--	--	--	--	--
205R02762		Ross Creek	Yes	No	No	--	--	--	--	--	--
205R02771		Lower Silver Creek	Yes	No	Yes	--	--	--	--	--	--
205R02835	205COY135	Upper Penitencia Creek	Yes	No	No	--	--	--	Yes	--	Yes
	205STE021	Stevens Creek	--	--	--	No	No	Yes	--	--	--
	205STQ010	San Thomas Aquino	--	--	--	No	No	Yes	--	--	--
	205AAG025	Arroyo Aguague	--	--	--	--	--	--	Yes	--	--
	205COY114	Upper Penitencia Creek	--	--	--	--	--	--	Yes	No	--
	205COY121	Upper Penitencia Creek	--	--	--	--	--	--	Yes	Yes	--
	205COY130	Upper Penitencia Creek	--	--	--	--	--	--	Yes	--	--
	205COY140	Upper Penitencia Creek	--	--	--	--	--	--	No	--	--
	205COY142	Upper Penitencia Creek	--	--	--	--	--	--	No	--	--
	205COY145	Upper Penitencia Creek	--	--	--	--	--	--	No	--	--

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.

6.3 Management Implications

The Program's Creek Status and Pesticides and Toxicity Monitoring programs (consistent with MRP provisions C.8.c and C.8.g, respectively) focus on assessing the water quality condition of urban creeks in the Santa Clara Valley and identifying stressors and sources of impacts observed. Although the sample size from WY 2016 (overall n=20; urban n=17) is not sufficient to develop statistically representative conclusions regarding the overall condition of all creeks, it builds on data collected in WY 2012 through WY 2015 and is analyzed with the full five-year dataset (n=112). Most urban streams have likely or very likely altered populations of aquatic life indicators (e.g., aquatic macroinvertebrates). These 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 50 plus years. Additionally, episodic or site specific increases temperature (particularly in lower creek reaches) may not be optimal for aquatic life in 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 MRP provision C.3, new and redevelopment projects in the Bay Area are now designed to more effectively reduce water quality and hydromodification impacts associated with urban development. Low impact development (LID) methods, such as rainwater harvesting and use, infiltration and biotreatment are required as part of development and redevelopment projects. In addition, Green Infrastructure planning is now part of all municipal projects. These LID measures are expected to reduce the impacts of urban runoff and associated impervious surfaces on stream health.
- In compliance with MRP provision C.9, 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, the adoption of formal State pesticide registration procedures, and sustainable landscaping requirements for new and redevelopment projects. Through these efforts, it is estimated that the amount of pyrethroids observed in urban stormwater runoff will decrease by 80-90% over time, and in turn significantly reduce the magnitude and extent of toxicity in local creeks.
- Trash loadings to local creeks have been reduced through implementation of new control measures in compliance with MRP provision C.10 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 full trash capture systems, and requires development of receiving water monitoring programs for trash.
- In compliance with MRP 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) 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 MRP provision C.13, 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 MRP provisions C.11 (mercury) and C.12 (PCBs), the Program will continue to identify sources of

these pollutants and will implement control actions designed to achieve new minimum load reduction goals. Monitoring activities conducted in WY 2016 that specifically target mercury and PCBs are described in the Pollutants of Concern Monitoring Data Report that is included as Appendix D to the WY 2016 UCMR.

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 Santa Clara Valley Water District'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 will identify, prioritize and implement activities at a watershed scale to meet flood protection, water supply, water quality and environmental stewardship goals and objectives. The Santa Clara Valley Water District was also recently awarded a Proposition 1 grant to develop a Storm Water Resource Plan for the Santa Clara Basin that will support the development and implementation of MRP-required Green Infrastructure Plans and produce a list of prioritized runoff capture and use projects 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 overtime. 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 "grey" infrastructure and disconnect impervious areas constructed over the course of the past 50-plus years will take time to implement. Consequently, it may take several decades to observe the outcomes of these important, large-scale improvements to our watersheds in our local creeks. Long-term creek status monitoring programs designed to detect these changes over time are therefore beneficial to our collective understanding of the condition and health of our local waterways.

In recognition of SCVURPPP's accomplishments, the Water Environment Federation (WEF) awarded SCVURPPP the Overall Highest Score for a Phase 1 Municipal Stormwater Program and Gold Level for Innovation and Program Management. The awards are part of the National Municipal Stormwater and Green Infrastructure Awards program, led by WEF through a cooperative agreement with the U.S. Environmental Protection Agency (USEPA). The awards program was established in 2015 to recognize high-performing regulated MS4s throughout the United States. The objective of the program is to inspire MS4 program leaders to seek new and innovative ways to meet and exceed regulatory requirements in a manner that is both technically effective as well as financially efficient.

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ATTACHMENTS

Attachment 1

QA/QC Report

Quality Assurance/Quality Control Report

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March 31, 2017

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ACRONYMS

BASMAA	Bay Area Stormwater Management Agencies Association
BMI	Benthic Macroinvertebrates
DQO	Data Quality Objective
EDDs	Electronic data deliverables
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MQO	Measurement Quality Objective
MS	Matrix Spike
MSD	Matrix Spike Duplicate
PAH	Polycyclic Aromatic Hydrocarbon
PR	Percent Recovery
QA	Quality Assurance
QC	Quality Control
QAPP	Quality Assurance Project Plan
RMC	Regional Monitoring Coalition
RPD	Relative Percent Difference
SAFIT	Southwest Association of Freshwater Invertebrate Taxonomists
SCVURPPP	Santa Clara Valley Urban Pollution Prevention Program
SFRWQCB	San Francisco Regional Water Quality Control Board
SOP	Standard Operating Procedures
STE	Standard Taxonomic Effort
SWAMP	Surface Water Ambient Monitoring Program

1. INTRODUCTION

In Water Year 2016 (WY 2016; October 1, 2015 through September 30, 2016), the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) conducted Creek Status Monitoring in compliance with provision C.8.d and dry weather Pesticide & Toxicity Monitoring in compliance with provision C.8.g of the National Pollutant Discharge Elimination System (NPDES) stormwater permit for Bay Area municipalities referred to as the Municipal Regional Permit (MRP). The monitoring strategy includes regional ambient/probabilistic monitoring and local “targeted” monitoring as described in the Bay Area Stormwater Management Agencies Association (BASMAA) Regional Monitoring Coalition (RMC) Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012). SCVURPPP implemented a comprehensive data quality assurance and quality control (QA/QC) program, covering all aspects of the probabilistic and targeted monitoring. QA/QC for data collected was performed according to procedures detailed in the Quality Assurance Project Plan (QAPP) developed by the BASMAA RMC (BASMAA 2016a) and BASMAA RMC Standard Operating Procedures (SOP; BASMAA 2016b), SOP FS-13 (Standard Operating Procedures for QA/QC Data Review). The BASMAA RMC SOP and QAPP are based on the SOP and QAPP developed by the Surface Water Ambient Monitoring Program (SWAMP; SCCWRP 2008).

Based on the QA/QC review, some WY 2016 data were rejected (continuous dissolved oxygen results) and some data were flagged. However, overall, WY 2016 data met QA/QC objectives. Details are provided in the sections below.

1.1. DATA TYPES EVALUATED

During creek status monitoring, several data types were collected and evaluated for quality assurance and quality control. These data types include the following:

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

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

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

1.2. LABORATORIES

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

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

- City of San Jose, Environmental Services Department Laboratory (pathogen indicators)
- BioAssessment 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. Conversely, 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 in RMC. The key measure of comparability for all RMC data is the California Surface Water Ambient Monitoring Program (SWAMP).

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 5% of all samples for all parameters¹. The results of the duplicate analyses are reported by the laboratories and evaluated using RMC Database QA/QC Testing Tool. Results of the Tool are confirmed manually. Acceptable levels of precision are specified for chemical analytes and toxicity test parameters in RMC QAPP Appendix A: Measurement Quality Objectives for RMC Analytes, and for biological measurements in Appendix B: Benthic Macroinvertebrate MQOs and Data Production Process.

1.3.7. Contamination

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

¹ The QAPP also requires the collection of field duplicate samples for 10% of biological samples (BMI and algae). However, there are no prescribed methods for determining 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. 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 SOP, ensuring that all samples and field measurements are representative of conditions in Santa Clara Valley 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 lists². Completed templates were reviewed using SWAMP's online data checker³, 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 was reviewed immediately following deployment, and if data were rejected, samplers were redeployed immediately.

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 Look up lists available online at http://swamp.waterboards.ca.gov/swamp_checker/LookUpLists.php.

³ Checker available online at http://swamp.waterboards.ca.gov/swamp_checker/SWAMPUpload.php

2.3.2. Field Sheets

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

2.3.3. Laboratory Results

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

2.4. SENSITIVITY

2.4.1. Biological Data

Benthic macroinvertebrates were identified to SAFIT STE Level I.

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 measurement quality objectives (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
EV = 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 is replaced.

2.6. PRECISION

2.6.1. Field Duplicates

For creek status monitoring, duplicate biological samples were collected at 10% (two) of the 20 probabilistic sites and duplicate water chemistry samples were collected at 5% (one) of the probabilistic sites sampled to evaluate precision of field sampling methods. The relative percent difference (RPD) for water chemistry field duplicates was calculated and compared to the MQO (RPD < 25%) set by Table 26-1 in Appendix A of the RMC QAPP. If the RPD of the two field duplicates did not meet the MQO, the results were flagged.

The RMC QAPP requires collection and analysis of duplicate sediment chemistry and toxicity samples at a rate of 5% of total samples collected for the project. SCVURPPP collected one field duplicate for dry weather sediment chemistry, sediment toxicity, and water toxicity sample to account for the six pesticide & toxicity sites collectively monitored by the RMC in WY 2016. 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:

$$\text{RPD} = \text{ABS} ([X1-X2] / [(X1+X2) / 2])$$

Where: X1 = the first sample result

X2 = the duplicate sample result

2.6.2. Chemical Analysis

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

2.7. CONTAMINATION

Blank samples were analyzed for contamination, and results were compared to MQOs set by Appendix A of the RMC QAPP. In addition to a laboratory blank that was run with each batch, the RMC QAPP requires the collection and analysis of field blank samples at a rate of 5% for orthophosphate. This equates to a total of one samples for the 20 samples collected in Santa Clara County.

For creek status monitoring, the RMC QAPP requires all blanks (laboratory and field) to be less than the analyte reporting limits. If a blank sample did not meet this MQO, all samples in that batch for that particular analyte were flagged.

3. RESULTS

3.1. OVERALL PROJECT REPRESENTATIVENESS

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

3.2. OVERALL PROJECT COMPARABILITY

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

3.3. BIOASSESSMENTS AND PHYSICAL HABITAT ASSESSMENTS

The BMI taxonomic laboratory, BioAssessment Services, received the RMC QAPP, and confirmed that the laboratory QA/QC procedures aligned with the procedures in Appendices B through D of the RMC QAPP and meet the BMI MQOs in Appendix B.

3.3.1. Completeness

SCVURPPP completed bioassessments and physical habitat assessments for all 11 transects at 20 of 20 planned/required sites for a 100% sampling completion rate. However, the analytical laboratory lost the chlorophyll a sample filter collected for site 205R01731 and could not analyze the sample⁴. The loss of one sample is acceptable as SCVURPPP met the QAPP target completion rate of 95% for chlorophyll a, and exceeded the target with a 100% completion rate for all other parameters.

3.3.2. Sensitivity

The benthic macroinvertebrate 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.

The reporting limits for ash free dry mass analysis (8-13 mg/L) were much higher than the RMC QAPP target reporting limits (2 mg/L) due to high concentrations requiring large dilutions. The results were several orders of magnitude higher than the actual and target reporting limit and were not affected by the higher reporting limit. Similarly, the chlorophyll a analytical reporting limits (50 mg/L) were an order of magnitude higher than the QAPP target limits (5 mg/L). Again, reporting limits were elevated due to large dilutions as concentrations were well above the analytical reporting limit and were not impacted by the elevated reporting limit.

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

3.3.3. Accuracy

The two BMI samples submitted to a separate QC taxonomic laboratory had no major taxonomic discrepancies. The QC laboratory calculated sorting and taxonomic identification metrics, which were compared to the measurement quality objectives in Table 27-1 in Appendix B of the RMC QAPP. All metrics met their respective MQOs. A comparison of the metrics with the MQOs is shown in Table 1. A copy of the QC laboratory report is available upon request. There is no protocol for evaluating the accuracy of algae taxonomic identification.

⁴ The sample was assigned a "LST" QA code to indicate that the sample was lost.

Table 1. Quality control metrics for taxonomic identification of benthic macroinvertebrates collected in Santa Clara County in WY 2016 compared to measurement quality objectives.

Quality Control Metric	Error Rate	MQO	Exceeds MQO?
Absolute Recount	2.37%	< 5% ^a	No
Taxa ID	4.92%	≤ 10%	No
Individual ID	0.95%	≤ 10%	No
Lower Taxonomic Resolution Individual	0%	≤ 10%	No
Lower Taxonomic Resolution Count	0%	≤ 10%	No

^athe RMC QAPP MQO for recount accuracy is ≥ 95%

3.3.4. Precision

Duplicate algae and BMI samples were collected at two sites in WY 2016 and were sent to the taxonomic laboratories for identification. However, only one duplicate sample was collected for chlorophyll a and ash free dry mass, due to a staff mistaking those analytes for water chemistry parameters and not biological parameters.

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

Again, discrepancies were to be 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 205R02618, collected on May 20, 2016.

Analyte Name	Fraction Name	Unit	Original Result	Duplicate Result	RPD	Exceeds MQO (>25%) ^a
Chlorophyll a	Particulate	mg/m ²	3.8	6.37	51%	Yes
Ash Free Dry Mass	Fixed	g/m ²	9.89	107.24	166%	Yes

^aIn accordance with the RMC QAPP, if the native concentration of either sample is less than the reporting limit, the RPD is not applicable

3.3.5. Contamination

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

3.4. FIELD MEASUREMENTS

Field measurements of temperature, dissolved oxygen, pH, specific conductivity, and chlorine residual were collected concurrently with bioassessments and water chemistry samples. Chlorine residual was measured using a HACH Pocket Colorimeter™ II, which uses the DPD method. All other parameters

were measured with a YSI Professional Plus 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, total chlorine residual, and free chlorine residual were collected at all 20 bioassessment sites for a 100% completeness rate.

3.4.2. Sensitivity

Free and total chlorine residual were measured using a HACH Pocket Colorimeter™ II, which uses the DPD method. For this method, the estimated detection limit for the low range measurements (0.02-2.00 mg/L) was 0.02 mg/L. There is, however, no established method reporting limit. Based on industry standards and best professional judgment, the method reporting limit is assumed to be 0.1 mg/L, which is much lower than the 0.5 mg/L target reporting limit listed in the RMC QAPP for free and total chlorine residual.

There are also 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.

3.4.3. Accuracy

Data collection occurred Monday through Thursday, and the multi-parameter instrument was calibrated at least 12 hours prior to the first sample on Monday, with the dissolved oxygen probe 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 does not need to be calibrated.

3.4.4. Precision

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

3.5. WATER CHEMISTRY

Water chemistry samples were collected by SCVURPPP staff concurrently with bioassessment samples, and analyzed by Caltest Analytical Laboratory (Caltest) 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 Measurement Quality Objectives (MQOs) are listed in RMC QAPP Table 26-2.

3.5.1. Completeness

SCVURPPP collected 100% of planned/required water chemistry samples at the 20 bioassessment sites including one duplicate sample (5% of total project sample count). Samples were analyzed for all requested analytes, and 100% of results were reported. Water chemistry data were flagged when necessary, but none were rejected.

3.5.2. Sensitivity

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

The reporting limit and method detection limit for all nitrate samples were higher than the target reporting limit, but one sample, collected at 205R01114, was affected and flagged as “detected, not quantified” when it would have been quantified at the lower reporting limit. SCVURPPP will discuss the nitrate reporting limit with Caltest for future analysis. Target and actual reporting limits are shown in Table 3.

Table 3. Target and actual reporting limits for nutrients analyzed in SCVURPPP creek status monitoring.

Analyte	Target RL mg/L	Actual RL mg/L
Ammonia	0.02	0.02
Chloride	0.25	1-100
Total Kjeldahl Nitrogen	0.5	0.1
Nitrate	0.01	0.05
Nitrite	0.01	0.005
Orthophosphate	0.01	0.01
Silica	1	1
Phosphorus	0.01	0.01
Ash Free Dry Mass	2	2
Chlorophyll a	N/A	50

3.5.3. Accuracy

Recoveries on all laboratory control samples (LCS) were within the MQO target range of 80-120% recovery, and most matrix spikes (MS) and matrix spike duplicates (MSD) percent recoveries (PR) were within the target range. Seven MS/MSD percent recoveries exceeded the MQO range listed in the RMC QAPP for various conventional analytes, including ammonia, phosphorus, total Kjeldahl nitrogen (TKN), and silica. The affected samples have been assigned the appropriate SWAMP flag.

The PR ranges on laboratory reports were 70-130%, 85-115% or 90-110% for some conventional analytes (nutrients) while the RMC QAPP lists the PR as 80-120% for all conventional analytes in water. As a result, some QA samples that exceeded RMC MQOs were flagged by the local QA officer, but not by the laboratory and vice versa.

3.5.4. Precision

The relative percent differences (RPD) for all laboratory control sample and matrix spike duplicate pairs were consistently below 7%, well below the MQO target of < 25%.

The field duplicate samples exceeded the RPD MQO for total Kjeldahl nitrogen. In past years of sampling, total Kjeldahl nitrogen has been common among the analytes that exceed the field duplicate RPD MQOs. Field crews will continue to make an effort in subsequent years to collect the original and duplicate samples in an identical fashion.

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

Table 4. Field duplicate water chemistry results for site 205R02618, collected on May 20, 2016. Data in highlighted rows exceed monitoring 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	0.015	< 0.015	NA	No
Chloride	None	mg/L	15	16	6%	No
Nitrate as N	None	mg/L	0.54	< 0.02	NA	No
Nitrite as N	None	mg/L	0.001	0.001	0%	No
Nitrogen, Total Kjeldahl	None	mg/L	0.48	0.35	31%	Yes
Orthophosphate as P	Dissolved	mg/L	0.081	0.065	22%	No
Phosphorus as P	Total	mg/L	0.087	0.084	4%	No
Silica as SiO ₂	Total	mg/L	23	23	0%	No

^aIn accordance with the RMC QAPP, if the native concentration of either sample is less than the reporting limit, the RPD is not applicable

3.5.5. Contamination

None of the target analytes were detected in any of the laboratory blanks at levels above their reporting limit. Phosphorus was detected but not quantified in one laboratory blank, and silica was also detected but not quantified in another blank sample. However, both analytes were detected at concentrations below the reporting limit, and thus no data were flagged due to these results.

SCVURPPP did not collect an orthophosphate field blank sample (5% of total project samples) as required by the RMC QAPP for the 20 samples collected in Santa Clara County in WY 2016. However, the field crew took precautions to prevent contamination during sample collection by following RMC SOP protocols, including but not limited to wearing gloves during sample collection and rinsing bottles with stream water prior to collection. In future years, SCVURPPP QA staff will work closer with field staff to avoid QA oversights.

3.6. PATHOGEN INDICATORS

Pathogen indicator samples were collected by SCVURPPP staff at WY 2016 bioassessment sites and were analyzed by the City of San Jose's Environmental Services Department Laboratory. Samples were collected on the morning of June 22, 2016 and were analyzed later that day for *E. coli* and enterococcus.

3.6.1. Completeness

All five required/planned pathogen indicator samples were collected for a 100% completeness rate. However, two samples exceeded the eight-hour hold time. Culturing began at 5:09 PM for *E. coli* and 5:36 PM for enterococcus, but the samples collected at 205R02835 and 205R01731 were collected at 8:30 AM and 8:55 AM, respectively. As a result, these samples exceeded the target hold time by 14-66 minutes. Due to the well persevered nature of the samples and minimal time exceedance, data were flagged but not rejected.

3.6.2. Sensitivity

The reporting limits for *E. coli* and enterococcus (1 MPN/100mL for both indicators) were below the target RL of 2 MPN/100mL listed in the project QAPP.

3.6.3. Accuracy

No certified reference material (CRM) was run for pathogen indicators. As a result, accuracy could not be calculated for pathogen indicators.

3.6.4. Precision

Due to the number of samples collected and the laboratory methodology, it was not possible to run a laboratory duplicate and evaluate the pathogen samples could not be evaluated for precision

3.6.5. Contamination

One method blank 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 (April 2016), concurrent with bioassessment sampling, and again in the summer (June 2016) in compliance with the MRP. Temperature, pH, dissolved oxygen, and specific conductivity were recorded once every 15 minutes over two-week deployments using a multi-parameter water quality sonde (YSI 6600-V2).

3.7.1. Completeness

During the spring deployment, the sonde located at 205COY114 recorded erroneous dissolved oxygen concentrations for 36% of the deployment. However, more than one week of data (the MRP minimum) were unaffected, so the deployment was kept and erroneous data points were flagged and rejected. No data from the other deployments were rejected.

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

A summary of the drift measurements is shown in Table 5. During the first event, the pH 10 drift for the sensor installed at 205COY114 exceeded the measurement quality objective for pH 10. This sensor also failed in the field for dissolved oxygen. All measurements for that site have been flagged for the pH drift exceedance, but not rejected, and dissolved oxygen measurements that were affected by the sensor malfunction were rejected for that site during the first event. The multi-parameter sonde was serviced immediately following the first event, but the problem could not be identified as the sensors passed all diagnostic tests.

The same sonde was installed at 205RCOY114 during the second event, and did not meet the measurement quality objects for the pH 10 drift check once again. The pH 10 data were again flagged at that site, but not rejected due to percolation pond releases upstream of the site, which confounded known conditions. The pH sensor for the errant sonde will be replaced prior to the next field season, and diagnostic tests will be run to prevent questionable data during future deployments.

Table 5. Drift measurements for two continuous water quality monitoring events in Santa Clara Valley urban creeks during WY 2016. Bold and highlighted values exceeded measurement quality objectives.

Parameter	Measurement Quality Objectives	205COY114		205COY117		205COY121	
		Event 1	Event 2	Event 1	Event 2	Event 1	Event 2
Dissolved Oxygen (mg/l)	± 0.5 mg/L or 10%	0.1	-0.24	-0.01	0	0.23	0.07
pH 7.0	± 0.2	-0.07	0.16	0.02	-0.03	-0.06	-0.03
pH 10.0	± 0.2	0.35	0	-0.04	0.44	0.01	0.06
Specific Conductance (uS/cm)	± 10%	-0.1%	-0.1%	-0.2%	0.1%	0.2%	-0.1%

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 2016 at eight sites in Santa Clara. Onset HOB0 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 in past years one to two loggers have been lost during the deployment. Anticipating a lost HOB0 temperature logger, SCVURPPP deployed one extra temperature loggers, for a total of nine loggers. Additionally, SCVURPPP staff periodically checked the loggers to ensure that they were still recording. During the June field check, staff discovered that two temperature loggers were missing at sites 205COY117 and 205COY135. New loggers were redeployed at that time, but the reach at 205COY117 went dry by the next field check in July. Similarly, the most downstream reach at site 205COY114 was also dry by July. The temperature loggers at 205COY114, 205COY135, and 205COY117 recorded 70%, 61%, and 8% of the deployment period, respectively, while the loggers at the other six reaches recorded 100% of the deployment period. Since data collected at site 205COY117 is too limited to compare with data collected at the other eight sites, data for this site were excluded from reporting and analysis.

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 2016. None of the loggers exceeded the 0.2 °C mean difference for the room temperature bath (<0.25 °C) or for the ice bath (0.27 °C). All tested loggers were deployed and no data were flagged.

3.8.4. Precision

There are no precision protocols for continuous temperature monitoring.

3.9. SEDIMENT CHEMISTRY

Dry season sediment chemistry samples were collected by Kinnetic Laboratories, Inc (KLI) concurrently with dry season toxicity samples on July 11, 2016. Inorganic and synthetic organic compounds were analyzed by Caltest and grain size distribution was analyzed by Soil Control Laboratories, a subcontractor

laboratory. All samples were analyzed within the one year holding time for analytes in sediment, set by the RMC SOP. Caltest conducted all QA/QC requirements as specified in the RMC QAPP and reported their findings to the RMC. Key sediment chemistry MQOs are listed in RMC QAPP Tables 26-9 through 26-11.

3.9.1. Completeness

Both planned/required samples were collected and analyzed for all requested analytes, and 100% of results were reported.

3.9.2. Sensitivity

Laboratory reporting limits generally met or were lower than RMC QAPP target reporting limits, except for metals, one bifenthrin sample, and one permethrin sample. A comparison of target and actual reporting limits for those parameters is shown in Table 6. For all samples where the reporting limit was higher than the target limits, concentrations were measured at concentrations above the RLs; therefore, the method provided adequate sensitivity.

Table 6. Comparison of target and actual reporting limits for sediment analytes where reporting limits exceeded target limits. Sediment samples were collected in Santa Clara County creeks in WY 2016.

Analyte	Target RL mg/kg	Actual RL mg/kg
Arsenic	0.3	1
Cadmium	0.01	0.08
Chromium	0.1	0.2-0.21
Copper	0.01	0.41
Lead	0.01	0.2-0.21
Nickel	0.02	0.2-0.21
Zinc	0.1	4.1
Bifenthrin	0.33	0.33-0.51
Permethrin	0.03	0.33-0.51

3.9.3. Accuracy

Inorganic Analytes

No QA samples exceeded the QAPPP MQO for LCS or MS percent recovery (PR) for metals (75-125%).

Synthetic Organic Compounds

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

None of the laboratory control sample (LCS) percent recoveries exceeded the RMC MQO range. The MS/MSD percent recoveries exceeded the RMC MQO range for carbaryl, 12 PAHs, and three surrogates. The PAHs MS/MSD samples that exceeded the PR MQO include benzo(a)pyrene, benzo(b)fluoranthene, benzo(e)pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, biphenyl, dibenz(a,h)anthracene, dimethylnaphthalene, 2,6-indeno(1,2,3-c,d)pyrene, methylnaphthalene, 2-perylene. Sediment chemistry data were flagged when necessary, but none were rejected.

3.9.4. Precision

Inorganic Analytes

The RMC QAPP lists the maximum RPD for inorganic analytes (metals) as 25%, while the laboratory report lists the maximum as 30% for most metals and 35% for mercury. None of the duplicates for metals exceeded the RMC RPD MQO.

Synthetic Organic Compounds

The maximum RPD for synthetic organics listed in the sediment laboratory report lists ranges from 30 to 50% for most analytes. However, the RMC QAPP lists the MQO as < 25% RPD for all synthetic organics excepting pyrethroids, and as <35% for pyrethroids. The RPD for duplicates was evaluated using the RMC MQOs, and as a result, three analytes that were not flagged by the laboratory were flagged by the local QA officer; the MS/MSD RPDs for benz(a)anthracene, phenanthrene, and 2-methylnaphthalene were all slightly over the MQO of < 25%.

Field Duplicates

A sediment sample field duplicate was collected in Santa Clara County on July 11, 2016, and was evaluated for precision. The field duplicate sample and corresponding RPDs are shown in Table 7. Because of the variability in reporting limits, values less than the Reporting Limit (RL) were not evaluated for RPD. Analytes that exceeded the MQO of RPD < 25% were small pebbles (4 to <8 mm), benz(a)anthracene, 2-methylnaphthalene, and phenanthrene. Given the inherent variability associated with field duplicates, the low number of analytes with RPDs outside of the MQO limits is remarkable. 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 very precise.

Table 7. Sediment chemistry duplicate field results for site 205STE021, collected on July 11, 2016 in Santa Clara County. Data in highlighted rows exceed monitoring quality objectives in RMC QAPP.

Analyte		Unit	Original	Duplicate	RPD	Exceeds MOO? (<25%) ^a
Grain Size Distribution	Clay: <0.0039 mm	%	4.44	4.51	2%	No
	Silt: 0.0039 to <0.0625 mm	%	4.49	4.42	2%	No
	Sand: V. Fine 0.0625 to <0.125 mm	%	5.77	5.69	1%	No
	Sand: Fine 0.125 to <0.25 mm	%	10.61	11	4%	No
	Sand: Medium 0.25 to <0.5 mm	%	18.59	19.24	3%	No
	Sand: Coarse 0.5 to <1.0 mm	%	28.68	28.88	1%	No
	Sand: V. Coarse 1.0 to <2.0 mm	%	27.42	26.25	4%	No
	Granule: 2.0 to <4.0 mm	%	12.85	10.83	17%	No
	Pebble: Small 4 to <8 mm	%	2.05	2.93	35%	Yes
	Pebble: Medium 8 to <16 mm	%	-0.01	2.64	N/A	N/A
	Pebble: Large 16 to <32 mm	%	-0.01	-0.01	N/A	N/A
	Pebble: V. Large 32 to <64 mm	%	-0.01	-0.01	N/A	N/A
Metals	Arsenic	mg/Kg dw	2.9	3	3%	No
	Cadmium	mg/Kg dw	0.21	0.21	0%	No
	Chromium	mg/Kg dw	72	65	10%	No
	Copper	mg/Kg dw	39	32	20%	No
	Lead	mg/Kg dw	14	14	0%	No
	Nickel	mg/Kg dw	63	63	0%	No
	Zinc	mg/Kg dw	98	93	5%	No
Pyrethroids (MOO <35%)	Bifenthrin	ng/g dw	1.1	0.8	32%	No
	Cyfluthrin, total	ng/g dw	0.39	0.32	20%	No
	Cyhalothrin, Total lambda-	ng/g dw	-0.06	0.072	N/A	N/A
	Cypermethrin, total	ng/g dw	0.14	0.14	0%	No
	Deltamethrin/Tralomethrin	ng/g dw	0.41	0.17	83%	Yes
	Esfenvalerate/Fenvalerate, total	ng/g dw	-0.13	-0.13	N/A	N/A
	Permethrin, Total	ng/g dw	0.92	0.88	4%	No
Total Organic Carbon	%	0.27	0.26	4%	No	
Carbaryl	mg/Kg dw	-0.021	-0.021	N/A	N/A	
Fipronil	ng/g dw	-0.1	-0.1	N/A	N/A	
Polycyclic Aromatic Hydrocarbons	Acenaphthene	ng/g dw	-3.1	-3.1	N/A	N/A
	Acenaphthylene	ng/g dw	-3.1	-3.1	N/A	N/A
	Anthracene	ng/g dw	5.1	4.1	22%	No
	Benz(a)anthracene	ng/g dw	10	21	71%	Yes
	Benzo(a)pyrene	ng/g dw	8.2	9.2	11%	No
	Benzo(b)fluoranthene	ng/g dw	21	21	0%	No
	Benzo(e)pyrene	ng/g dw	8.2	8.2	0%	No
	Benzo(g,h,i)perylene	ng/g dw	-3.1	10	N/A	N/A
	Benzo(k)fluoranthene	ng/g dw	7.2	7.2	0%	No
	Biphenyl	ng/g dw	-3.4	-3.4	N/A	N/A
	Chrysene	ng/g dw	51	51	0%	No
	Dibenz(a,h)anthracene	ng/g dw	-3.1	-3.1	N/A	N/A
	Dibenzothiophene	ng/g dw	-3.4	-3.4	N/A	N/A
	Dimethylnaphthalene, 2,6-	ng/g dw	6.2	5.1	19%	No
Fluoranthene	ng/g dw	82	72	13%	No	

Table 7. Sediment chemistry duplicate field results for site 205STE021, collected on July 11, 2016 in Santa Clara County. Data in highlighted rows exceed monitoring quality objectives in RMC QAPP.

Analyte		Unit	Original	Duplicate	RPD	Exceeds MOO? (<25%) ^a
	Fluorene	ng/g dw	3.1	-3.1	N/A	N/A
	Indeno(1,2,3-c,d)pyrene	ng/g dw	-3.1	8.2	N/A	N/A
	Methylnaphthalene, 1-	ng/g dw	-3.1	-3.1	N/A	N/A
	Methylnaphthalene, 2-	ng/g dw	4.1	3.1	28%	Yes
	Methylphenanthrene, 1-	ng/g dw	-3.1	-3.1	N/A	N/A
	Naphthalene	ng/g dw	-3.1	-3.1	N/A	N/A
	Perylene	ng/g dw	-3.1	-3.1	N/A	N/A
	Phenanthrene	ng/g dw	41	31	28%	Yes
	Pyrene	ng/g dw	72	72	0%	No
Surrogates	Chloroxuron(Surrogate)	%	101	96	5%	No
	Esfenvalerate-d6-1(Surrogate)	%	78	74	5%	No
	Esfenvalerate-d6-2(Surrogate)	%	88	84	5%	No
	Fluorobiphenyl, 2-(Surrogate)	%	60	50	18%	No
	Nitrobenzene-d5(Surrogate)	%	57	45	24%	No
	Tebuthiuron(Surrogate)	%	104	100	4%	No
	Terphenyl-d14(Surrogate)	%	94	91	3%	No

^a MOO 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

3.9.5. Contamination

Copper was detected in one blank at a concentration above the method detection limit, but not above the reporting limit. The RMC QAPP for blank samples is < RL, so the same was not flagged. None of the other target analytes were detected in any of the blanks.

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 11, 2016. All toxicity tests were performed by Pacific EcoRisk. The water samples were analyzed for toxicity to four organisms (*Selenastrum capricornutum*, *Ceriodaphnia dubia*, *Pimephales promelas*, and *Hyaella azteca*) and the sediment samples were analyzed for toxicity to *Hyaella azteca* and *Chironomus dilutus*.

3.10.1. Completeness

The MRP requires the collection of dry season water toxicity samples and dry season sediment toxicity samples at two sites per year in Santa Clara County. All planned/required dry season water and sediment toxicity samples were collected in WY 2016. Pacific EcoRisk tested 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

One field duplicate was collected in Santa Clara County and tested by Pacific EcoRisk. The mean toxicity endpoints of test organisms (mean survival, mean cell count, mean biomass, and mean young per

female) for the field duplicates were compared, and the RPD for each for toxicity test was calculated. These RPDs are compared to the RMC QAPP MQO of <20% for acute and chronic freshwater toxicity testing (Appendix A, Table 26-12 and 26-13) in Table 8. There is no MQO for sediment duplicates listed in the RMC QAPP, but sediment duplicates met the MQO for water toxicity testing with the exception of the *Ceriodaphnia dubia* growth endpoint (see Table 8).

Table 8. Water and sediment toxicity duplicate results for site 205STE021, collected on July 11, 2016 in Santa Clara County. Data in highlighted rows exceed monitoring quality objectives in RMC QAPP.

Matrix	Organism	Endpoint	Original Sample Mean	Duplicate Sample Mean	RPD	Exceeds MQO (<20%)?
Water	<i>Pimephales promelas</i>	% Survival	67.5	72.5	7%	No
Water	<i>Pimephales promelas</i>	Biomass (mg/individual)	0.605	0.612	1%	No
Water	<i>Ceriodaphnia dubia</i>	% Survival	100	100	0%	No
Water	<i>Ceriodaphnia dubia</i>	Young per female	32.4	24.9	26%	Yes
Water	<i>Selenastrum capricornutum</i>	Total Cell Count (cells/mL)	3120000	3340000	7%	No
Water	<i>Hyalella azteca</i>	% Survival	100	100	0%	No
Water	<i>Chironomus dilutus</i>	% Survival	70	80	13%	No
Sediment	<i>Hyalella azteca</i>	% Survival	98.8	98.8	0%	No
Sediment	<i>Chironomus dilutus</i>	% Survival	76.3	72.5	5%	No

3.10.4. Contamination

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

4. CONCLUSIONS

Sample collection and analysis generally followed MRP and RMC QAPP requirements, with the following exception:

- No orthophosphate field blank collected
- One chlorophyll a sample misplaced by the laboratory
- Two pathogen samples exceeded the 8-hour hold time between collection and analysis.

Data that exceeded measurement quality objectives were flagged, and no data were rejected with the following exception:

- 36% of dissolved oxygen field measurements for the April continuous water quality monitoring event at site 205COY114

5. REFERENCES

- Bay Area Stormwater Management Agency Association (BASMAA). 2012. Regional Monitoring Coalition Final Creek Status and Long-Term Trends Monitoring Plan. Prepared By EOA, Inc. Oakland, CA. 23 pp.
- Bay Area Stormwater Management Agency Association (BASMAA) Regional Monitoring Coalition. 2016a. Creek Status Monitoring Program Quality Assurance Project Plan, Final Draft Version 3. Prepared for BASMAA by EOA, Inc. on behalf of the Santa Clara Urban Runoff Pollution Prevention Program and the San Mateo Countywide Water Pollution Prevention Program, Applied Marine Sciences on behalf of the Alameda Countywide Clean Water Program, and Armand Ruby Consulting on behalf of the Contra Costa Clean Water Program. 128 pp.
- Bay Area Stormwater Management Agency Association (BASMAA) Regional Monitoring Coalition. 2016b. Creek Status Monitoring Program Standard Operating Procedures Version 3. Prepared for BASMAA by EOA, Inc. on behalf of the Santa Clara Urban Runoff Pollution Prevention Program and the San Mateo Countywide Water Pollution Prevention Program, Applied Marine Sciences on behalf of the Alameda Countywide Clean Water Program, and Armand Ruby Consulting on behalf of the Contra Costa Clean Water Program. 192 pp.
- Surface Water Ambient Monitoring Program (SWAMP) Quality Assurance Team. 2008. SWAMP Quality Assurance Program Plan, Version 1.0. Prepared for the California State Water Quality Control Board by Moss Landing Marine Laboratories and San Jose State University Research Foundation. 1 September. 108 pp.

Attachment 2

Biological Indicator Metric Scores

Table 1. Output for calculation of CSCI score, including O/E and MMI components of CSCI, for 20 bioassessment sites sampled in WY2016 in Santa Clara County.

Station Code	E	Mean_O	O/E	MMI	CSCI
205R00213	10.8	9.0	0.83	0.75	0.79
205R00305	10.9	9.0	0.82	1.01	0.92
205R00578	10.5	8.9	0.85	0.72	0.78
205R01114	8.5	5.9	0.69	0.27	0.48
205R01731	8.5	6.5	0.76	0.66	0.71
205R02330	9.1	6.4	0.70	0.37	0.54
205R02422	9.5	9.2	0.96	0.74	0.85
205R02458	9.5	7.7	0.81	0.70	0.75
205R02474	11.2	12.5	1.12	0.79	0.95
205R02538	9.3	7.5	0.80	0.50	0.65
205R02547	12.5	12.8	1.02	1.10	1.06
205R02563	10.1	6.5	0.65	0.51	0.58
205R02602	9.1	9.0	0.98	0.78	0.88
205R02618	13.1	11.6	0.88	0.82	0.85
205R02650	9.5	9.8	1.02	0.73	0.88
205R02659	9.5	8.9	0.93	0.53	0.73
205R02730	9.4	4.3	0.45	0.38	0.41
205R02762	8.5	4.9	0.57	0.31	0.44
205R02771	10.0	7.0	0.70	0.51	0.60
205R02835	11.3	10.1	0.89	0.84	0.87

Table 2. SoCal “D18” (diatom only) IBI scores for 20 bioassessment sites sampled in WY2016 in Santa Clara County. Individual metric values and scores are also shown. Each IBI score is scaled to 100 based on the number of metrics involved. For D18, the total sum of scores is multiplied by 100/50 to obtain the total score.

StationCode	Proportion halobiontic	Proportion low TP indicators	Proportion N heterotrophs	Proportion requiring >50% DO saturation	Proportion sediment tolerant (highly motile)	Proportion halobiontic Score	Proportion low TP indicators Score	Proportion N heterotrophs Score	Proportion requiring >50% DO saturation Score	Proportion sediment tolerant (highly motile) Score	Total MMI Score
205R00213	0.023	0.208	0.04	0.986	0.013	9	3	9	9	10	80
205R00305	0.062	0.023	0.147	0.875	0.257	9	1	7	6	5	56
205R00578	0.219	0.189	0.454	0.731	0.162	6	3	1	3	7	40
205R01114	0.151	0.084	0.233	0.876	0.319	7	1	5	7	4	48
205R01731	0.478	0.167	0.575	0.85	0.447	1	2	0	6	1	20
205R02330	0.791	0.01	0.86	0.91	0.622	0	1	0	7	0	16
205R02422	0.153	0.052	0.12	0.891	0.232	7	1	7	7	5	54
205R02458	0.149	0.03	0.145	0.972	0.117	7	1	7	9	8	64
205R02474	0.556	0.017	0.574	0.998	0.473	0	1	0	10	1	24
205R02538	0.288	0.017	0.208	0.92	0.114	5	1	6	8	8	56
205R02547	0.166	0.079	0.096	0.99	0.065	7	1	8	9	9	68
205R02563	0.096	0.065	0.059	0.99	0.041	8	1	8	9	9	70
205R02602	0	0.015	0	1	0.005	10	1	10	10	10	82
205R02618	0.497	0.013	0.546	0.944	0.413	1	1	0	8	2	24
205R02650	0.059	0.024	0.042	0.985	0.04	9	1	9	9	9	74
205R02659	0.105	0.03	0.041	0.973	0.11	8	1	9	9	8	70
205R02730	0.502	0.007	0.56	0.952	0.419	1	0	0	8	2	22
205R02762	0.101	0.013	0.105	0.946	0.062	8	1	8	8	9	68
205R02771	0.589	0.023	0.463	0.608	0.503	0	1	1	0	0	4
205R02835	0.253	0.145	0.26	0.875	0.244	5	2	5	6	5	46

Table 3. SoCal “S2” (soft algae only) IBI scores for 20 bioassessment sites sampled in WY2016 in Santa Clara County. Individual metric values and scores are also shown. Each IBI score is scaled to 100 based on the number of metrics involved. For S2, the total sum of scores is multiplied by 100/60 to obtain the total score. “NR” refers to values and scores that were not reported due to insufficient data.

Station Code	Prop high Cu (s, sp)	Prop high DOC (s, sp)	Prop low TP (s, sp)	Prop non-ref (s, sp)	Prop green algae in CRUS (s, b)	Prop ZHR (s, m)	Prop high Cu (s, sp) Score	Prop high DOC (s, sp) Score	Prop low TP (s, sp) Score	Prop non-ref (s, sp) Score	Prop green algae in CRUS (s, b) Score	Prop ZHR (s, m) Score	S2 Score
205R00213	0.00	0.50	0.50	0.00	0.00	0.25	10	4	10	10	10	4	80
205R00305	0.17	0.33	0.17	0.17	1.00	0.14	5	6	6	7	0	3	45
205R00578	0.00	0.00	0.50	0.00	0.00	0.25	10	10	10	10	10	4	90
205R01114	0.40	0.80	0.00	0.40	0.83	0.00	0	0	0	2	2	0	7
205R01731	0.33	0.50	0.00	0.17	1.00	0.07	1	4	0	7	0	2	23
205R02330	0.40	0.60	0.00	0.60	1.00	0.00	0	2	0	0	0	0	3
205R02422	0.20	0.60	0.00	0.20	1.00	0.08	4	2	0	7	0	2	25
205R02458	0.20	0.40	0.00	0.40	1.00	0.08	4	5	0	2	0	2	22
205R02474	1.00	1.00	0.00	1.00	1.00	0.00	0	0	0	0	0	0	0
205R02538	0.20	0.60	0.00	0.40	1.00	0.00	4	2	0	2	0	0	13
205R02547	0.50	0.50	0.00	0.50	1.00	0.17	0	4	0	0	0	3	12
205R02563	1.00	1.00	0.00	1.00	0.80	0.00	0	0	0	0	2	0	3
205R02602	1.00	1.00	0.00	1.00	0.00	0.00	0	0	0	0	10	0	17
205R02618 ^a	0.50	1.00	0.00	0.50	NR	0.00	0	0	0	0	NR	0	NR
205R02650	0.25	0.50	0.00	0.25	1.00	0.20	3	4	0	5	0	3	25
205R02659	1.00	1.00	0.00	1.00	1.00	0.00	0	0	0	0	0	0	0
205R02730	0.20	0.50	0.00	0.00	0.00	0.00	4	4	0	10	10	0	47
205R02762	0.33	0.33	0.00	0.33	1.00	0.13	1	6	0	3	0	2	20
205R02771	0.50	0.50	0.00	0.50	1.00	0.28	0	4	0	0	0	5	15
205R02835	0.33	0.33	0.00	0.33	1.00	0.00	1	6	0	3	0	0	17

^a Unable to calculate S2 score due to insufficient data causing null value for submetric.

Table 4. SoCal “H20” (hybrid) IBI scores for 20 bioassessment sites sampled in WY2016 in Santa Clara County. Individual metric values and scores are also shown. Each IBI score is scaled to 100 based on the number of metrics involved. For H20, the total sum of scores is multiplied by 100/80 to obtain the total score. “d” represents metrics based on diatoms, “s” represents metrics based on soft algae, “sp” is species richness metric.

Station Code	Prop halo-biontic (d)	Prop high Cu (s, sp)	Prop high DOC (s, sp)	Prop low TN (d)	Prop low TP (s, sp)	Prop N heterotrophs (d)	Prop require >50% DO sat (d)	Prop sed tol (highly motile) (d)	Prop halo-biontic Score	Prop high Cu Score	Prop high DOC Score	Prop low TN Score	Prop low TP Score	Prop N heterotrophs Score	Prop require >50% DO sat Score	Prop sed tol (highly motile) Score	Total MMI Score
205R00213	0.023	0.000	0.500	0.208	0.500	0.040	0.986	0.013	9	10	4	3	10	9	9	10	80
205R00305	0.062	0.167	0.333	0.021	0.167	0.147	0.875	0.257	9	5	6	1	6	7	6	5	56
205R00578	0.219	0.000	0.000	0.227	0.500	0.454	0.731	0.162	6	10	10	3	10	1	3	7	62
205R01114	0.151	0.400	0.800	0.128	0.000	0.233	0.876	0.319	7	0	0	2	0	5	7	4	31
205R01731	0.478	0.333	0.500	0.196	0.000	0.575	0.850	0.447	1	1	4	3	0	0	6	1	20
205R02330	0.791	0.400	0.600	0.009	0.000	0.860	0.910	0.622	0	0	2	0	0	0	7	0	11
205R02422	0.153	0.200	0.600	0.052	0.000	0.120	0.891	0.232	7	4	2	1	0	7	7	5	41
205R02458	0.149	0.200	0.400	0.029	0.000	0.145	0.972	0.117	7	4	5	1	0	7	9	8	51
205R02474	0.556	1.000	1.000	0.017	0.000	0.574	0.998	0.473	0	0	0	1	0	0	10	1	15
205R02538	0.288	0.200	0.600	0.016	0.000	0.208	0.920	0.114	5	4	2	1	0	6	8	8	42
205R02547	0.166	0.500	0.500	0.073	0.000	0.096	0.990	0.065	7	0	4	1	0	8	9	9	48
205R02563	0.096	1.000	1.000	0.053	0.000	0.059	0.990	0.041	8	0	0	1	0	8	9	9	44
205R02602	0.000	1.000	1.000	0.015	0.000	0.000	1.000	0.005	10	0	0	1	0	10	10	10	51
205R02618	0.497	0.500	1.000	0.013	0.000	0.546	0.944	0.413	1	0	0	1	0	0	8	2	15
205R02650	0.059	0.250	0.500	0.027	0.000	0.042	0.985	0.040	9	3	4	1	0	9	9	9	55
205R02659	0.105	1.000	1.000	0.033	0.000	0.041	0.973	0.110	8	0	0	1	0	9	9	8	44
205R02730	0.502	0.200	0.500	0.042	0.000	0.560	0.952	0.419	1	4	4	1	0	0	8	2	25
205R02762	0.101	0.333	0.333	0.012	0.000	0.105	0.946	0.062	8	1	6	1	0	8	8	9	51
205R02771	0.589	0.500	0.500	0.015	0.000	0.463	0.608	0.503	0	0	4	1	0	1	0	0	8
205R02835	0.253	0.333	0.333	0.139	0.000	0.260	0.875	0.244	5	1	6	2	0	5	6	5	38