Santa Clara Valley
Urban Runoff
Pollution Prevention Program

Watershed Monitoring and Assessment Program

Appendix A
Creek Status Monitoring Report

Water Year 2015 (October 2014 – September 2015)

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

March 28, 2016

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 2009 Municipal Regional National Pollutant Discharge Elimination System (NPDES) Stormwater Permit (in this document the 2009 permit is referred to as “MRP 1.0”)[1]. The RMC includes the following participants:

- Clean Water Program of Alameda County (ACCWP)
- Contra Costa Clean Water Program (CCCWP)
- San Mateo County Wide 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)

In 2015, the San Francisco Bay Regional Water Quality Control Board (SFRWQCB or Regional Water Board) revised and reissued the MRP (the 2015 permit is referred to as “MRP 2.0”). This Creek Status Monitoring Report complies with MRP 2.0 provision C.8.h.iii for reporting of all data in Water Year 2015 (October 1, 2014 through September 30, 2015). Data were collected pursuant to provision C.8.c of MRP 1.0. Data presented in this report were produced under the direction of the RMC and the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) 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 BASMAA RMC Quality Assurance Program Plan (QAPP; BASMAA, 2014a) and the BASMAA RMC Standard Operating Procedures (SOPs; BASMAA, 2014b). Where applicable, monitoring data were derived using methods comparable with methods specified by the California Surface Water Ambient Monitoring Program (SWAMP) QAPP[2]. Data presented in this report were also 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 MRP 2.0.

[1] The San Francisco Bay Regional Water Quality Control Board (SFRWQCB) issued MRP 1.0 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.

[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 County 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
CRAM	California Rapid Assessment Method
CSCI	California Stream Condition Index
CTR	California Toxics Rule
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
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
SFEI	San Francisco Estuary Institute
SFRWQCB	San Francisco Bay Regional Water Quality Control Board
SMCWPPP	San Mateo County Water Pollution Prevention Program
SOP	Standard Operating Protocol
SSC	Suspended Sediment Concentration
SSID	Stressor/Source Identification
SWAMP	Surface Water Ambient Monitoring Program
TEC	Threshold Effects Concentrations
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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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 (referred to as MRP 1.0). On November 19, 2015, the SFRWQCB updated and reissued the MRP as Order R2-2015-0049 (referred to as MRP 2.0). This report fulfills the requirements of provision C.8.h.iii of MRP 2.0 for comprehensively interpreting and reporting all Creek Status[3] monitoring data collected during the foregoing October 1 – September 30 (i.e., Water Year 2015). Data were collected pursuant to water quality monitoring requirements in provision C.8.c of MRP 1.0[4]. 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** – Probabilistic monitoring design, biological condition assessment, and stressor analysis
- **Section 3.0** – Targeted monitoring (continuous temperature, continuous general water quality, and pathogen indicators)
- **Section 4.0** – Pesticides and toxicity monitoring
- **Section 5.0** – Chlorine monitoring
- **Section 6.0** – Conclusions and recommendations

1.1 Creek Status Monitoring Goals

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

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

Creek Status Monitoring required by provision C.8.c of the MRP builds upon monitoring conducted by SCVURPPP between 2002 and 2009, is coordinated through the Regional Monitoring Coalition (RMC), and began on October 1, 2011. Creek status monitoring parameters, methods, occurrences, durations and minimum number of sampling sites are described in Table 8.1 of MRP 1.0 provision C.8.c. Monitoring results are evaluated to determine whether triggers are met and further investigation is warranted as a potential Monitoring Project as described in MRP 1.0 provision C.8.d.i. Results of Creek Status Monitoring conducted in Water Years 2012 through 2014 were submitted in prior reports (SCVURPPP 2015, SCVURPPP 2014).

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

[4] Water quality monitoring requirements in MRP 2.0 are generally similar to requirements in MRP 1.0. Differences in water quality monitoring requirements between MRP 1.0 and MRP 2.0 are briefly outlined in this report where applicable.

1.2 Regional Monitoring Coalition

Provision C.8.a (Compliance Options) of MRP 1.0 allows Permitees to address monitoring requirements through a "regional collaborative effort," their Stormwater Program, and/or individually. The RMC was formed in early 2010 as a collaboration among a number of the Bay Area Stormwater 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[5]. With notification of participation in the RMC, Permittees were required to commence water quality data collection by October 2011. Implementation of the RMC's Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012) allows Permittees and the Regional Water Board to modify their existing creek monitoring programs, and 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. SCVURPPP will continue its participation in the RMC during the permit term of MRP 2.0.

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
Clean Water Program of Alameda County (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 MRP 1.0 provision C.8 (Water Quality Monitoring);
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.

[5] The San Francisco Bay Regional Water Quality Control Board (SFRWQCB) issued the 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.

The RMC's monitoring strategy for complying with MRP 1.0 provision C.8.c is described in the RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012). The strategy includes regional ambient/probabilistic monitoring and local "targeted" monitoring. The combination of these two components allows each individual RMC participating program to assess the status of beneficial uses in local creeks within its jurisdictional area, while also contributing data to answer management questions at the regional scale (e.g., differences between aquatic life condition in urban and non-urban creeks). 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 MRP 2.0.

Table 1.2. Creek Status Monitoring parameters in compliance with MRP 1.0 provision C.8.c and associated monitoring component.

Monitoring Elements of MRP 1.0 provision C.8.c	Monitoring Component		Report Section
	Regional Ambient (Probabilistic)	Local (Targeted)	
Bioassessment & Physical Habitat Assessment	X		2.0
Nutrients	X		2.0
Chlorine	X		5.0
Water Toxicity[1]	X		4.0
Sediment Toxicity[1]	X		4.0
Sediment Chemistry[1]	X		4.0
General Water Quality (Continuous)		X	3.0
Temperature (Continuous)		X	3.0
Pathogen Indicators		X	3.0
Stream Survey (CRAM)[2]		X	2.0

Notes:
1. Consistent with the RMC Creek Status and Long-term Trends Monitoring Plan (BASMAA 2012), toxicity and sediment chemistry monitoring was conducted at probabilistic sites during MRP 1.0. Similar monitoring is required in MRP 2.0 but has been moved out of the Creek Status Monitoring provision into a new provision (Pesticides and Toxicity Monitoring)..It is likely that SCVURPPP will no longer collect these samples at probabilistic sites during MRP 2.0.
2. Stream surveys under the SCVURPPP Monitoring Program were conducted at probabilistic sites. This type of monitoring is not required in MRP 2.0.

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 2014b) and associated Quality Assurance Project Plan (QAPP; BASMAA 2014a). 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) QAPP[6], 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.

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

1.3.2 Laboratory Analysis Methods

RMC participants, including SCVURPPP, agreed to use the same laboratories for individual parameters, developed standards for contracting with the labs, and coordinated quality assurance issues. All samples collected by RMC participants that were sent to laboratories for analysis were analyzed and reported per SWAMP-comparable methods as described in the RMC QAPP (BASMAA 2014a). Analytical laboratory methods, reporting limits and holding times for chemical water quality parameters are also reported in BASMAA (2014a). Analytical laboratory contractors included:

- BioAssessment Services, Inc. – BMI identification
- EcoAnalysts, Inc. – Algae identification
- CalTest, Inc. – Sediment Chemistry, Nutrients, Chlorophyll a, Ash Free Dry Mass
- Pacific EcoRisk, Inc. - Water and Sediment Toxicity
- BioVir Laboratories, Inc. – Pathogen indicators

1.3.3 Data Analysis Methods

Water and sediment chemistry and toxicity data generated during WY2015 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). Per Table 8.1 of MRP 1.0 (SFRWQCB 2009), Creek Status Monitoring data must be evaluated with respect to thresholds specified in the “Results that Trigger a Monitoring Project in provision C.8.d.i” column. MRP 2.0 requires a similar analysis of the monitoring data to identify candidate sites for Stressor/Source Identification (SSID) projects; however, some of the trigger thresholds in MRP 2.0 have been revised or clarified. Unless otherwise noted, this report evaluates the data with respect to the trigger criteria listed in MRP 2.0.

In compliance with provision C.8.e.i of MRP 2.0, all monitoring results exceeding trigger thresholds are added to a list of candidate SSID projects that will be maintained throughout the permit term. 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, is bounded by the Diablo Mountains on the east and the Santa Cruz Mountains to 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 land use at 600 to 800 feet. Areas above this threshold have steeper slopes and are largely forest and rangeland; 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 urbanized Sunnyvale East and West Channel watersheds were constructed in the 1960s to manage flooding and contain no natural creek bed.

WY2015 Creek Status Monitoring Stations

The complete list of probabilistic and targeted monitoring sites samples by SCVURPPP in WY2015 is presented in Table 1.4. Monitoring locations with monitoring parameter(s) are mapped in Figure 1.2.

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

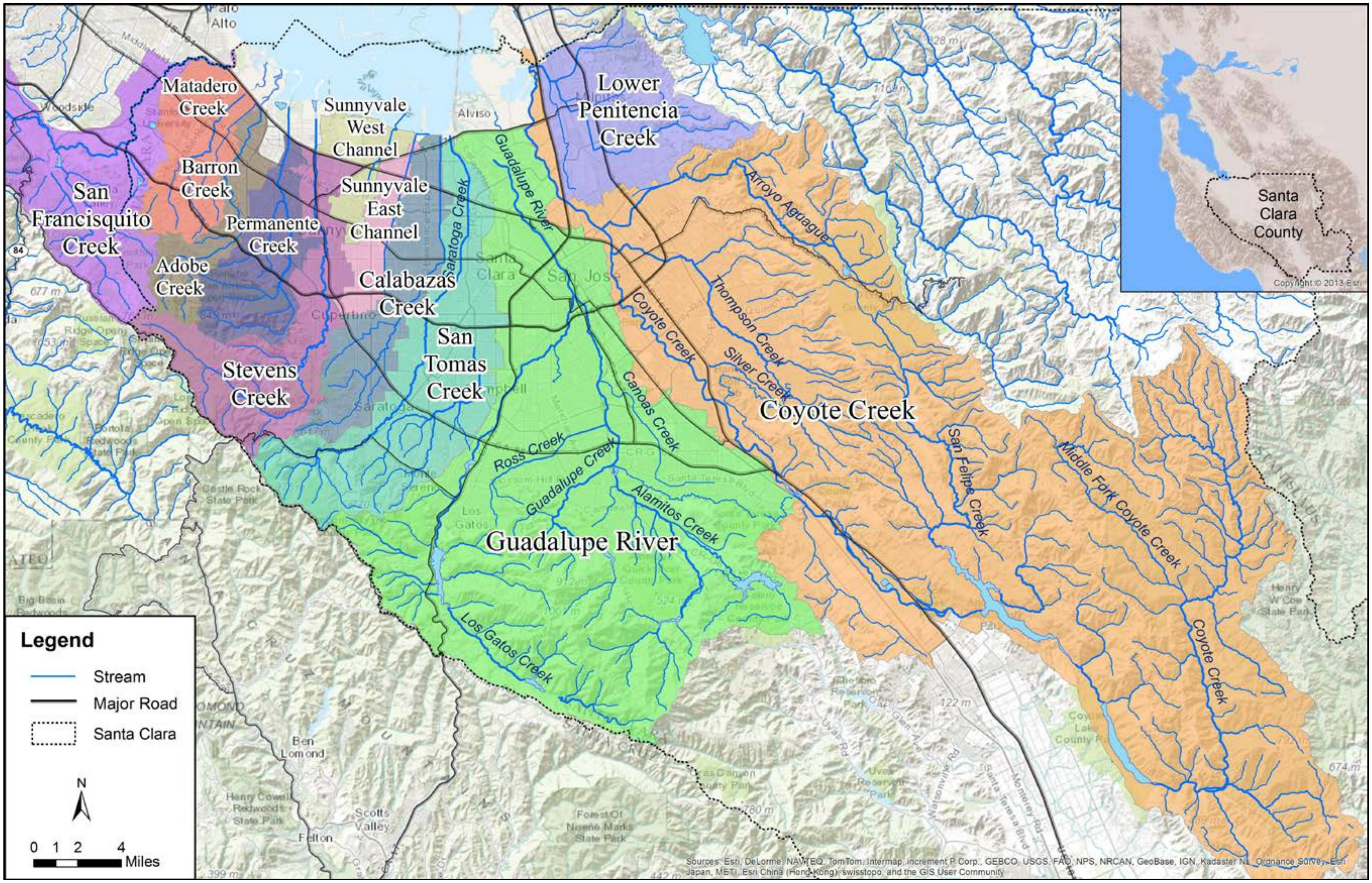

Figure 1.1. Watersheds within SCVURPPP jurisdictional boundaries.

Table 1.4. Sites and parameters monitored in WY2015 in Santa Clara County.

Map ID	Station Number	Watershed	Creek Name	Land Use	Latitude	Longitude	Probabilistic Monitoring		Targeted Monitoring			
							Bioassessment, Nutrients, General WQ	Toxicity, Sediment Chemistry	CRAM	Temp	Cont WQ	Pathogen Indicators
253	204R00253	Alameda Creek	Isabella Creek	NU	37.37893	-121.68361	x		x			
1315	205R01315	Coyote Creek	Coyote Creek	U	37.32263	-121.85837	x		x			
1411	205R01411	San Thomas Aquino	San Thomas Aquino	U	37.38842	-121.96863	x	x	x			
1562	205R01562	Guadalupe River	Shannon Creek	U	37.21995	-121.92418	x		x			
1610	205R01610	Guadalupe River	Los Gatos Creek	U	37.15754	-121.97052	x		x			
1669	205R01669	Coyote Creek	Coyote Creek	U	37.16628	-121.64787	x		x			
1706	205R01706	San Thomas Aquino	Saratoga Creek	U	37.26485	-121.02638	x	x	x			
1715	205R01715	Permanente Creek	Hale Creek	U	37.35606	-121.11071	x		x			
1738	205R01738	Guadalupe River	Ross Creek	U	37.23844	-121.94789	x		x			
1747	205R01747	Coyote Creek	Lower Silver Creek	U	37.35223	-121.84211	x		x			
1882	205R01882	Guadalupe River	Alamitos Creek	U	37.23577	-121.87047	x	x	x			
1923	205R01923	Lower Penitencia Creek	Lower Penitencia Creek	U	37.42266	-121.90707	x		x			
1930	205R01930	Guadalupe River	Los Gatos Creek	U	37.26308	-121.95209	x		x			
1962	205R01962	San Thomas Aquino	Sobey Creek	U	37.26295	-121.99919	x		x			
2051	205R02051	Guadalupe River	Guadalupe River	U	37.34548	-121.90422	x		x			
2074	205R02074	Guadalupe River	Golf Creek	U	37.23195	-121.87455	x		x			
2119	205R02119	San Francisquito Creek	Los Trancos Creek	U	37.36044	-122.20276	x		x			
2154	205R02154	San Thomas Aquino	Wildcat Creek	U	37.24502	-122.03136	x		x			
2211	205R02211	Stevens Creek	Stevens Creek	U	37.30555	-122.07191	x		x			
2307	205R02307	Guadalupe River	Los Gatos Creek	U	37.29904	-121.92683	x		x			
5	205SAR005	San Thomas Aquino	Saratoga Creek	U	37.35759	-121.97309						x
64	205STE064	Stevens Creek	Stevens Creek	U	37.31873	-122.06143				x		x
65	205STE065	Stevens Creek	Stevens Creek	U	37.31321	-122.06412				x	x	x
70	205STE070	Stevens Creek	Stevens Creek	U	37.30592	-122.07321				x		
71	205STE071	Stevens Creek	Stevens Creek	U	37.30253	-122.07487					x	x
95	205STE095	Stevens Creek	Stevens Creek	U	37.28269	-122.07527				x		
105	205STE105	Stevens Creek	Stevens Creek	U	37.26958	-122.09925				x	x	
225	204GUA225	Guadalupe River	Arroyo Calero	U	37.21388	-121.83368						x
205	205GUA205	Guadalupe River	Guadalupe Creek	U	37.22685	-121.90283				x		
210	205GUA210	Guadalupe River	Guadalupe Creek	U	37.21748	-121.91031				x		
213	205GUA213	Guadalupe River	Guadalupe Creek	U	37.21018	-121.90386				x		
218	205GUA218	Guadalupe River	Guadalupe Creek	U	37.20280	-121.88845				x		

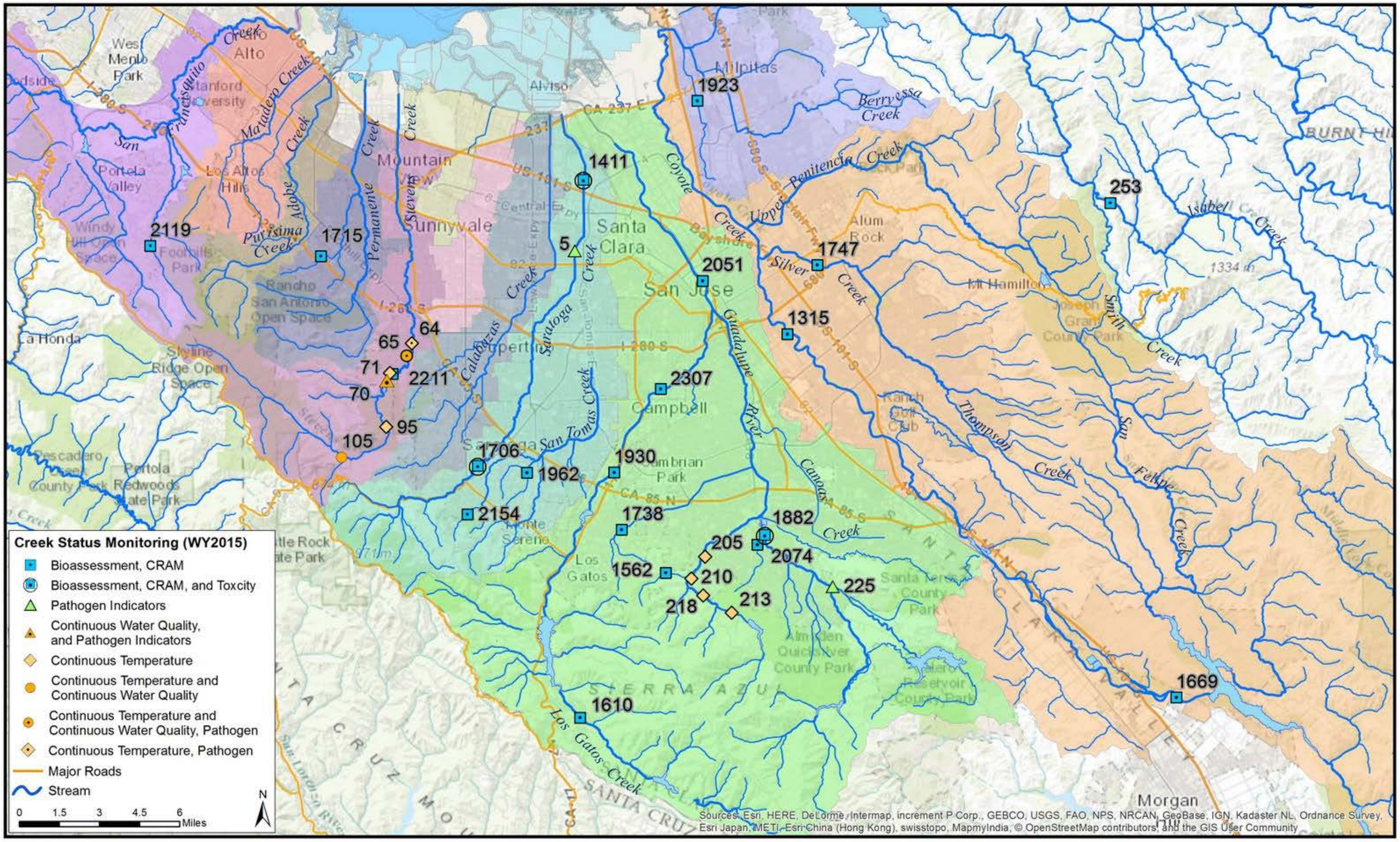

Figure 1.2. Map of SCVURPPP Program Area, major creeks, and sites monitored in WY2015.

1.4.2 Designated Beneficial Uses

Beneficial Uses in Santa Clara Valley creeks are designated by the SFRWQCB for specific water bodies and generally apply to all its tributaries. 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 WY2015.

Table 1.5. Creeks monitored by SCVURPPP in WY2015 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	
Coyote Creek				E			E		E			E	E	E	E	E	E	E	
Golf Creek																			
Guadalupe River				E					E			E	E	E	E	E	E	E	
Hale Creek									E						E	E	E	E	
Isabel Creek		E	E						E					E	E	E	E	E	
Los Gatos Creek		E	E	E					E			P	E	P	E	E	E	P	
Los Trancos Creek									E			E	E	E	E	E	E	E	
Lower Penitencia Creek															E	E	E	E	
Lower Silver Creek															E	E	E	E	
Ross Creek				E											E	E	E	E	
San Tomas Aquino Creek									E				E		E	E	E	E	
Saratoga Creek	E		E	E					E						E	E	E	E	
Shannon Creek			E	E					E			E	E	E	E	E	E	E	
Sobey Creek																			
Stevens Creek			E	E					E			E	E	E	E	E	E	E	
Wildcat Creek																			

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, 1981-2010[7]). 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

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

given year rarely equals the statistical average. Extended periods of drought and wet conditions are common. 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 WY2012 which was the first year of an ongoing severe drought on a statewide and local basis. Some climate scientists even suggest the current drought began as early as WY2006, punctuated by two slightly above average years in WY2009 and WY2010 (UCLA Water Resources Group[8]). Although measured precipitation in WY2015 at the San Jose Airport was near average, it did not signal the end of the drought as most of the rainfall occurred before January resulting in an uncharacteristically dry mid-winter and spring. As discussed in Section 2.0, this rainfall pattern drove decisions to discount a potentially significant April rainfall event and commence bioassessment monitoring early in the index period in order to ensure flowing conditions in several streams that were likely to desiccate.

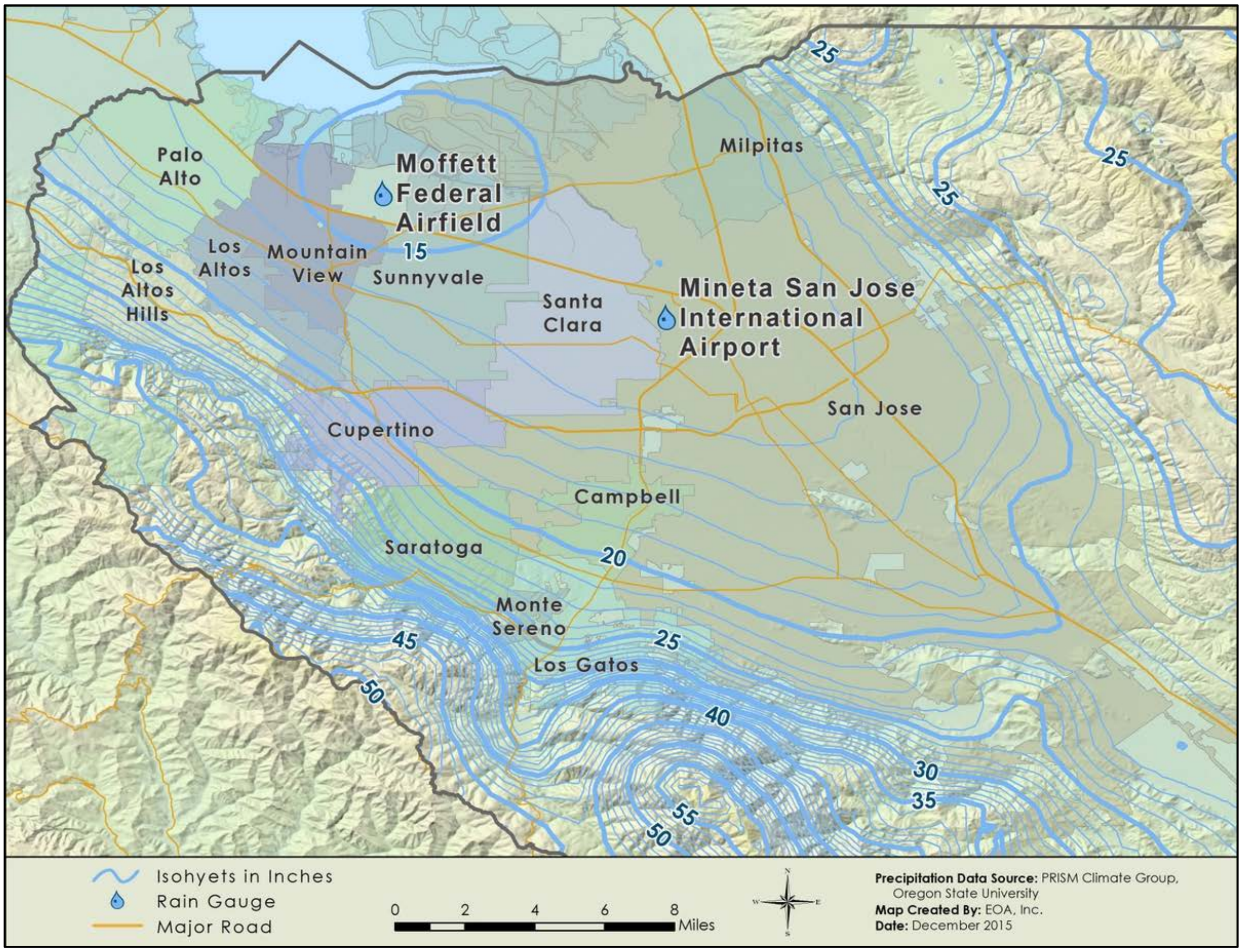

Figure 1.3. Average annual precipitation in Santa Clara Valley, modeled by the PRISM Climate Group for the period of 1981-2010.

[8] http://www.environment.ucla.edu/water/drought

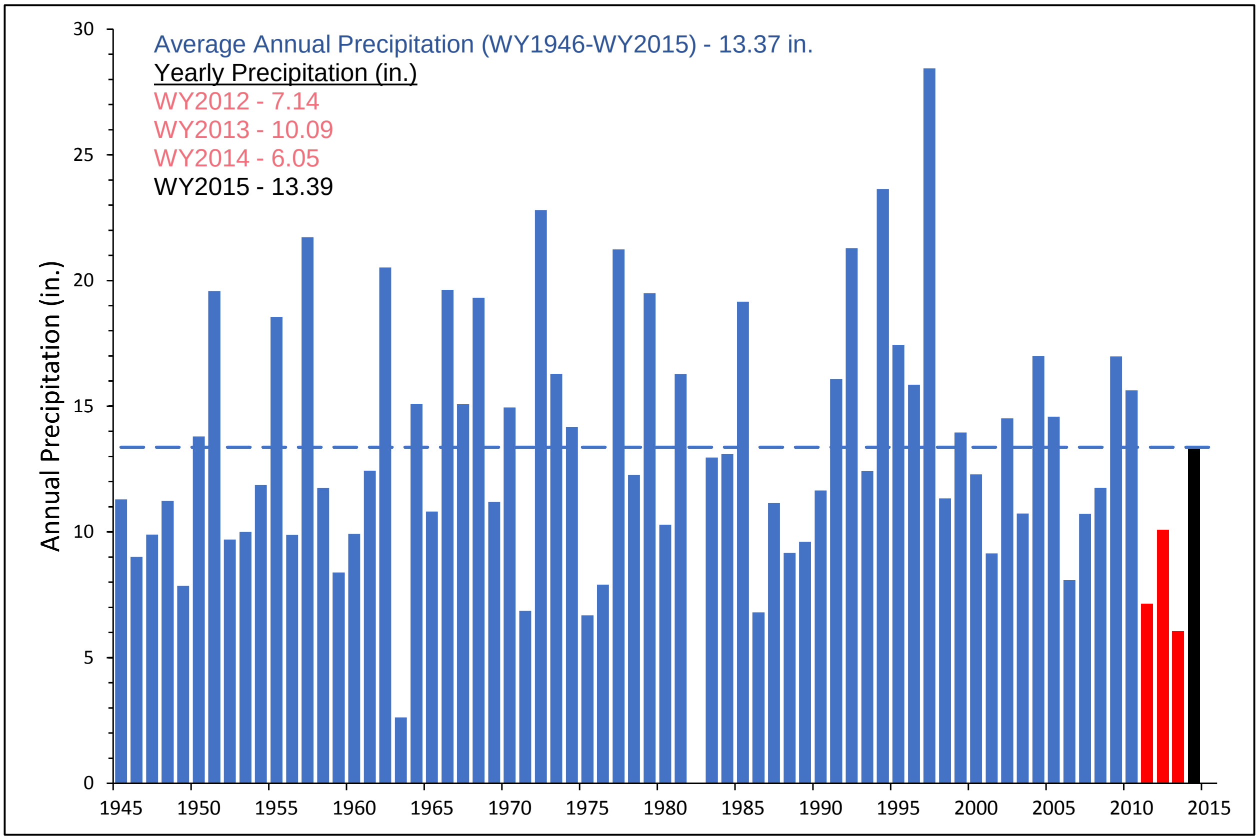

Figure 1.4. Annual rainfall recorded at the San Jose Airport, WY1946 – WY2015.

Individual dry years often result in decreased summer stream flows or earlier 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. Therefore, periods of drought can influence some of 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.

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, 2014a), and monitoring was performed according to protocols specified in the BASMAA RMC SOPs) (BASMAA, 2014b), and in conformity with methods specified by the SWAMP QAPP[9]. 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 WY2015 was of sufficient quality. While some data were flagged in the project database, none of the data were rejected.

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

2.0 PROBABILISTIC MONITORING

2.1 Introduction

The probabilistic monitoring design allows each individual RMC participating program to objectively assess stream ecosystem conditions within its program area (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 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 four years, the SCVURPPP and Regional Water Board have sampled 92 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)[10].

The second question 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 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. Trend analysis for the RMC probabilistic survey however, will require more than four years of data collection. Preliminary long-trend analysis of biological condition may be possible for some stream reaches using a combination of historical targeted data with the probabilistic data.

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

The following section of this report will present bioassessment data collected at twenty sites in WY2015. A preliminary regional analysis of biological indicator and stressor data collected in Santa Clara County over the past four years (WY2012-WY2015) is being developed.

2.2 Methods

2.2.1 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 (SMC 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. 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 future 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 in urban areas and 20% in non-urban areas. During the permit term of MRP 1.0, RMC participants coordinated with the SFRWQCB by identifying additional non-urban sites from the probabilistic sample frame for SWAMP to conduct bioassessments[11]. Between WY2012 and WY2015, the SFRWQCB conducted 34 non-urban bioassessments within RMC jurisdiction, including 12 sites in Santa Clara County. Bioassessment data from Santa Clara County collected by SWAMP prior to WY2015 are included in this report.

2.2.2 Site Evaluations

Sites identified in the regional sample draw were evaluated by each RMC participant in chronological order using a two-step process described in RMC Standard Operating Procedure FS-12 (BASMAA 2014b), consistent with the procedure described by Southern California Coastal Water Research Project (SCCWRP) (2012). Each site was evaluated to determine if it met the following RMC sampling location criteria:

1. The location (latitude/longitude) provided for a site is located on or is within 300 meters of a non-impounded receiving water body[12];
2. Site is not tidally influenced;

[11] SFRWQCB SWAMP staff have indicated that they will not conduct RMC related bioassessment monitoring during MRP 2.0.
[12] The evaluation procedure permits certain adjustments of actual site coordinates within a maximum of 300 meters.

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[13].

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.

2.2.3 Field Sampling Methods

Biological sample collection and processing was consistent with the BASMAA RMC QAPP (BASMAA 2014a) and SOPs (BASMAA 2014b).

In accordance with the RMC QAPP (BASMAA 2014a) 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 WY2015, significant storms occurred on April 7 and April 25. Due to antecedent dry conditions, bioassessments were initiated on April 16 at sites exhibiting low flow conditions. Visual observations at these sites indicated that the April 7 storm event did not appear to generate high flows. Presumably, antecedent dry ground conditions absorbed much of the runoff from the precipitation event. Bioassessments were not conducted between April 27 and May 7 to allow some of the more urban sites to recover from the April 7 rainfall event.

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 (Ode 2007, Fetscher 2009). Physical habitat data were collected within the sample reach using methods described in Ode (2007) for the SWAMP "Basic" level of effort[14], with the following additional measurements/assessments as defined in the "Full" level of effort (as prescribed in MRP 1.0): water depth and pebble counts, cobble embeddedness, flow habitat delineation, and instream habitat complexity. The presence of micro- and macroalgae was assessed during the pebble counts following methods described in Fetscher (2009).

[13] 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.

[14] The SWAMP "Full" level of effort of physical habitat data collection is now required in MRP 2.0, starting in WY2016.

Immediately prior to biological and physical habitat data collection, water samples were collected at probabilistic sites for nutrients, conventional analytes, ash free dry mass, and chlorophyll a using the Standard Grab Sample Collection Method as described in SOP FS-2 (BASMAA 2014b). 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 2014b) (see Section 5.0 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 laboratory for analysis. The laboratory analytical methods used for BMIs followed Woodward et al. (2012), using 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 and revised when necessary to match the SWAMP master taxonomic list.

Approximately one month following bioassessments, riparian assessments using the California Rapid Assessment Method (CRAM) were conducted at the same locations (and reach lengths) monitored for the RMC probabilistic design (i.e., biological and physical habitat assessments, nutrients and physical chemical water quality). CRAM was conducted at bioassessment locations to assess the utility of using CRAM data to explain the aquatic biological condition. CRAM is performed within a defined riparian Assessment Area and is composed of the following subcategories: 1) buffer and landscape context; 2) hydrology; 3) physical structure; and 4) biotic structure. Procedures describing methods for scoring riparian attributes are described in Collins et al. (2008).

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.

2.2.4.1 Biological Indicators

Benthic Macroinvertebrates

The California Stream Condition Index (CSCI) is an assessment tool that was developed by the State Water Resources Control Board (State Board) to support the development of California's statewide Biological Integrity Plan[15]. The CSCI translates benthic macroinvertebrate data into an overall measure of stream health. The CSCI was developed using a large reference data set that represents the full range of natural conditions in California and by the use of site-specific models for predicting biological communities. The CSCI combines two types of indices: 1) taxonomic completeness, as measured by the ratio of observed-to-expected taxa (O/E); and 2) ecological structure and function, measured as a predictive 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.

The State Board is continuing to evaluate the performance of CSCI in a regulatory context. In the re-issued MRP 2.0 (adopted on November 19, 2015), the Regional Water Board defined a CSCI score of

[15] The State Water Board is currently working on a draft Biological Integrity Plan with public draft anticipated in spring 2016.

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

The State Water Board is currently developing and testing assessment tools for benthic algae data as a measure of biological condition and identification of potential stressors. A comprehensive set of 25 stream algal indices of biological integrity (IBIs) have been developed and tested using algae data collected in Southern California (Fetscher et al. 2014). The 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). Three of these algal IBIs were used to evaluate algae data collected in Santa Clara County including a soft algae index (S2), a diatom index (D18) and a hybrid index (H20). Algae scores for these IBIs were calculated using an online calculator available on the Southern California Coastal Water Research Project (SCCWRP) website (http://www.sccwrp.org/Data/DataTools/algaeIBI.aspx). As previously mentioned, the algae IBIs were developed and tested on data collected in Southern California. Further study is needed to determine their applicability for assessing the biological condition of San Francisco Bay Area streams.

Riparian Habitat

The California Rapid Assessment Method (CRAM) evaluates four different components of riparian condition on a scale from 25 to 100. The four attributes include: 1) buffer and landscape context; 2) hydrology; 3) physical structure; and 4) biotic structure. These four attributes are summed together and divided by four to calculate an overall total CRAM score for each bioassessment site. For this study, total CRAM score was used as the biological indicator for riparian habitat condition. A statewide approach to define condition categories for CRAM scores has not been developed.

2.2.4.2 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 and CRAM). 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, Algae IBI, and CRAM scores.

Index	Likely Intact (>30th)	Possibly Intact (10th – 30th)	Likely Altered (1st – 10th)	Very Likely Altered (< 1st)
Benthic Macroinvertebrates (BMI)				
CSCI Score	≥ 0.92	0.79 – 0.92	0.63 – 0.79	< 0.63
Benthic Algae				
S2 Score	≥ 60	47 - 60	29 - 47	< 29
D18 Score	≥ 72	62 - 72	49 - 62	< 49
H20 Score	≥ 70	63 - 70	54 - 63	< 54
Riparian Habitat Condition				
Total CRAM Score	≥ 79	72 - 79	63 - 72	< 63

A CSCI score below 0.795 is referenced in the recently re-issued MRP 2.0 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).

2.2.4.3 Stressor Variables

The 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 Basin Plan. 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 km^2, 5000 km^2 and entire watershed).

2.2.4.4 Stressor Thresholds

Stressor thresholds were used to evaluate the water chemistry data collected at the bioassessment sites (Table 2.2). Per provision C.8.d, thresholds for some of the nutrient and conventional analytes were derived from existing regulations and guidance. Relevant water quality standards for these analytes include the San Francisco Basin Water Quality Control Plan (Basin Plan) (SFRWQCB 2013), the California Toxics Rule (CTR) (USEPA 2000), and various USEPA sources. Of the eleven nutrients and conventional analytes sampled in association with bioassessment monitoring, water quality standards or established thresholds only exist for three: ammonia (unionized form) and chloride and nitrate (for waters with MUN beneficial use only). The Basin Plan also lists Water Quality Objectives for three of the general water quality parameters: dissolved oxygen, pH, and temperature (narrative). MRP 2.0 references an acute threshold for continuous measurements of temperature, defined by Sullivan et al. (2001), for streams supporting salmonid fish communities.

Table 2.2. Thresholds for physical habitat, nutrient and general water quality variables.

Environmental Variable	Units	Threshold	Direction	Source
Nutrients and Ions				
Nitrate as N	mg/L	10	Increase	Basin Plan
Un-ionized Ammonia	mg/L	0.025	Increase	Basin Plan
Chloride	mg/L	250	Increase	Basin Plan
General Water Quality				
Oxygen, Dissolved	mg/L	5.0 or 7.0	Decrease	Basin Plan
pH		6.5 and 8.5		Basin Plan
Temperature	°C	24	Increase	MRP

2.2.4.5 Stressor Association with Biological Conditions

Correlations between biological indicator data (i.e., CSCI scores, algae IBIs) and potential stressors (i.e., physical habitat measurements, water chemistry) were evaluated for all 20 probabilistic sites using the Spearman Rank Correlation 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.

Probabilistic data can be used to assess the extent and relative risk of stressors at the regional scale. 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. A preliminary analysis of these approaches using bioassessment data collected at probabilistic sites over the past four years in the Santa Clara Valley (n=89) is currently being developed.

2.3 Results and Discussion

2.3.1 Site Evaluations

During WY2015, the SCVURPPP and Regional Water Board conducted site evaluations at a total of 125 potential probabilistic sites in Santa Clara County drawn from the Master List. Of these sites, a total of twenty-three were sampled in WY2015 (rejection rate of 82%). Approximately 17% of the sampled sites were classified as non-urban land use. Land use classification, sampling location and date for each sampled site are shown in Table 2.3.

Table 2.3. Bioassessment sampling date and locations in Santa Clara County in WY2015.

Station Code	Creek	Program	Land Use	Sample Date	Latitude	Longitude
204R00253	Isabel Creek	SCVURPPP	NU	4/20/15	37.37893	-121.68361
205R00593	Soda Springs Canyon	SWAMP	NU	5/28/15	37.16919	-121.50815
205R00657	MF Coyote Creek	SWAMP	NU	6/02/15	37.17992	-121.50095
204R00893	Smith Creek	SWAMP	NU	6/11/15	37.32321	-121.66777
205R01315	Coyote Creek	SCVURPPP	U	5/18/15	37.32263	-121.85837
205R01411	San Thomas Aquino	SCVURPPP	U	5/19/15	37.38842	-121.96863
205R01562	Shannon Creek	SCVURPPP	U	4/16/15	37.21995	-121.92418
205R01610	Los Gatos Creek	SCVURPPP	U	4/28/15	37.15754	-121.97052
205R01669	Coyote Creek	SCVURPPP	U	5/20/15	37.16628	-121.64787
205R01706	Saratoga Creek	SCVURPPP	U	4/28/15	37.26485	-122.02638
205R01715	Hale Creek	SCVURPPP	U	4/29/15	37.35606	-122.11071
205R01738	Ross Creek	SCVURPPP	U	4/27/15	37.23844	-121.94789
205R01747	Lower Silver Creek	SCVURPPP	U	5/18/15	37.35223	-121.84211
205R01882	Alamitos Creek	SCVURPPP	U	4/27/15	37.23577	-121.87047
205R01923	Lower Penitencia Cr	SCVURPPP	U	5/21/15	37.42266	-121.90707
205R01930	Los Gatos Creek	SCVURPPP	U	5/26/15	37.26308	-121.95209
205R01962	Sobey Creek	SCVURPPP	U	4/21/15	37.26295	-121.99919
205R02051	Guadalupe River	SCVURPPP	U	5/19/15	37.34548	-121.90422
205R02074	Golf Creek	SCVURPPP	U	4/21/15	37.23195	-121.87455
205R02119	Los Trancos Creek	SCVURPPP	U	4/29/15	37.36044	-122.20276
205R02154	Wildcat Creek	SCVURPPP	U	4/16/15	37.24502	-122.03136
205R02211	Stevens Creek	SCVURPPP	U	5/14/15	37.30555	-122.07191
205R02307	Los Gatos Creek	SCVURPPP	U	5/26/15	37.29904	-121.92683

Since WY2012, a total of 92 probabilistic sites were sampled by SCVURPPP (n=80) and SWAMP (n=12)[16] in Santa Clara County. During the four year sampling period, SCVURPPP sampled 70 urban and 10 non-urban sites; SWAMP sampled 12 non-urban sites. A total of 347 total sites were evaluated to obtain 92 samples, a rejection rate of 72%[17]. The rejection criteria included no access, low or no flow and combination of other reason (e.g., creek not present, tidal influence). 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 347 sites are shown in Figure 2.1.

Table 2.4. Probabilistic site evaluation results in Santa Clara County between WY2012 – WY2015.

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	70 (37%)	15 (8%)	83 (44%)	44 (11%)	212
Non-Urban	22 (16%)	37 (27%)	72 (53%)	4 (3%)	135
Total	92 (28%)	52 (16%)	155 (48%)	25 (8%)	347

[16] The data from three SWAMP samples collected in WY2015 were not available for analyses in this report. Data results from nine probabilistic sites sampled by SWAMP are included in this report.
[17] The rejection rate is an important factor in defining the confidence level of statistical data interpretations at countywide and regional scales.

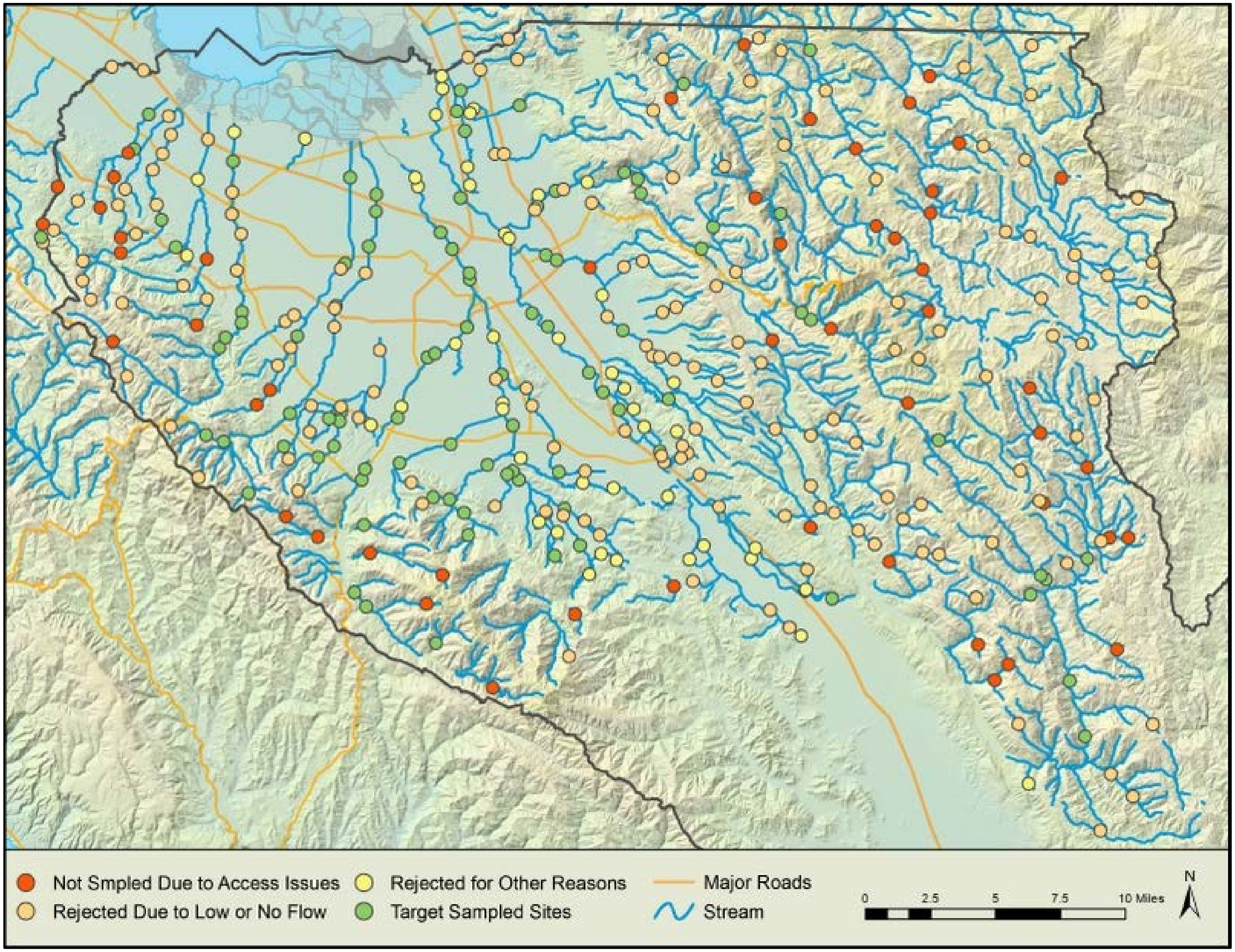

Figure 2.1. Site evaluation results for probabilistic sites (n=347) in Santa Clara County, WY2012 – WY2015.

Low or no flow conditions were the most common reason for site rejection (48% 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 four 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 the second most common reason for not sampling a site (16% 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 were rejected for a variety of reasons, including site location not on a creek, site was tidally influenced, or site was not wadeable.

2.3.2 Biological Condition Assessment

Biological condition, as represented by CSCI scores and algae IBI scores (S2, D18 and H20), for the 20 probabilistic sites sampled by SCVURPPP during WY2015 are listed in Table 2.5. The data from three SWAMP samples collected in WY2015 were not available for analyses in this report The condition categories for three of the biological indicator scores (CSCI, D18 and CRAM), as defined in Table 2.1, are illustrated in Figure 2.2 for each of the 20 sites sampled in 2015.

Three of the twenty bioassessment sites sampled in WY2015 by SCVURPPP had CSCI scores that were classified as “possibly intact” or “likely intact” condition. The combined classifications are above the MRP 2.0 threshold value of 0.795 and are herein referred to as “good” biological condition in this report. Although all three sites are classified as urban (Table 2.3), two of the three sites were located near the urban boundary and likely have less development in their contributing watersheds compared to other urban sites. Thirteen of the urban sites were ranked “very likely altered” (CSCI < 0.63), indicating highly degraded condition. Site with a D18 score greater than or equal to 62 is considered to be in “good” biological condition. For S2 and H20, sites with scores great than or equal to 47 and 63, respectively, are considered to be in “good” biological condition.

The CSCI scores from WY2015 show similar pattern to previous years. Biological condition, based on CSCI score, for all 89 probabilistic sites sampled over the previous four years (2012-2015) are shown in Figure 2.3. The CSCI scoring distribution, shown as box plots, for both urban and non-urban sites sampled between WY2012 and WY2015 is shown are Figure 2.4. The median CSCI score for all four years ranged from 0.44 to 0.63 for urban sites and 0.7 to 0.98 for non-urban sites.

Table 2.5. Biological condition scores, presented as CSCI and algae IBIs (S2, D18 and H20) for 20 probabilistic sites sampled in WY2015. Site characteristics related to channel modification and flow condition are also presented. Bold values indicate "good" condition[1].

Station Code	Creek	Elevation (ft)	Land Use	Modified Channel[2]	Flow[3]	CSCI Score	Algae "S2" IBI Score	Diatom "D18" IBI Score	Hybrid "H20" IBI Score
204R00253	Isabel Creek	1682	NU	N	P	0.7	**83**	**78**	**86**
205R01315	Coyote Creek	96	U	N	P	0.33	20	20	16
205R01411	San Thomas Aquino	22	U	Y	P	0.4	13	24	20
205R01562	Shannon Creek	485	U	N	NP	0.57	40	**86**	**69**
205R01610	Los Gatos Creek	732	U	N	P	**1.08**	40	**80**	54
205R01669	Coyote Creek	389	U	N	P	0.67	7	32	20
205R01706	Saratoga Creek	403	U	N	P	**0.81**	7	60	40
205R01715	Hale Creek	283	U	N	NP	0.56	38	32	31
205R01738	Ross Creek	313	U	N	P	0.54	27	46	41
205R01747	Lower Silver Creek	101	U	Y	P	0.39	15	28	21
205R01882	Alamitos Creek	205	U	N	P	0.67	30	60	50
205R01923	Lower Penitencia Cr	21	U	Y	P	0.26	2	40	25
205R01930	Los Gatos Creek	233	U	N	P	0.42	25	48	40
205R01962	Sobey Creek	315	U	N	NP	0.46	**47**	16	21
205R02051	Guadalupe River	55	U	N	P	0.3	13	6	8
205R02074	Golf Creek	213	U	Y	NP	0.51	17	40	36
205R02119	Los Trancos Creek	579	U	N	NP	0.78	38	**64**	52
205R02154	Wildcat Creek	669	U	N	NP	**0.86**	**83**	**78**	**74**
205R02211	Stevens Creek	403	U	N	P	0.51	37	46	49
205R02307	Los Gatos Creek	152	U	N	P	0.61	**67**	56	51

[1] "Good" condition scores are CSCI > 0.795, D18 ≥ 62, S2 ≥ 47, or H20 ≥ 63.
[2] Highly modified channel is defined as having armored bed and banks (e.g., concrete, gabion, and rip rap) for majority of the reach or characterized as highly channelized earthen levee.
[3] Flow status (P = perennial, NP = non-perennial) was based on visual observations at each site made during fall or springs seasons.

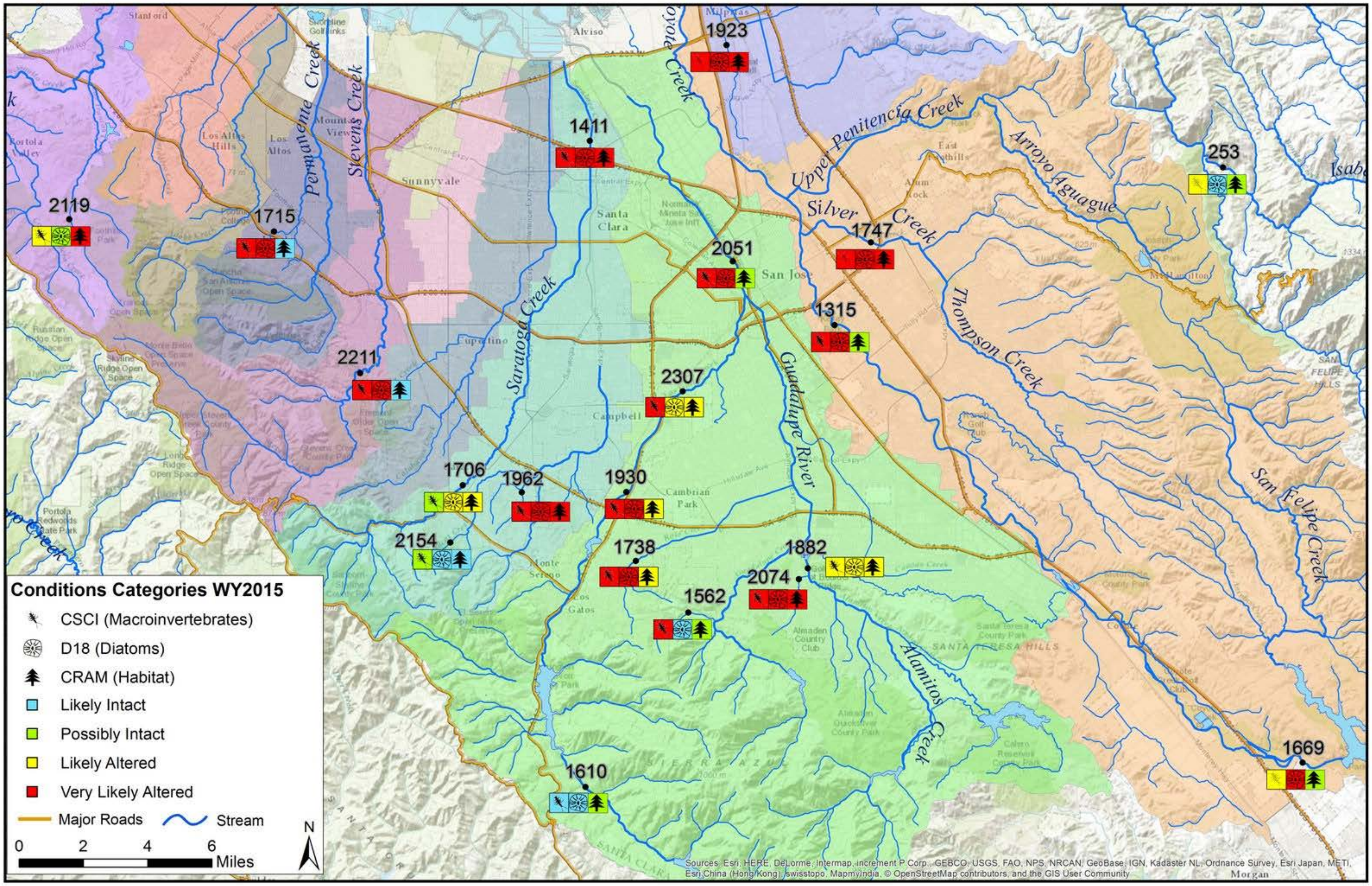

Figure 2.2. Condition category as represented by CSCI, D18 and total CRAM scores for 20 probabilistic sites sampled in Santa Clara County during WY2015.

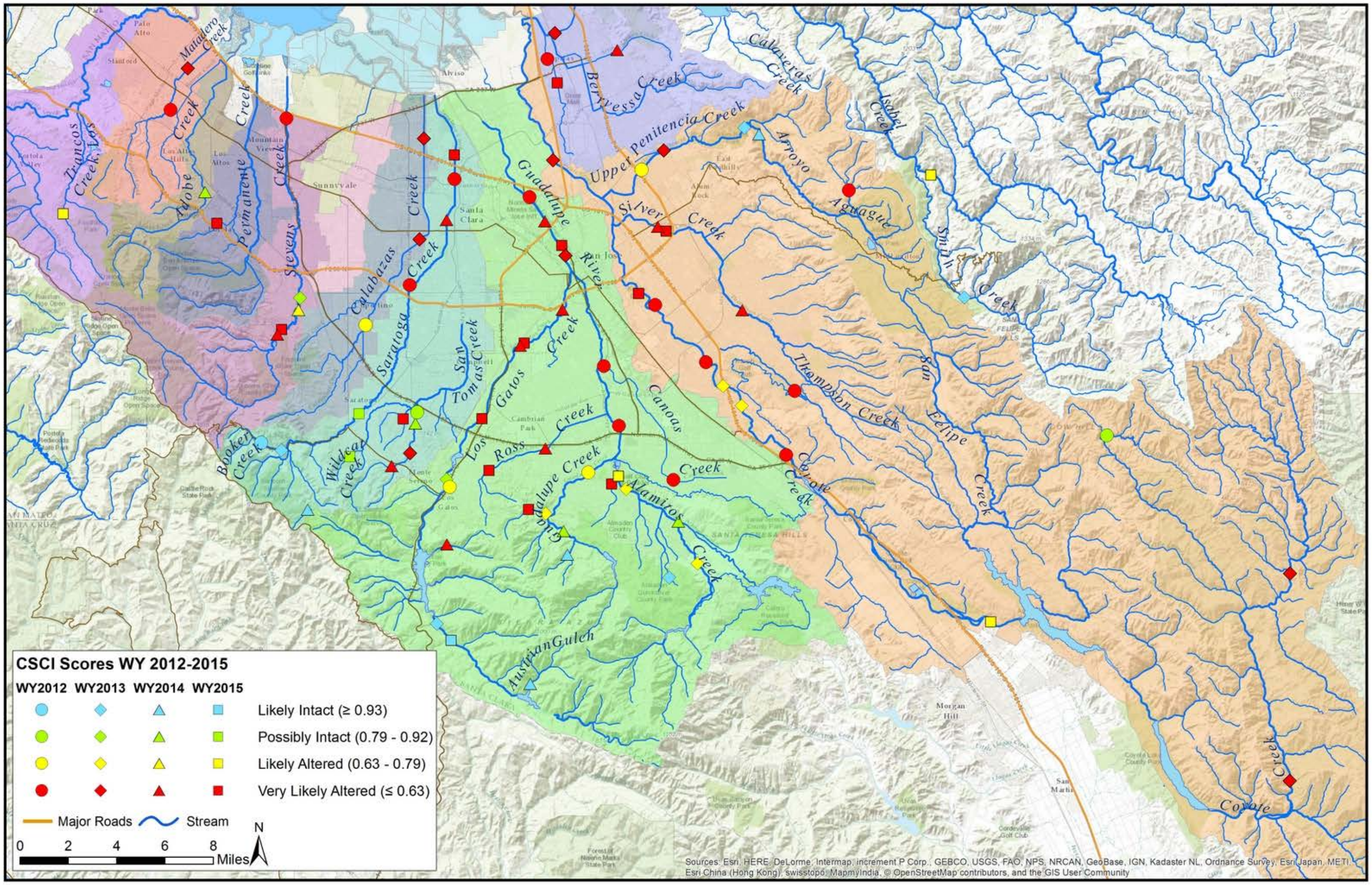

Figure 2.3. Biological condition based on CSCI scores for 89 sites sampled in Santa Clara County by SCVURPPP and SWAMP between WY2012 and WY2015.

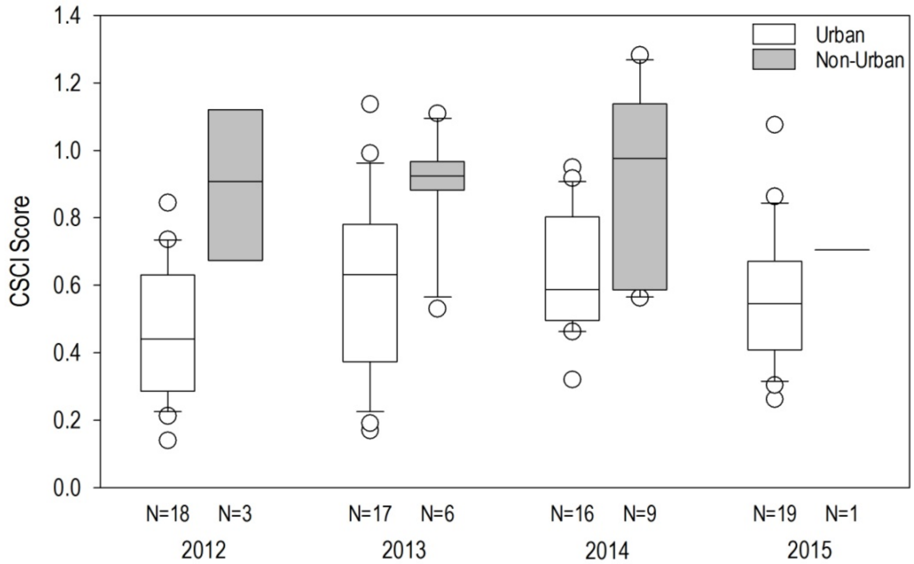

Figure 2.4. Box plots showing CSCI scores, grouped by land use classification, for 89 bioassessment sites sampled in Santa Clara County between WY2012 and WY2015.

The biological condition of probabilistic sites monitored in WY2015 was slightly higher using algae IBI scores. Five sites were ranked in good condition based on D18 scores (D18 ≥ 62). Good condition, based on S2 (S2 ≥ 47) and H20 (H20 ≥ 63) scores, occurred at four and three of the sites, respectively. Two of these sites (204R00253 and 205R02154) were ranked in good condition for each of the three algae IBIs.

It is important to understand that the CSCI was developed by the State Board to assess wadeable, perennial streams in California. However, this report (and the MRP) use the CSCI to evaluate BMI data collected at both perennial and non-perennial sites. The CSCI scoring tool appears to have a similar scoring distribution and central tendencies at non-perennial sites compared to perennial sites[18] (Figure 2.5). Similarly, all three algae IBIs seem to have similar performance at sites with either flow classification[19].

[18] Not significantly different, two-tailed p-value = 0.479
[19] All two-tailed p-values > 0.15

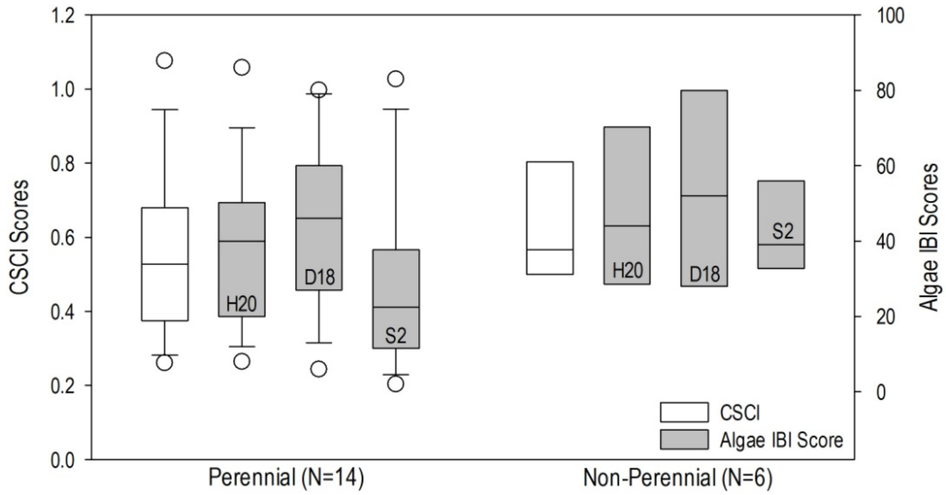

Figure 2.5. Box plots showing CSCI and algae IBI scores, grouped by flow classification, for 20 bioassessment sites sampled in Santa Clara County in WY2015.

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 2.6). The algae IBI scores were especially variable at sites with low percent impervious area (< 3%).

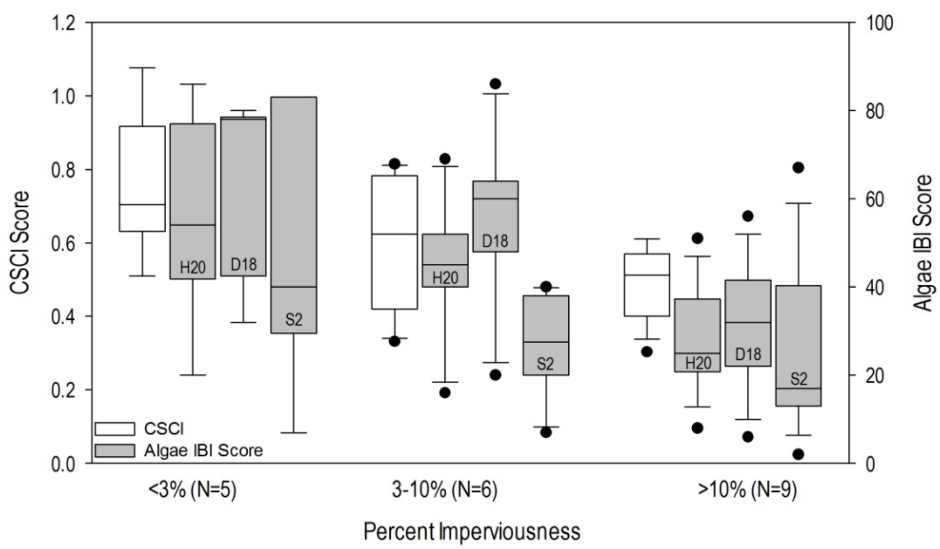

Figure 2.6. Box plots showing CSCI and algae IBI scores, grouped by percent impervious area, for 20 bioassessment sites sampled in Santa Clara County in 2015.

CSCI scores were better correlated with site elevation (r^2 = 0.76, p value ≤0.001) compared to D18 scores (r^2 = 0.13, 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 2.7). For this reason, algae may provide useful data to assess water quality issues at urban sites with poor habitat.

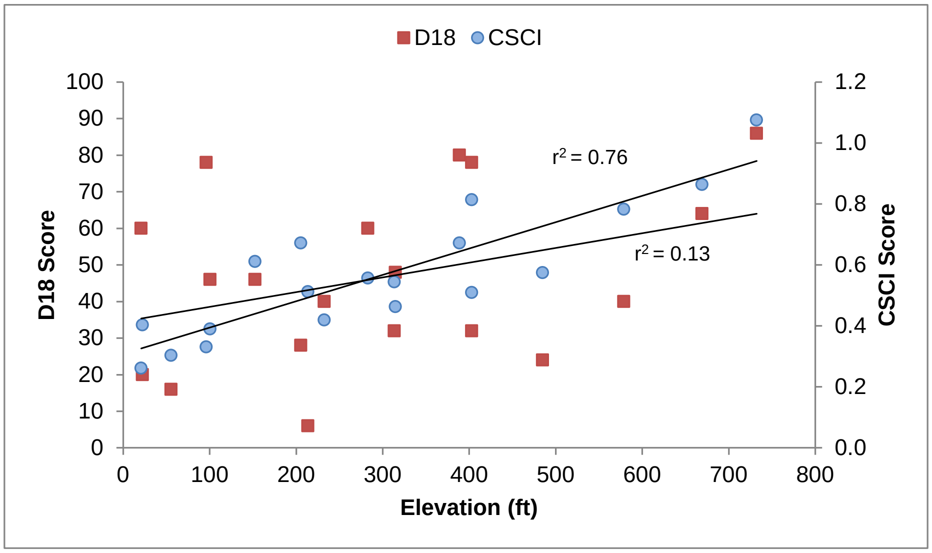

Figure 2.7. D18 and CSCI scores plotted with elevation for 20 bioassessment sites sampled in Santa Clara County in WY2015.

The individual attribute and CRAM scores for the same 20 probabilistic sites are presented in Table 2.6. Nine of the twenty bioassessment sites had CRAM scores that were ranked in good condition (total CRAM ≥ 72). PHAB score, a qualitative physical habitat assessment, is also provided in Table 2.6. Although not considered a biological indicator, PHAB scores may be useful for evaluating factors related to physical habitat that may impact biological communities. Total PHAB score had better correlation with CSCI score (r^2=0.36, p value = 0.005) (Figure 2.8) compared to total CRAM score (r^2=0.19, p value = 0.005) (Figure 2.9).

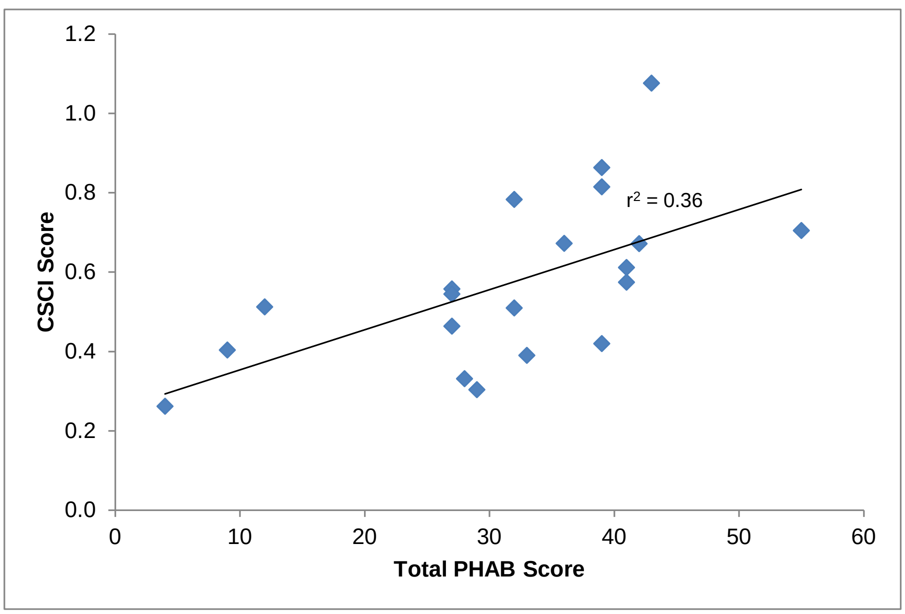

Figure 2.8. Total PHAB scores compared to CSCI scores at 20 bioassessment sites sampled in Santa Clara County in WY2015.

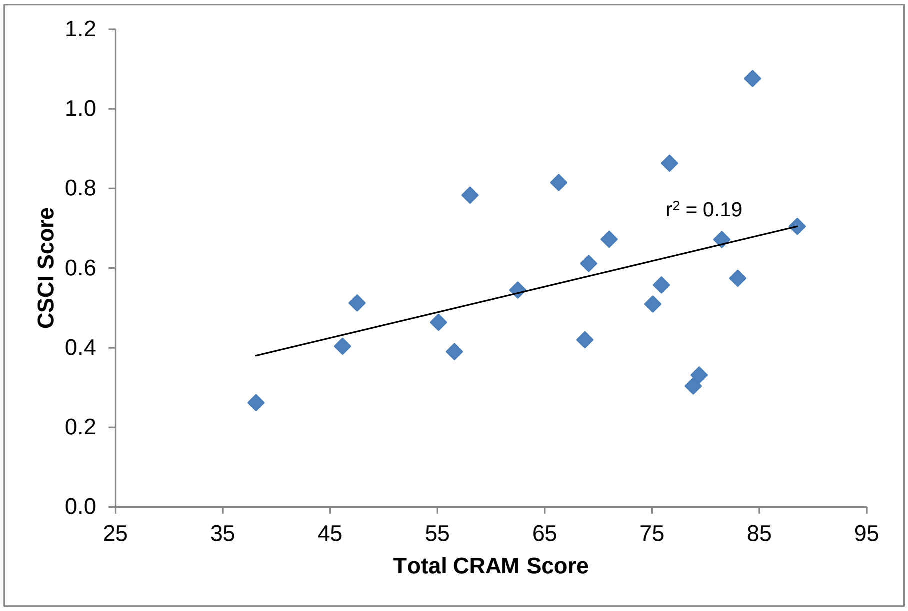

Figure 2.9. Total CRAM scores compared to CSCI scores at 20 bioassessment sites sampled in Santa Clara County in WY2015.

Sites with CSCI scores below the 0.795 threshold will be added to the list of candidate SSID projects.

Table 2.6. Physical habitat (PHAB) and riparian assessment scores (CRAM) for 20 probabilistic sites sampled in Santa Clara County during WY2015.

Station Code	Creek Name	PHAB				CRAM				
		Channel Alteration Score	Epifaunal Substrate Score	Sediment Deposition Score	Total Score	Land	Hydro	Physical	Biotic	Total Score
204R00253	Isabel Creek	20	17	18	55	100	83	88	83	89
205R01315	Coyote Creek	13	7	8	28	83	75	88	72	79
205R01411	San Thomas Aquino	5	3	1	9	50	58	38	39	46
205R01562	Shannon Creek	16	12	13	41	81	83	88	81	83
205R01610	Los Gatos Creek	18	17	8	43	90	83	75	89	84
205R01669	Coyote Creek	13	16	13	42	68	83	100	75	82
205R01706	Saratoga Creek	12	13	14	39	63	58	75	69	66
205R01715	Hale Creek	18	6	3	27	66	83	88	67	76
205R01738	Ross Creek	6	15	6	27	63	58	63	67	63
205R01747	Lower Silver Creek	11	9	13	33	25	83	63	56	57
205R01882	Alamitos Creek	12	13	11	36	41	75	88	81	71
205R01923	Lower Penitencia Creek	2	1	1	4	55	42	25	31	38
205R01930	Los Gatos Creek	14	16	9	39	38	75	88	75	69
205R01962	Sobey Creek	11	7	9	27	73	42	50	56	55
205R02051	Guadalupe River	8	9	12	29	81	58	88	89	79
205R02074	Golf Creek	3	3	6	12	66	50	38	36	48
205R02119	Los Trancos Creek	14	11	7	32	49	58	50	75	58
205R02154	Wildcat Creek	15	15	9	39	73	75	75	83	77
205R02211	Stevens Creek	16	11	5	32	86	58	75	81	75
205R02307	Los Gatos Creek	13	17	11	41	75	67	63	72	69

2.3.3 Stressor Assessment

2.3.3.1 Stressor Thresholds

Nutrient and conventional analyte concentrations measured in water samples collected at twenty bioassessment sites in Santa Clara County during WY2015 are shown in Table 2.7. Sites with nutrient concentrations exceeding water quality objectives are indicated in bold. The water quality objective for un-ionized ammonia (0.025 mg/L) was slightly exceeded at site 205R02074, with a value of 0.027 mg/L.

Physical habitat data and general water quality measurements sampled at the twenty bioassessment sites in WY2015 are listed in Table 2.8. GIS calculations of percent urbanization of the drainage area upstream of each sampling location are also listed in Table 2.8. Sites with general water quality results exceeding water quality objectives or MRP 2.0 thresholds are indicated in bold. Three measurements were below water quality objectives for dissolved oxygen. Site 205R01315 (Coyote Creek at Kelley Park) and site 205R02051 (Guadalupe River at Coleman) were below dissolved oxygen (DO) objectives for both WARM and COLD Beneficial Uses, and site 205R01882 (Alamitos Creek 0.5 mile upstream Almaden Reservoir) was below DO objectives for COLD Beneficial Uses. Thresholds from published sources were rarely exceeded for physical habitat variables.

2.3.3.2 Stressor Association with Biological Condition

Spearman Rank Correlations for environmental variables associated with CSCI scores are presented in Figure 2.10, and D18 scores in Figure 2.11. Statistically significant variables are indicated as shaded columns. Coefficients values greater than ±0.5 indicate a strong relationship between the variables.

CSCI scores are negatively correlated with land use variables (percent impervious and urban), specific conductivity, unionized ammonia and SSC. D18 had negative correlations with same environmental variables as CSCI, in addition to chloride, total phosphorus and HDI score. CSCI and D18 scores were both positively correlated with two PHAB parameters (epifaunal substrate score and channel alteration score) and the biotic attribute score from CRAM.

Another potential stressor that should be considered but was not qualitatively assessed relates to the lower than average precipitation and stream flow during the four 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.

Table 2.7. Nutrient and conventional constituent concentrations of water samples collected at 20 sites in Santa Clara County during WY2015. 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	DOC	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen As N	Total Nitrogen	Ortho-Phosphate as P	Phosphorus as P	Silica as SiO2	SSC
		mg/L	mg/L	mg/L	g/m2	mg/m2	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Water Quality Objective		NA	0.025	250	NA	NA	NA	10	NA	NA	NA	NA	NA	NA	NA
204R00253	Isabel Cr	0.13	0.004	9	16	6	2.1	0.005	0.0025	0.62	0.58	0.003	0.02	12	1
205R01315	Coyote Cr	0.055	0.002	8	150	9	1.3	0.046	0.0025	0.53	1.32	0.016	0.02	17	1
205R01411	San Thomas Aquino	0.2	0.011	83	302	15	6.3	0.29	0.025	1	0.61	0.21	0.23	19	2
205R01562	Shannon Cr	0.18	0.000	59	87	108	2.5	0.17	0.0025	0.44	0.89	0.046	0.06	15	4.8
205R01610	Los Gatos Cr	0.02	0.001	45	229	11	1.5	0.005	0.0025	0.88	1.04	0.024	0.02	26	1
205R01669	Coyote Cr	0.044	0.001	100	175	56	4.2	0.64	0.0025	0.4	0.56	0.088	0.1	16	3.6
205R01706	Saratoga Cr	0.044	0.002	32	48	84	1.5	0.12	0.0025	0.44	0.98	0.043	0.04	23	1
205R01715	Hale Cr	0.15	0.002	110	672	101	5.1	0.005	0.0025	0.97	2.06	0.061	0.06	30	5.1
205R01738	Ross Cr	0.02	0.001	85	17	40	3.3	0.95	0.006	1.1	3.42	0.23	0.23	36	2.7
205R01747	Lower Silver Cr	0.22	0.008	110	350	4	2.8	2.8	0.045	0.57	2.27	0.05	0.13	27	42
205R01882	Alamitos Cr	0.044	0.000	78	38	183	1.2	1.7	0.0025	0.57	0.68	0.012	0.01	26	1
205R01923	Lower Penitencia Cr	0.099	0.005	110	199	50	2.4	0.15	0.0025	0.53	0.92	0.015	0.02	14	6
205R01930	Los Gatos Cr	0.044	0.001	21	63	45	4.5	0.038	0.0025	0.88	0.98	0.02	0.04	12	5.2
205R01962	Sobey Cr	0.14	0.003	210	61	7	3.2	0.36	0.0025	0.62	1.31	0.071	0.09	35	1
205R02051	Guadalupe R	0.22	0.003	180	217	16	4.7	0.67	0.016	0.62	1.43	0.2	0.22	20	4.9
205R02074	Golf Cr	0.14	0.027	150	99	26	3.5	0.43	0.0025	1	0.21	0.058	0.08	24	1
205R02119	Los Trancos Cr	0.02	0.000	29	63	7	1.6	0.005	0.0025	0.2	0.41	0.009	0.01	18	1
205R02154	Wildcat Cr	0.02	0.001	15	148	5	1.2	0.005	0.0025	0.4	0.99	0.022	0.02	24	1
205R02211	Stevens Cr	0.16	0.002	17	762	73	5.8	0.33	0.0025	0.66	0.54	0.029	0.05	18	4.4
205R02307	Los Gatos Cr	0.02	0.001	20	44	87	4.6	0.005	0.0025	0.53	0.63	0.026	0.05	7.5	6.7
Number of exceedances		NA	1	0	NA	NA	NA	0	NA	NA	NA	NA	NA	NA	NA

NA = not applicable

Table 2.8. Selected physical habitat variables and general water quality measurements collected at 20 bioassessment sites in Santa Clara County during WY2015. Land use data calculated in GIS, is also provided. Measurements that exceed objectives or MRP 2.0 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)	DO (mg/L)	pH	Specific Cond (uS/cm)
Water Quality Objective/Threshold		NA	NA	NA	NA	NA	NA	NA	24	5 or 7	6.5 and 8.5	2000
204R00253	Isabel Cr	21	6	67	14	0.2	0	1	16.8	9.6	8.1	430
205R01315	Coyote Cr	10	7	87	20	1.9	6	5	15.7	**3.3**	7.6	1236
205R01411	San Thomas Aquino	0	46	7	25	3.5	72	39	18.6	11.7	8.3	967
205R01562	Shannon Cr	0	3	97	21	1.6	14	3	12.9	7.6	7.6	793
205R01610	Los Gatos Cr	0	3	89	30	0.5	4	2	12.3	10.2	8.0	403
205R01669	Coyote Cr	10	24	84	28	2.0	0	1	15.2	9.6	8.1	643
205R01706	Saratoga Cr	0	22	90	20	1.9	13	5	16.6	10.2	8.2	597
205R01715	Hale Cr	0	37	92	47	1.4	59	11	14.1	7.0	7.8	1406
205R01738	Ross Cr	5	24	86	21	3.3	62	22	16.7	8.5	8.1	1162
205R01747	Lower Silver Cr	1	28	38	66	2.8	47	23	17.1	9.9	8.2	1320
205R01882	Alamitos Cr	10	52	88	23	1.6	19	9	16.6	**5.9**	7.3	867
205R01923	Lower Penitencia Cr	8	33	8	40	2.7	96	69	18.7	10.4	8.2	1467
205R01930	Los Gatos Cr	5	30	77	30	1.2	16	8	18.3	8.2	7.8	479
205R01962	Sobey Cr	0	8	88	33	2.2	100	16	13.8	8.6	8.0	1240
205R02051	Guadalupe R	6	24	84	16	1.6	41	23	16.2	**3.1**	7.8	1360
205R02074	Golf Cr	0	24	4	16	3.6	54	26	23.2	14.8	8.8	1434
205R02119	Los Trancos Cr	0	4	75	9	1.5	13	4	16.4	8.0	8.0	590
205R02154	Wildcat Cr	0	0	96	30	1.0	6	2	13.3	9.4	8.2	520
205R02211	Stevens Cr	3	22	89	35	1.2	2	2	12.7	10.3	7.9	481
205R02307	Los Gatos Cr	10	33	73	16	2.4	22	12	20.7	10.2	8.2	495
Number of exceedances		1	2	3	1	-	8	9	-	3	0	-

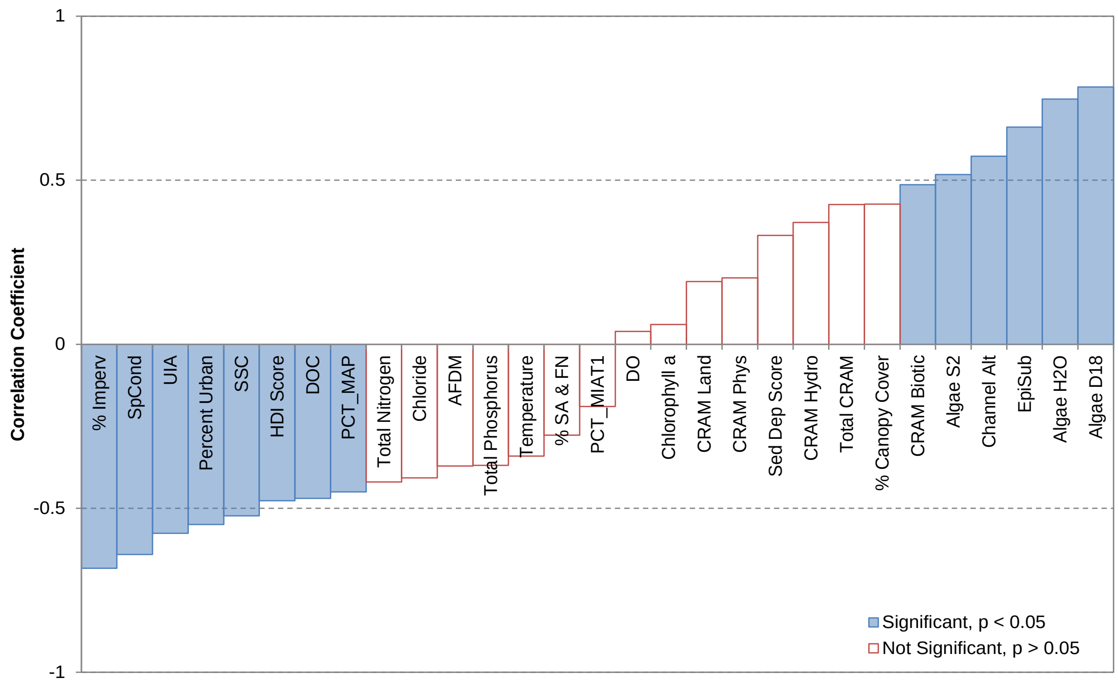

Figure 2.10. Spearman Rank Correlation for CSCI scores and stressor variable data collected at 20 bioassessment sites in Santa Clara County in WY2015.

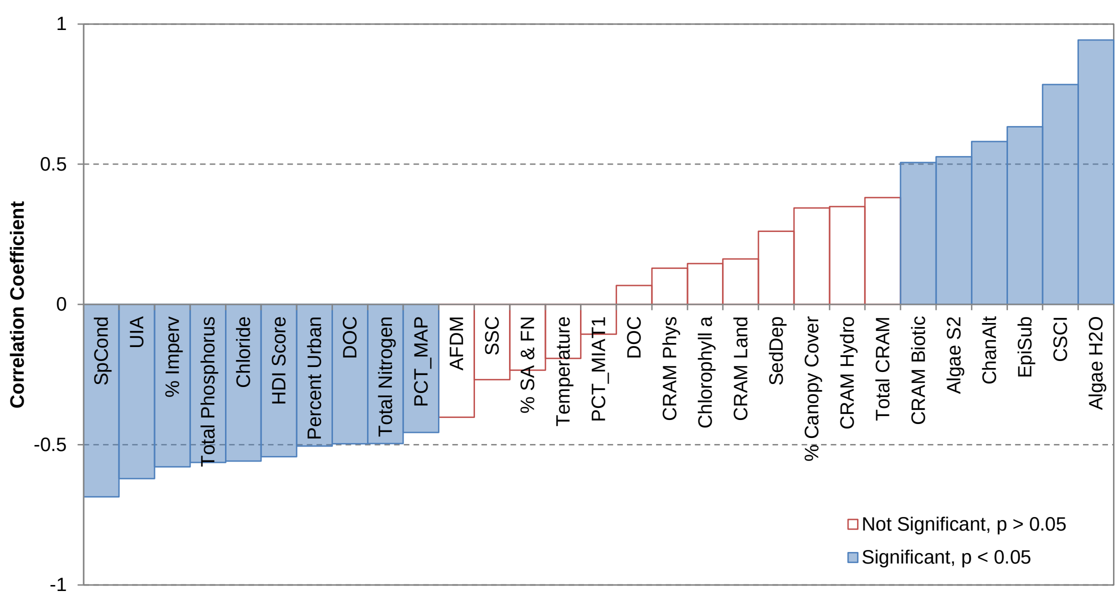

Figure 2.11. Spearman Rank Correlation for D18 scores and stressor variable data collected at 20 bioassessment sites in Santa Clara County in WY2015.

2.4 Conclusions and Recommendations

The following conclusions from the MRP Creek Status Monitoring conducted during WY2015 in Santa Clara County are based on the following management questions:

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

The first management question is addressed primarily through the evaluation of probabilistic 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.

The second management question is addressed primarily through calculation of indices of biological integrity 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.

Probabilistic Survey Design

- Between WY2012 and WY2015, a total of 92 probabilistic sites were sampled by SCVURPPP (n=80) and SWAMP (n=12)[20] in Santa Clara County, including 70 urban and 22 non-urban sites. 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).

Biological Condition Assessment

- The California Stream Condition Index (CSCI) tool was used to assess the biological condition for benthic macroinvertebrate data collected at probabilistic sites. Of the 20 sites monitored in WY2015, three sites were rated in good condition (CSCI scores ≥ 0.795); four sites rated as likely altered condition (CSCI score 0.635 – 0.795) and thirteen sites rated as very likely altered condition (≤ 0.635).
- The 17 sites with CSCI scores less than the trigger threshold of 0.795 will be added to the list of candidate SSID projects.
- Three algae IBI metrics were used to evaluate benthic algae data collected synoptically with BMIs at probabilistic sites. These include D18 (diatoms), S2 (soft algae, and H20 (combination of diatoms and algae).
- Five sites were ranked in good condition based on D18 scores (D18 ≥ 62). Two of these sites (204R00253 and 205R02154) were ranked in good condition for each of the three algae IBIs (D18, S2 and H20).
- The five urban sites that were ranked in good condition based on either CSCI or D18 scores had similar characteristics: limited urban influence (1-5% impervious area); foothill region of Santa Cruz Mountains (sites ranged between 400 and 750 feet in elevation); not located below a major dam. Three of the five sites had non-perennial flow status.

[20] The data from three SWAMP samples collected in WY2015 were not available for analyses in this report. Data results from nine probabilistic sites sampled by SWAMP are included in this report.

- There was no significant difference ($p > 0.15$) in CSCI or algae IBI scores between perennial (n=14) and non-perennial (n=6) sites. Both CSCI scores and algae IBI scores had were responsive to different levels of urbanization (calculated as percent impervious area).
- CSCI scores were better correlated with site elevation ($r^2 = 0.76$) compared to D18 scores ($r^2 = 0.13$), suggesting at these sites, 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

- Nutrients, algal biomass indicators, and other conventional analytes were measured in samples collected concurrently with bioassessments which are conducted in the spring season.
- Land use variables (percent impervious and urban), specific conductivity, unionized ammonia and SSC showed significant negative correlations with CSCI scores. Two PHAB parameters (epifaunal substrate score and channel alteration score) were significantly positively correlated with CSCI scores.
- Thresholds for water quality objectives were generally not exceeded.
- Thresholds for physical habitat and nutrient variables from published sources were used to evaluate stressor data. Several nutrient constituents (total nitrogen, total phosphorus, AFDM and chlorophyll a) frequently exceeded these thresholds. Additional study is needed to evaluate suitable reference-based thresholds for streams in Santa Clara County.

Trend Assessment

- Trend analysis for the RMC probabilistic survey will require more than four 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 WY2015 water temperature, general water quality, and pathogen indicators were monitored at selected sites using a targeted monitoring design based on the directed principle[21] 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?

3.2 Study Area

In compliance with MRP 1.0, temperature was monitored at a minimum of eight sites, general water quality was monitored at three sites, and five sites were sampled for pathogen indicators[22]. 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

Water temperature was monitored at a total of nine stations: four stations within the Guadalupe Creek watershed and five stations within the Stevens Creek watershed[23]. These sites were also monitored for temperature in WY2014. Both creeks have dams at the base of the Santa Cruz Mountain foothills that are operated by the Santa Clara Valley Water District (SCVWD), primarily for ground water percolation during the dry season. Temperature stations were located both above and below reservoirs. Both creeks support rainbow trout/steelhead populations, as well as other native fishes.

Three of the five sites in Stevens Creek were located downstream of the Stevens Creek Reservoir; one at Blackberry Farm (205STE64), one at McClellan Ranch (205STE65), and one at the SCVWD stream gage within Lower Stevens Creek County Park (205STE70) (Figure 3.1). These locations were selected to provide temperature data in a reach that supports both rearing and spawning habitat for existing steelhead population. The remaining two sites were upstream of the reservoir; one at the Sycamore Group Picnic Area (205STE95) and the other adjacent to Stevens Creek Canyon Road (205STE105) (approximately 3 miles upstream of the reservoir). The upper station was selected to provide temperature data in perennial section of the creek upstream of the reservoir.

In Guadalupe Creek, water temperature was monitored at four locations below the Guadalupe Reservoir; one site downstream of Camden and Coleman intersection (205GUA205); one site at the stream gage near Shannon Oaks Lane (205GUA201); one site below the fish ladder (205GUA213); and one site approximately 0.5 mile downstream of the reservoir (205GUA218) (Figure 3.2). All four sites are located in a reach of Guadalupe Creek that can potentially support both rearing and spawning habitat for steelhead. An additional site, located directly below the confluence of Rincon Creek (205GUA229), was selected to measure temperature upstream of the reservoir; however the temperature logger was lost during the deployment.

[21] 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."

[22] MRP 2.0 requires a similar targeted sampling design.

[23] SCVURPPP typically monitors water temperature at more stations than the MRP required minimum to mitigate for potential equipment loss. For example, a temperature logger was deployed at a fifth location in Guadalupe Creek (site 205GUA229) in both WY2014 and WY2015; however the device was not recovered in WY2015 and thus, no data was retrieved for the current year.

3.2.2 General Water Quality

Continuous general water quality data (dissolved oxygen, specific conductance, pH, and temperature) were recorded at a total of three locations in the Stevens Creek watershed during WY2015 (Figure 3.1). Two of the sampling stations were located at WY2014 probabilistic sites (i.e., bioassessment sampling locations) within the urban area below Stevens Creek Reservoir. These locations were selected to provide water quality data in a reach that supports both rearing and spawning habitat for the existing steelhead population. A third sampling location was established near the urban boundary approximately three miles upstream of the Stevens Creek Reservoir. The upper station was selected to provide water quality data in a perennial reach of the creek upstream of the reservoir.

3.2.3 Pathogen Indicators

Pathogen indicator samples were collected at five sites located in municipal or county owned parks in areas with good public access to creeks and potential for recreational water contact (Figure 3.3). Three of the five sites were located within a 2-mile reach of Stevens Creek downstream of the Stevens Creek Reservoir at Blackberry Farm (64), McClellan Ranch (65) and Lower Stevens Creek County Park (71). One site was located in Arroyo Calero, at Singer Park (225), just upstream of the confluence with Alamitos Creek. One site was located in Saratoga Creek, at Bowers Park (5), short distance upstream of the confluence with San Thomas Aquino. Samples were also collected at these five locations for pathogen indicators analyses in WY2014, with the exception of site 205STE064 (Stevens Creek at Blackberry Farm), which replaced WY2014 site 205GUA050 (Los Gatos Creek at Lonus Street) due to dry channel conditions. The four sites that were sampled both years were probabilistic sites that were also sampled for bioassessments in WY2014.

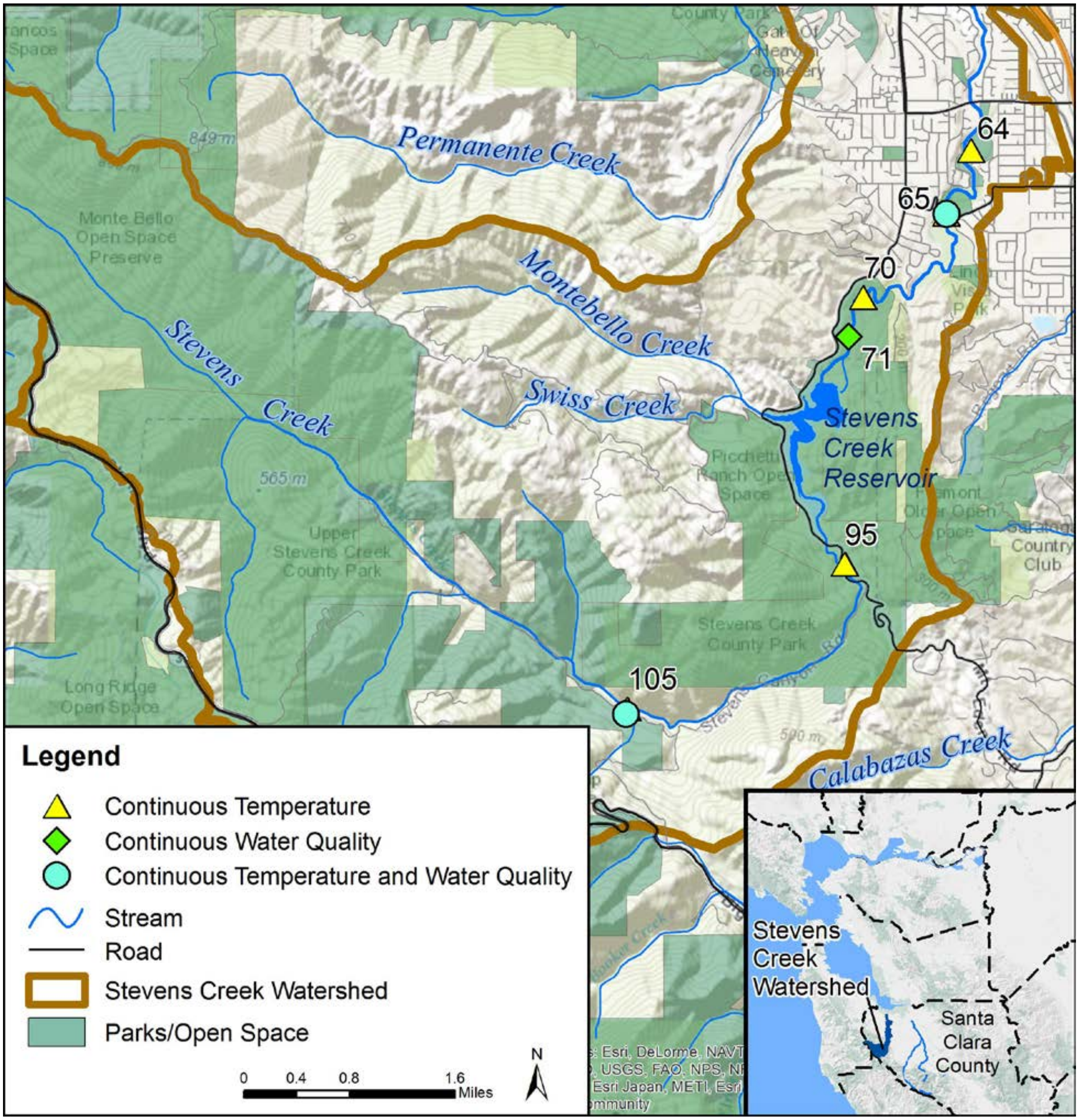

Figure 3.1. Continuous temperature and water quality monitoring stations deployed in Stevens Creek during WY2014 and WY2015.

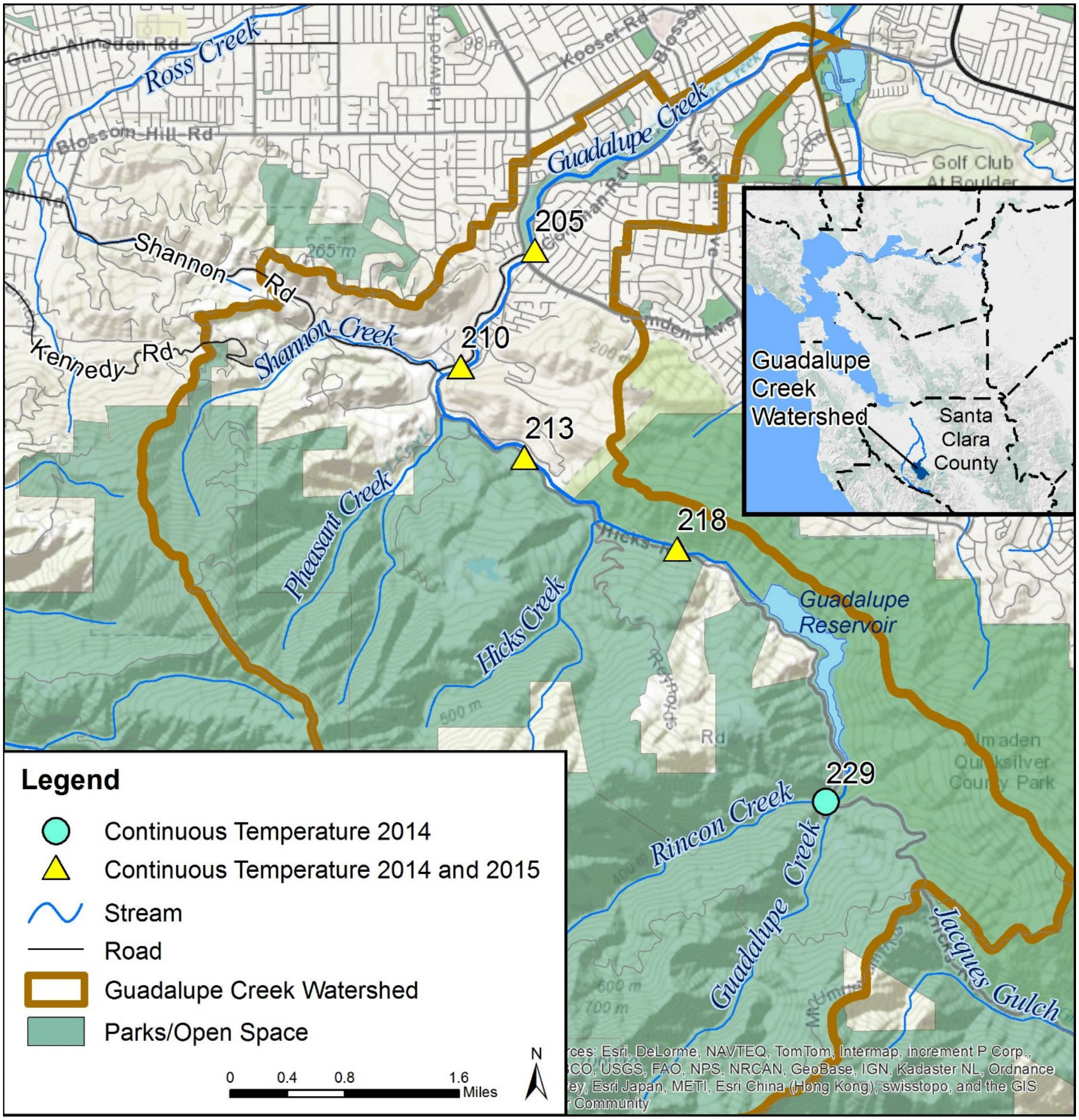

Figure 3.2. Continuous temperature monitoring sites deployed in Guadalupe Creek during WY2014 and WY2015.

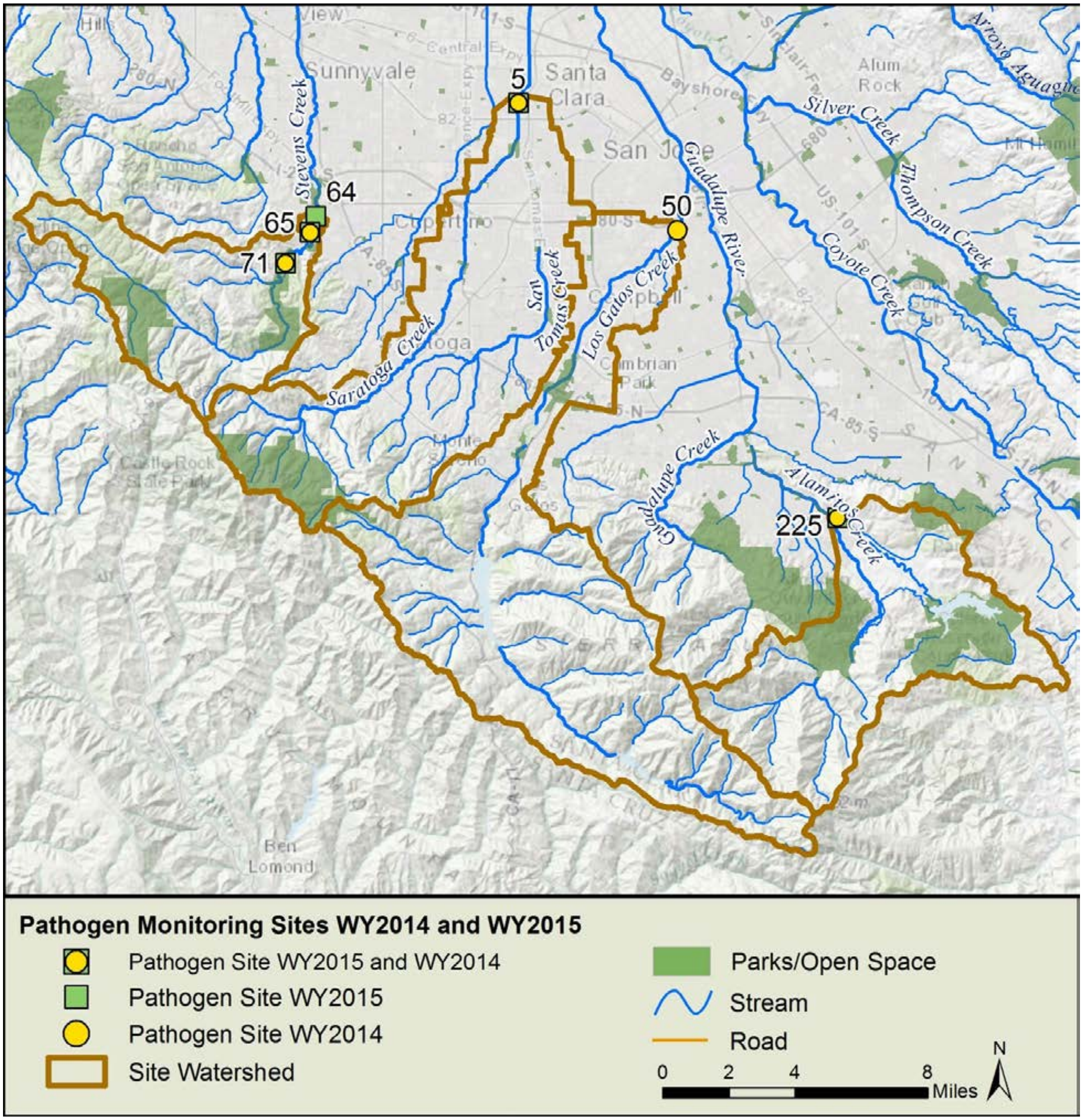

Figure 3.3. Pathogen indicator monitoring sites, Santa Clara County, WY2014 and WY2015.

3.3 Methods

Water quality data were collected in accordance with SWAMP-comparable methods and procedures described in the BASMAA RMC SOPs (BASMAA 2014b) and associated QAPP (BASMAA 2014a). Data were evaluated with respect to the MRP 2.0 provision C.8.d "Followup" triggers for each parameter and/or triggers from MRP 1.0 were monitoring parameters differ from MRP 2.0.

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 2015. Procedures used for calibrating, deploying, programming and downloading data are described in RMC SOP FS-5 (BASMAA 2014b).

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 2015. Procedures used for calibrating, deploying, programming and downloading data are described in RMC SOP FS-4 (BASMAA 2014b).

3.3.3 Pathogen Indicators Sampling

Water samples were collected during the dry season. Sampling techniques for pathogen indicators (fecal coliform and *E. coli*) include direct filling of sterile containers at targeted sites and immediate transfer of samples to analytical laboratories within specified holding time requirements. Procedures used for sampling and transporting samples are described in RMC SOP FS-2 (BASMAA 2014b). MRP 2.0 replaces fecal coliform with Enteroccoci.

3.3.4 Data Evaluation

Trigger Comparison

Continuous temperature, water quality, and pathogen indicator data generated during WY2015 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 MRP 2.0 (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.	^{o}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			
Fecal coliform	≥ 400	MPN/ 100ml	SF Bay Basin Plan Ch. 3
E. coli	≥ 410	MPN/ 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 2.0 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 2015, the National Marine Fisheries Service (NMFS) released a public draft of their Coastal Multispecies Recovery Plan for 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 2.0 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 (2015) CAP.

3.4 Results and Discussion

3.4.1 Continuous Temperature

Summary statistics for continuous water temperature data collected at five sites in Stevens Creek during WY2015 are shown in Table 3.2. Hourly temperature data was collected between March and September 2015. Consistent with MRP 2.0 requirements, maximum weekly average temperature (MWAT) was calculated for non-overlapping, 7-day periods. The highest MWAT and the total number of weeks when the MWAT exceeded the 17°C trigger threshold are presented in the table. Four of the five stations exceeded the MRP 2.0 trigger threshold of having two or more MWATs above 17°C and will be added to the list of candidate SSID projects.

Table 3.2. Descriptive statistics for continuous water temperature measured in Stevens Creek at five sites during WY2015.

	Site	205STE105	205STE95	205STE70	205STE65	205STE64
	Location	Upper	Sycamore	Gage	McClellan	Blackberry
	Start Date	3/30/2015	3/30/2015	3/30/2015	3/30/2015	3/30/2015
	End Date	9/22/2015	9/22/2015	9/22/2015	9/22/2015	9/22/2015
Temperature (°C)	Minimum	8.0	7.7	11.1	9.8	10.2
	Median	14.7	16.2	14.4	15.0	15.4
	Mean	14.5	15.6	14.7	15.1	15.4
	Maximum	20.2	22.1	22.1	22.5	22.4
	Max 7-day Average	16.9	19.4	20.8	19.8	19.4
	Total # weeks MWAT > 17°C	0	11	4	4	4
	N	4218	4219	4219	4219	4219

The MWAT for the five monitoring locations in Stevens Creek over the 26-week period of monitoring are shown in Figure 3.4. During the months of June through August, the MWAT at the Sycamore picnic area site, located just upstream of the Stevens Creek reservoir, was consistently above 17°C. The MWAT for the remaining four monitoring locations were consistently below the 17°C threshold between the months of April and September. In September, the MWAT for the three sites below the Stevens Creek reservoir exceeded the 17°C threshold for the last four weeks of the monitoring period, while the two sites upstream of the reservoir were consistently below this threshold.

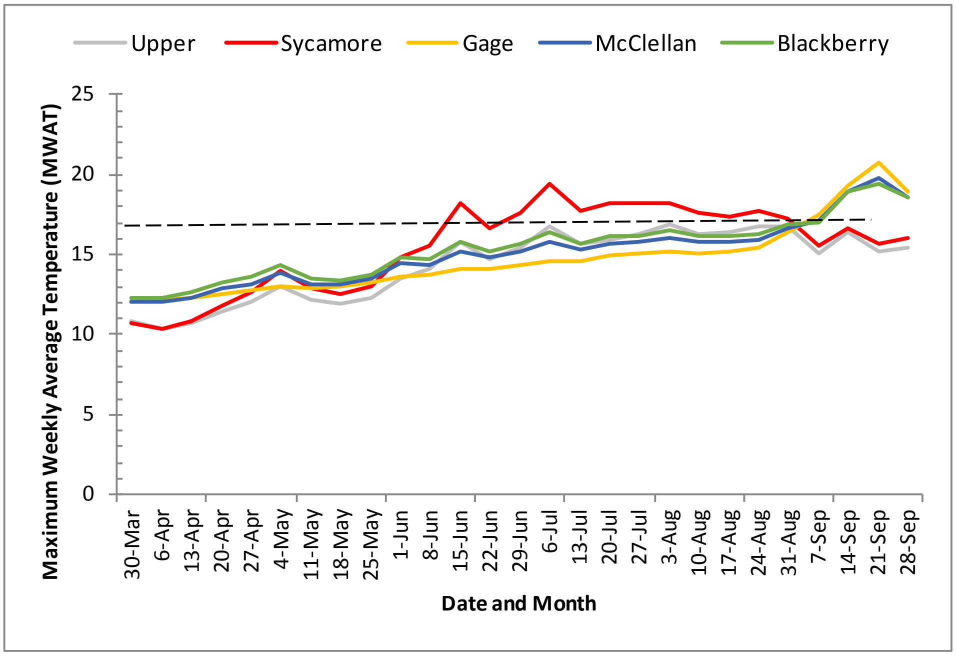

Figure 3.4. Maximum Weekly Average Temperature (MWAT), calculated for non-overlapping 7-day periods, for five sites in Stevens Creek.

Summary statistics for water temperature data collected at four sites in Guadalupe Creek during WY2015 are shown in Table 3.3. Hourly temperature data was collected between March and September 2015. Three of the four stations exceeded the MRP 2.0 trigger threshold of having two or more MWATs above 17°C and will therefore be added to the list of candidate SSID projects.

Table 3.3. Descriptive statistics for continuous water temperature measured at four sites in Guadalupe Creek during WY2015.

	Site	205GUA218	205GUA213	205GUA210	205GUA205
	Start Date	3/30/2015	3/30/2015	3/30/2015	3/30/2015
	End Date	9/22/2015	9/22/2015	9/22/2015	9/22/2015
Temperature (°C)	Minimum	9.7	8.8	8.5	9.2
	Median	14.8	15.6	16.2	17.0
	Mean	14.5	15.3	15.8	16.5
	Maximum	18.8	19.9	21.3	21.5
	Max 7-day Mean	17.5	17.8	19.0	20.0
	Total # weeks MWAT > 17°C	1	3	9	14
	N	4223	4223	4223	4223

The calculated MWATs for the four monitoring locations in Guadalupe Creek over the 26 week period of monitoring are shown in Figure 3.5. The MWAT at the two lowest elevation sites exceeded the 17°C trigger threshold primarily during months of June and July. The fish ladder site was slightly over the MWAT threshold for a total of three weeks and the site below the dam was consistently below the MWAT threshold. It appears that cool water released from the reservoir warms as it travels downstream.

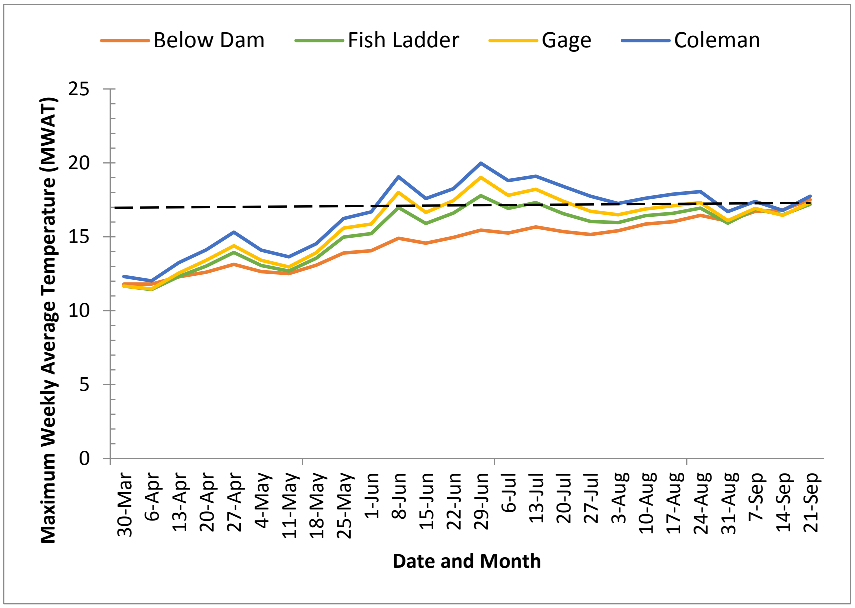

Figure 3.5. Maximum Weekly Average Temperature (MWAT), calculated for non-overlapping 7-day periods, for five sites in Guadalupe Creek.

The distribution of instantaneous temperature measured at the five sites in Stevens Creek, and four sites in Guadalupe Creek are shown in Figures 3.6 and 3.7, respectively. The records from WY2014 and WY2015 are shown for comparison and the acute temperature threshold (24.0 °C) is shown for comparison. Temperatures collected at all sites in both watersheds were below the acute threshold during WY2014 and WY2015, with the exception of a small percentage of the data (2%) collected at the Blackberry Farm site in Stevens Creek (STE064) in WY2014.

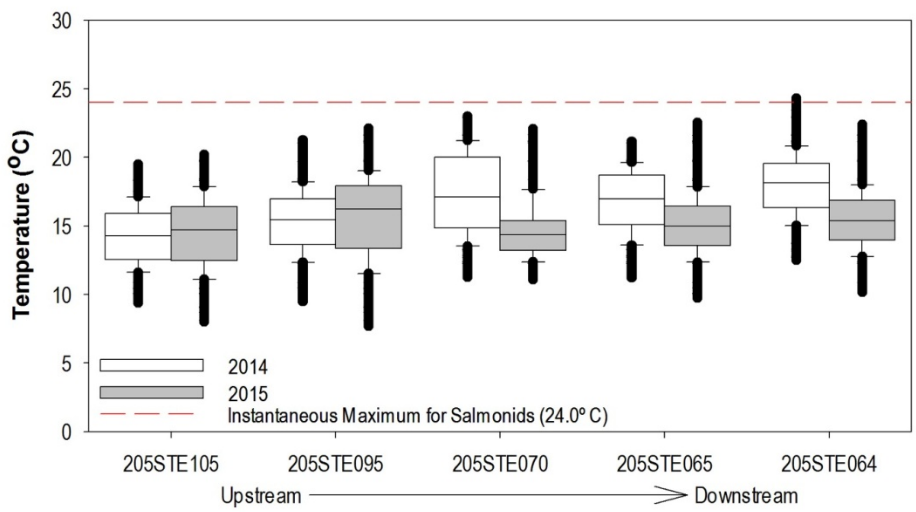

Figure 3.6. Box plots of water temperature data collected at five stream locations in Stevens Creek, Santa Clara County, from April through September 2014 and 2015.

Median temperatures were one to four degrees lower at all sites in both watersheds in WY2015 compared to WY2014, with the exception of two upper sites in Stevens Creek, where median temperatures were the same or slightly higher.

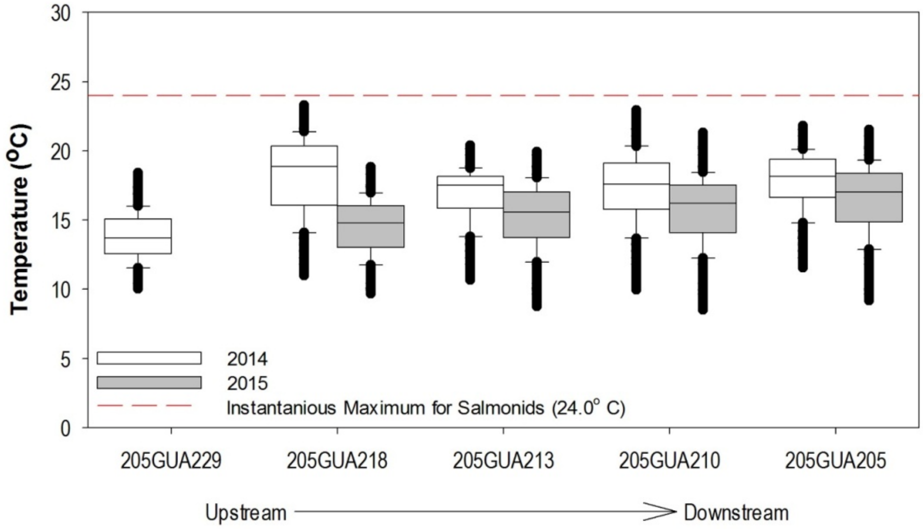

Figure 3.7. Box plots of water temperature data collected at five stream locations (device at 205GUA229 was not recovered in 2015) in Guadalupe Creek, Santa Clara County, from April through September 2014 and 2015.

The Maximum Weekly Maximum Temperature (MWMT) was calculated for each site by breaking the measurements into non-overlapping, 7-day periods at each site. The calculated values of MWAT and MWMT for all sites in Stevens Creek are listed in Table 3.4 and for all sites in Guadalupe Creek in Table 3.5. The shaded cells represent weekly averages that exceeded 17°C for MWAT and 20°C for MWMT. A summary showing the number of weeks that exceed each threshold is presented in Table 3.6.

The Basin Plan (SFRWQCB 2013) designates several Beneficial Uses for Stevens and Guadalupe 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 reach in Stevens Creek between Blackberry Farm and Stevens Creek Reservoir as having the best quality steelhead spawning and juvenile rearing habitat within the Stevens Creek watershed (Stillwater 2004).

The limiting factors analysis evaluated water temperature data collected by the SCVWD in WY2000 and determined that temperatures downstream of the dam were relatively warm, but within the range to support a steelhead population (Stillwater 2014). Across eight monitoring sites below Stevens Creek dam, the daily average temperatures ranged between 11.7 to 21.7 °C (note: raw temperature data was not available to calculate daily averages for any one site). The study concluded that WY2000 was considered an “average” year climatologically suggesting that the stream temperature data was representative of typical conditions below Stevens Creek Reservoir (Stillwater 2004).

In WY2015, the furthest upstream site monitored by SCVURPPP (STE105) did not record any exceedances of MWAT, likely a result of the logger being located in a fast flowing and well shaded part of the stream. Site STE095, approximately half-mile upstream of the Stevens Creek Reservoir, recorded 11 MWAT exceedances between the middle of June and the end of August. During this period, high summer water temperatures upstream of the reservoir did not appear to affect temperatures below the dam due to stratification and releases from the cooler lower levels of the reservoir. The three downstream monitoring sites in Stevens Creek are located within the reach that potentially supports steelhead populations. The three sites in this reach had temperatures that exceeded the MWAT (17 °C) threshold for steelhead in WY2015 for the last four weeks of the sampling period.

Table 3.4. Comparison of the weeks that the MWAT (17°C) and MWMT (20°C) maximum threshold values were exceeded at the five sites monitored in Stevens Creek in Santa Clara County, WY2015.

Week Starting Date	205STE105		205STE95		205STE70		205STE65		205STE64	
	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT
3/30	10.87	12.87	10.76	12.37	12.02	12.96	12.06	13.45	12.34	13.17
4/6	10.39	12.34	10.41	12.12	12.18	13.13	12.09	13.62	12.34	13.40
4/13	11.35	13.83	11.62	13.80	12.49	13.51	12.74	14.45	13.12	14.25
4/20	12.11	14.12	12.71	14.55	12.73	13.59	13.13	14.49	13.58	14.49
4/27	13.03	15.60	13.96	16.41	13.05	14.15	13.82	15.60	14.36	15.50
5/4	12.21	14.21	12.85	14.97	12.92	13.89	13.14	14.63	13.47	14.56
5/11	11.88	13.49	12.49	14.42	13.00	13.90	13.09	14.62	13.40	14.46
5/18	12.24	13.61	13.02	14.92	13.25	14.01	13.50	14.69	13.78	14.60
5/25	13.49	15.71	14.80	17.31	13.67	14.64	14.44	15.93	14.86	15.78
6/1	14.05	16.17	15.57	18.22	13.73	14.56	14.37	16.04	14.77	16.14
6/8	15.75	17.72	18.22	20.67	14.08	14.87	15.17	17.00	15.78	17.24
6/15	14.74	17.20	16.70	19.80	14.10	15.12	14.78	16.74	15.20	16.72
6/22	15.41	17.68	17.61	20.40	14.37	15.37	15.20	17.12	15.69	17.18
6/29	16.73	18.83	19.45	21.54	14.62	15.49	15.79	17.43	16.40	17.67
7/6	15.67	17.26	17.77	19.40	14.63	15.29	15.31	16.57	15.74	16.76
7/13	15.97	18.20	18.21	20.35	14.92	15.81	15.73	17.47	16.21	17.61
7/20	16.23	18.33	18.27	20.00	15.04	15.92	15.77	17.44	16.21	17.54
7/27	16.85	19.01	18.24	19.28	15.14	16.00	16.04	17.80	16.55	17.95
8/3	16.25	18.04	17.66	18.67	15.11	15.85	15.75	17.26	16.14	17.36
8/10	16.46	18.49	17.37	18.26	15.21	15.86	15.76	17.33	16.14	17.59
8/17	16.80	18.74	17.69	18.53	15.40	15.95	15.96	17.25	16.31	17.49
8/24	16.79	18.89	17.27	18.29	16.39	16.95	16.70	18.06	16.94	18.25
8/31	15.02	17.06	15.59	16.80	17.43	18.07	17.08	18.61	17.06	18.53
9/7	16.45	18.56	16.67	18.07	19.25	19.86	18.93	20.42	18.90	20.38
9/14	15.18	16.92	15.70	17.21	20.80	21.37	19.76	21.09	19.44	20.76
9/21	15.91	17.97	16.08	18.30	19.00	21.71	18.53	21.53	18.54	21.57

Table 3.5. Comparison of the weeks that MWAT (17°C) and MWMT (20°C) maximum threshold values were exceeded at the four sites monitored in Guadalupe Creek in Santa Clara County, WY2015.

Week Starting Date	205GUA218		205GUA213		205GUA210		205GUA205	
	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT
3/30	11.81	13.85	11.66	12.93	11.67	13.11	12.32	13.72
4/6	11.80	13.88	11.43	12.86	11.47	12.74	12.02	13.68
4/13	12.29	14.66	12.31	13.90	12.55	13.96	13.25	15.04
4/20	12.61	14.45	13.03	14.19	13.42	14.46	14.13	15.55
4/27	13.13	15.68	13.94	15.70	14.40	15.95	15.32	17.24
5/4	12.65	14.64	13.06	14.55	13.41	14.74	14.10	15.81
5/11	12.50	14.27	12.68	13.94	12.97	14.26	13.65	15.18
5/18	13.08	14.66	13.56	14.68	13.93	15.22	14.54	15.74
5/25	13.90	15.89	14.99	16.27	15.59	17.20	16.25	17.65
6/1	14.05	16.30	15.21	16.70	15.87	17.57	16.69	18.27
6/8	14.91	16.99	16.99	18.36	17.99	19.50	19.06	20.49
6/15	14.57	17.05	15.91	17.56	16.64	18.56	17.59	19.05
6/22	14.97	17.27	16.60	18.10	17.45	19.28	18.27	19.66
6/29	15.45	17.49	17.79	19.13	19.02	20.69	19.99	21.16
7/6	15.26	16.83	16.93	18.00	17.81	19.07	18.80	19.77
7/13	15.68	17.79	17.32	18.66	18.21	19.92	19.10	20.17
7/20	15.36	16.83	16.57	18.28	17.42	18.85	18.42	19.62
7/27	15.17	16.43	16.04	18.05	16.72	18.12	17.75	19.03
8/3	15.42	16.48	15.96	17.60	16.48	17.59	17.25	18.40
8/10	15.87	17.11	16.43	18.33	16.89	18.11	17.62	18.70
8/17	16.02	17.22	16.59	18.35	17.11	18.12	17.88	18.82
8/24	16.45	17.63	16.95	18.69	17.32	18.32	18.07	18.97
8/31	16.06	17.36	15.93	17.82	16.11	17.16	16.71	17.66
9/7	16.73	17.76	16.86	18.65	16.93	18.12	17.40	18.41
9/14	16.82	17.82	16.49	18.09	16.44	17.42	16.79	17.60
9/21	17.52	18.68	17.20	19.12	17.31	18.57	17.75	18.77

Table 3.6. Total number of weeks that the MWAT trigger threshold (17 °C) was exceeded at the nine temperature sites monitored in Guadalupe Creek and Stevens Creek in Santa Clara County, WY2015.

Site ID	Creek	Site Name	MWAT Trigger (>2 Weeks) Exceeded?	Total Number of weeks MWAT > 17°C	MWMT Trigger (>2 Weeks) Exceeded?	Total Number of weeks MWMT > 17°C
205GUA218	Guadalupe Creek	Downstream of the Horse Stable	No	1	No	0
205GUA213		At the Fish Ladder	Yes	3	No	0
205GUA210		At Shannon Oaks	Yes	9	No	1
205GUA205		At Camden and Coleman	Yes	14	Yes	3
205STE105	Stevens Creek	Upstream of the reservoir	No	0	No	0
205STE95		At Sycamore Group area	Yes	11	Yes	5
205STE70		At the SCVWD gage	Yes	4	Yes	2
205STE65		At McClellan Ranch	Yes	4	Yes	3
205STE64		At Blackberry Farm	Yes	4	Yes	3

Water temperatures measured during this study are expected to be higher than what might occur during a more typical year due to antecedent drought conditions causing very low water levels in the Stevens Creek Reservoir and minimal baseflows during the dry season. Additional temperature monitoring during wetter years would provide a useful comparison to data collected during WY2015.

Similar to Stevens Creek, Guadalupe Creek potentially supports steelhead rearing and spawning habitat downstream of the Guadalupe Creek Reservoir. At the three most downstream monitoring stations shown in Figure 3.2 (i.e., GUA213, GUA210, GUA205), average weekly temperatures exceeded the MWAT threshold 3, 9, and 14 weeks respectively (Tables 3.5 and 3.6). The increasing number of exceedances moving downstream is likely caused by low baseflows allowing for greater influence of warm climate conditions on water temperatures. Site GUA218, half-mile downstream of the dam, only recorded one week during which MWAT was greater than the 17°C threshold which is not enough to cause a trigger exceedance (Table 3.6). Being located closely downstream of the dam, site flows were likely regularly supplemented by cool water releases from the dam. Even at this station, water temperatures are expected to be higher than what would be observed during wetter years because of the low water levels in the Guadalupe reservoir as a result of the extreme drought that began in WY2012 and continued through WY2015.

In comparison to MWAT, there were far fewer exceedance events of the MWMT threshold for the Stevens Creek and Guadalupe Creek sites (Tables 3.4 and 3.5). Most notably in Stevens Creek, at site STE105, located above the reservoir, there were only 5 weekly exceedances for MWMT compared to 11 for MWAT. The MWMT index provides a different insight into the effect of water temperature as a stressor on summer rearing juveniles. In a stream with continuous flow we know that juveniles will move to a different part of the stream looking for a cooler habitat before temperature values approach the MWMT threshold. As long as there is sufficient flow, temperatures will not be the main limiting factor for juvenile growth.

Although the MWAT trigger of 17.0 ºC was exceeded at several stations, it is unlikely that temperature is a limiting factor for steelhead or rainbow trout (*Oncorhynchus mykiss*). The MWAT trigger was developed for salmonid streams in the Pacific Northwest where the climate is cooler than the Bay Area. Salmonid species in the Bay Area have adapted to warmer temperatures and as appropriate, regulatory/resource agencies (e.g., NMFS) have set temperature targets for certain cold water streams based on the life history needs of specific species. Taking into account the thresholds set by NMFS in their Coastal Multispecies Recovery Plan which consider regional history and the needs of local species, we observed far fewer temperature trigger exceedances. Furthermore, as a result of the ongoing drought, a majority of the monitoring sites were located in pools within channels that had intermittent flow late in the dry season in WY2015. It is likely that trout populations in WY2015 stations would have been limited by minimal food resources due to lack of flowing water and riffle habitat upstream of the pools rather than temperature.

3.4.2 General Water Quality

Summary statistics for general water quality measurements collected at the three sites in Stevens Creek during two sampling event periods in WY2015 are listed in Table 3.7. Sampling Event 1 was conducted in May and Event 2 during September. Station locations are mapped in Figure 3.1. Plots for all water quality parameters collected during both events are shown in Figure 3.8 and Figure 3.9.

Table 3.7. Descriptive statistics for daily and weekly continuous water temperature, dissolved oxygen, conductivity, and pH measured at three sites in Stevens Creek during two sampling events in 2015.

Parameter	Data Type	205STE105		205STE071		205STE065	
		May	Sept	May	Sept	May	Sept
Temp (° C)	Min	11.8	12.6	13.3	16.6	13.0	18.3
	Median	14.3	16.0	13.9	19.3	13.4	20.5
	Mean	14.2	15.9	13.9	19.3	13.4	20.3
	Max	18.3	19.8	14.6	22.4	14.2	21.8
	Max 7-day Mean	15.3	16.7	13.6	20.0	13.6	21.3
Dissolved Oxygen (mg/l)	Min	9.0	7.0	9.1	7.8	9.2	8.3
	Median	9.9	8.8	9.7	8.5	9.5	8.9
	Mean	9.9	8.8	9.7	8.5	9.5	8.8
	Max	10.6	10.4	10.2	9.2	9.9	9.3
	7-day Avg. Min	9.6	9.4	9.4	8.4	8.3	8.5
pH	Min	8.1	7.9	7.4	8.0	7.5	7.5
	Median	8.2	8.0	7.5	8.1	7.7	7.6
	Mean	8.2	8.0	7.5	8.1	7.6	7.7
	Max	8.2	8.4	7.8	8.2	7.7	8.0
Specific Conductance (uS/cm)	Min	585	631	494	532	488	523
	Median	589	640	502	563	497	543
	Mean	590	640	503	563	501	546
	Max	598	990	513	587	523	575
Total number data points (n)		1465	1436	1454	1451	1456	1438

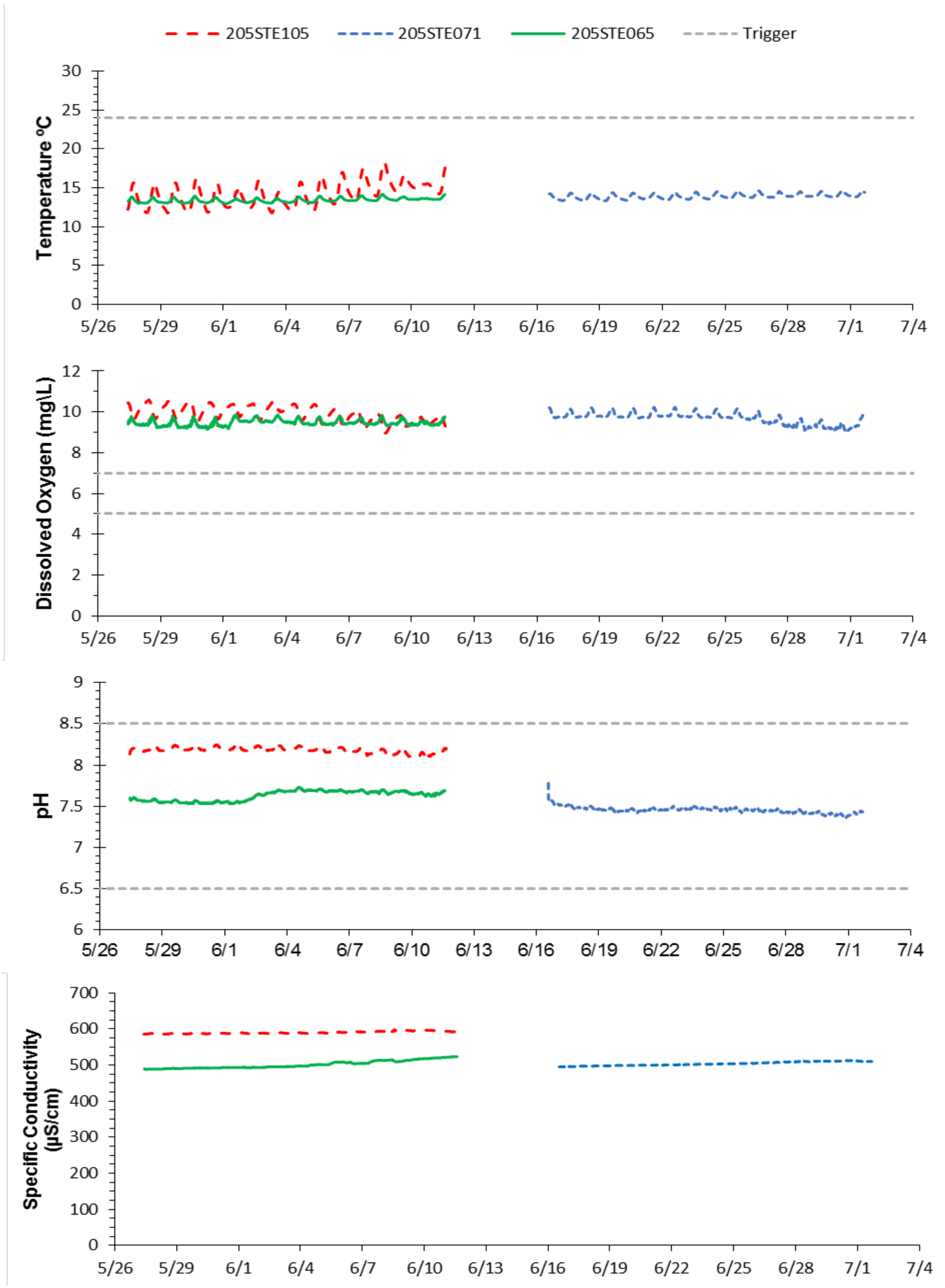

Figure 3.8. Continuous water quality data (temperature, dissolved oxygen, pH and specific conductance) collected using sondes at three sites in Stevens Creek during sampling Event 1 in 2015.

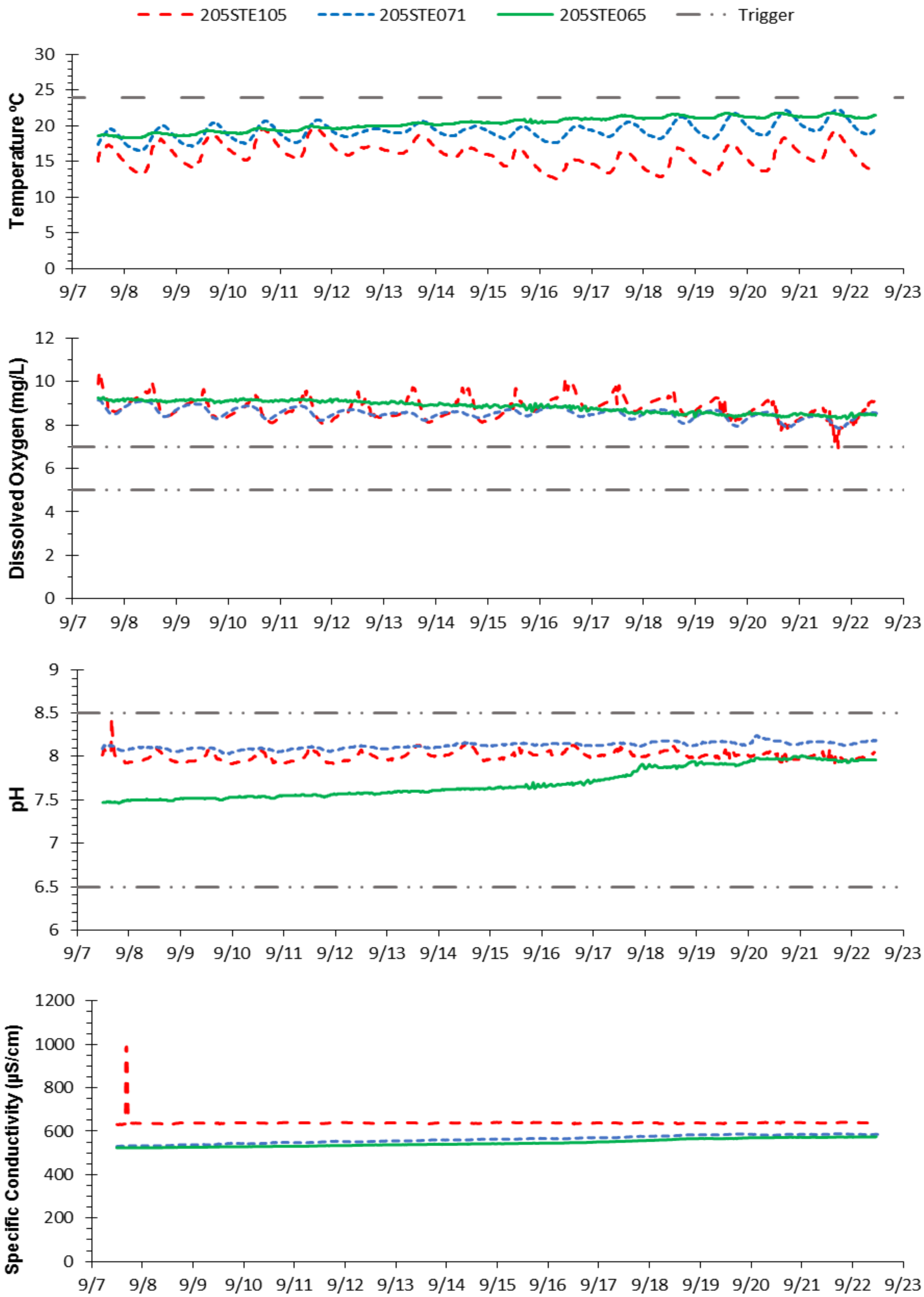

Figure 3.9. Continuous water quality data (temperature, dissolved oxygen, pH and specific conductance) collected using sondes at three sites in Stevens Creek during sampling Event 2 in 2015.

Temperature

Box plots showing distribution of temperature data collected at three sites in Stevens Creek during 2015 are shown in Figure 3.10. Temperatures never exceeded the 24°C acute threshold for salmonids at any of the sites. Box plots showing the distribution of 7-day average water temperature data are shown in Figure 3.11. The MWAT threshold (17.0 °C) was exceeded at the two lowest elevation sites during the September sampling event. Trigger analysis of temperature data using the MWAT threshold is included in Table 3.8. The MWAT threshold was exceeded at site 205STE065 (100% of the data) and at site 205STE071 (100% of Data) during the September event.

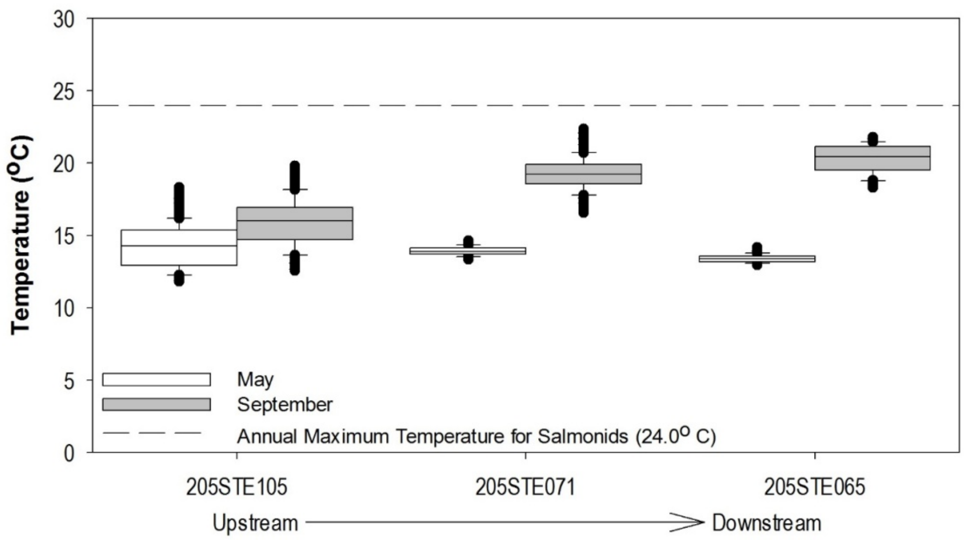

Figure 3.10. Box plots of water temperature data collected at 15-minute intervals at three stream locations in Stevens Creek, Santa Clara County, during two sampling events in 2015.

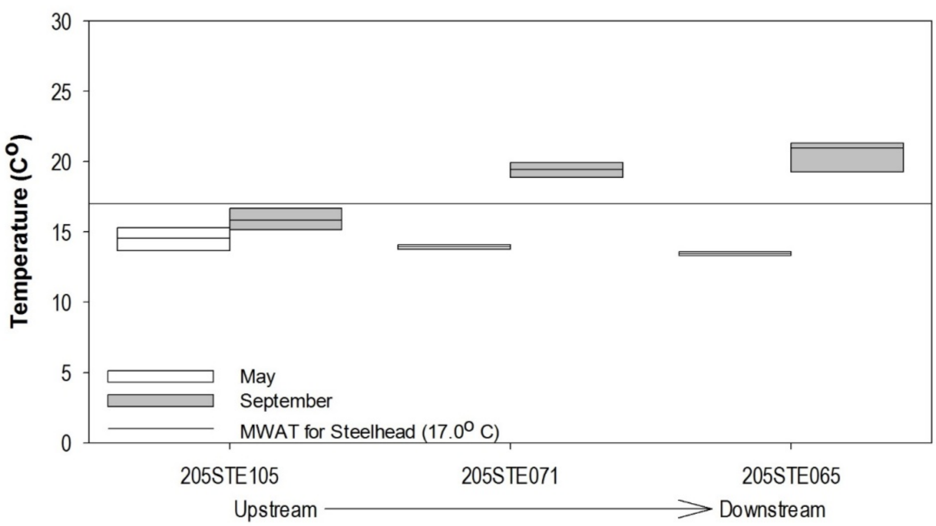

Figure 3.11. Box plots of 7-day average water temperature data at three stream locations in Stevens Creek, Santa Clara County, during two sampling events in 2015

Table 3.8. Percent of water temperature data measured at three sites in Stevens Creek, Santa Clara County for both events that exceed chronic and acute temperature triggers.

Site ID	Creek Name	Site	Monitoring Event	Total Number of weeks MWAT > 17°C	MWAT Trigger ≥2 weeks Exceeded?	Acute Trigger >20% results exceed 24°C
205STE105	Stevens Creek	Above Reservoir	May	0	No	No
			September	0	No	No
205STE071		Below Dam	May	0	No	No
			September	2	Yes	No
205STE065		McClellan Ranch	May	0	No	No
			September	2	Yes	No

Dissolved Oxygen

Box plots showing the distribution of dissolved oxygen data measured at three sites in Stevens Creek during WY2015 are shown in Figure 3.12. The dissolved oxygen WQOs for WARM and COLD Freshwater Habitat are shown in the figure. The WQO for COLD (7.0 mg/L) was exceeded only for a single measurement (6.96 mg/L) at the further upstream location (site 205STE105). The single measurement below the WQO for COLD was well below the trigger criteria.

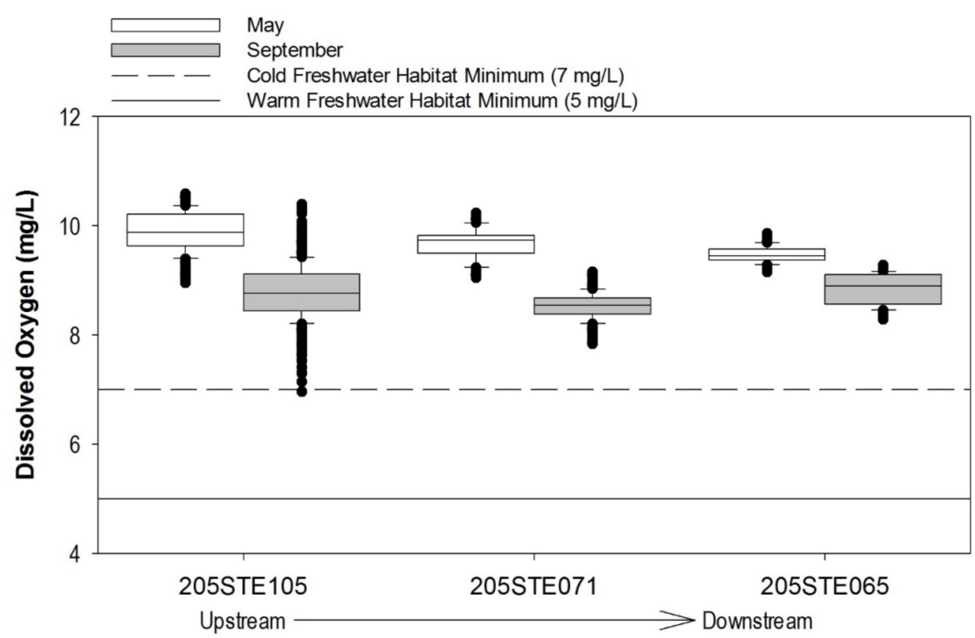

Figure 3.12. Box plots of dissolved oxygen data collected at three stream locations in Stevens Creek, Santa Clara County, during two sampling events in 2015.

pH

Box plots showing the distribution of pH measurements taken during the two sampling events in 2015 at three sites in Stevens Creek are shown in Figure 3.13. pH measurements never exceeded WQOs and thus, did not result in any triggers at any of the sites.

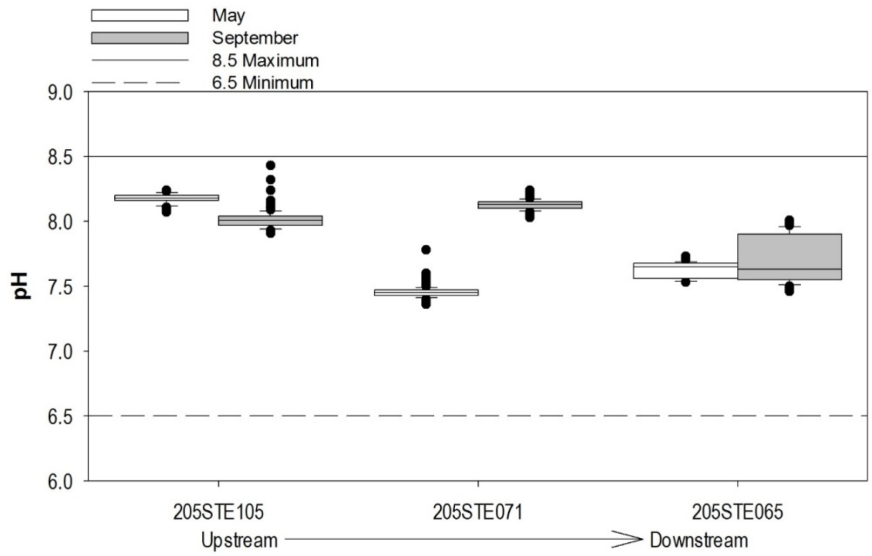

Figure 3.13. Box plots of pH measured at three stream locations in Stevens Creek, Santa Clara County, during two sampling events in 2015.

Specific Conductivity

Box plots showing the distribution of specific conductivity measurements taken during the two sampling events in 2015 at three sites in Stevens Creek are shown in Figure 3.14. None of the measurements exceeded the trigger for this parameter.

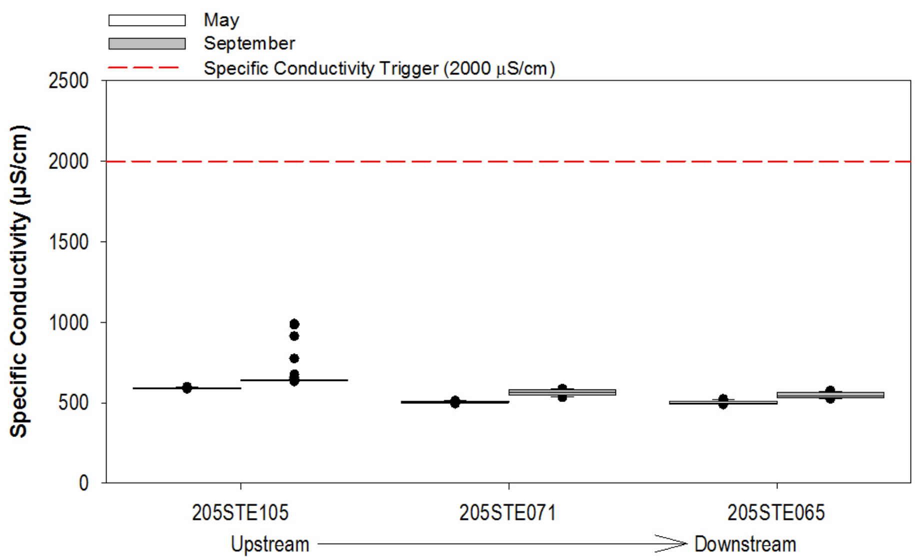

Figure 3.14. Box plots of specific conductivity measured at three stream locations in Stevens Creek, Santa Clara County, during two sampling events in 2015.

3.4.3 Pathogen Indicators

Pathogen indicator densities measured in water samples in WY2015 are listed in Table 3.9. Stations are mapped in Figure 3.3.

Table 3.9. Fecal coliform and E. coli levels measured in Santa Clara County during WY2015.

Site ID	Creek Name	Site Name	*Fecal Coliform (MPN/100ml)*	*E. Coli (MPN/100ml)*	Sample Date
		Trigger Threshold (REC-1/REC-2)	*400/4,000*	*410*	
205GUA225	Arroyo Calero	Singer Park	130	130	6/30/2015
205SAR005	Saratoga Creek	Bowers Park	700	700	6/30/2015
205STE064	Stevens Creek	Blackberry Farm	170	170	6/30/2015
205STE065	Stevens Creek	McClellan Ranch	80	80	6/30/2015
205STE071	Stevens Creek	Lower Stevens Creek Co Park	< 2	< 2	6/30/2015

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 trigger threshold for fecal coliform and for *E. coli* concentrations were exceeded at the site in Saratoga Creek (205SAR005). Additional investigations relative to characterizing exposure would be needed to better understand the waterborne pathogen-related risk at these sites. This site will be added to the list of candidate SSID projects.

3.5 Conclusions and Recommendations

The following conclusions from the MRP Creek Status Monitoring conducted during WY2015 in Santa Clara County are based on the following management questions:

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

The first management question is addressed primarily through the evaluation of 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.

The second 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 reach.

Spatial and Temporal Variability in Water Quality
Median water temperatures continuously measured in Guadalupe Creek (n=4) and Stevens Creek (n=5) were generally coolest at the site directly below the reservoir, gradually increasing at each site further downstream. In Stevens Creek, the temperatures became elevated at the three sites below the dam beginning in early September; this change was likely result of reduced flow releases from the reservoir. In Guadalupe Creek, temperatures were generally highest at all sites during months of June and July

Potential Impacts to Aquatic Life

- Potential impacts to aquatic life were assessed through analysis of continuous temperature data collected at nine targeted stations and continuous general water quality data (pH, dissolved oxygen, specific conductance, temperature) collected at three targeted stations. Stations were deliberatively selected using the Directed Monitoring Design Principle.
- Four of the five temperature stations in Stevens Creek and three of the four temperature stations in Guadalupe Creek exceeded the MRP 2.0 trigger threshold of having two or more weeks where the maximum weekly average temperature (MWAT) exceeded 17°C. Furthermore, two of the three general water quality stations in Stevens Creek exceeded the MWAT trigger. 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 Stevens Creek.
- Values for pH measured at the three Stevens Creek sites in WY2015 were within WQOs (6.5 to 8.5).
- Specific conductivity concentrations recorded at the three Stevens Creek sites in WY2015 were below the trigger threshold of 2000 us/cm.
- Field testing for free chlorine and total chlorine residual was conducted at all 20 probabilistic sites concurrent with spring bioassessment sampling (April-May), and at a subset (three) of the sites concurrent with dry season toxicity sampling (July). The MRP 1.0 trigger threshold of 0.08 mg/L was exceeded at one site on Lower Penitencia Creek. This site will be added to the list of candidate SSID projects.

Potential Impacts to Water Contact Recreation

- Pathogen indicator densities were measured at five targeted sites during WY2015. 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. Threshold triggers for fecal coliform and *E. coli* were exceeded at one site in Saratoga Creek Saratoga Creek (205SAR005). This site 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 WY2015 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.

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4.0 TOXICITY AND SEDIMENT CHEMISTRY MONITORING

4.1 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 conducted synoptically with toxicity monitoring provides preliminary insight into the possible causes of toxicity should they be found.

MRP 1.0 provision C.8.c (Table 8.1) requires that SCVURPPP collect and analyze water toxicity samples from three sites at a frequency of twice per year. Sediment samples must be collected from the same three sites during the dry season and analyzed for toxicity and a large suite of potential pollutants.

4.2 Methods

4.2.1 Water Toxicity

In WY2015, in compliance with Table 8.1 of MRP 1.0, water toxicity samples were collected from three sites at a frequency of twice per year, during storm events and summer dry conditions. Sites were selected from urban probabilistic sites that would be safe to access during storm events and with a high likelihood of containing fine depositional sediments during dry season sampling. See Figure 1.2 for a map of toxicity and sediment chemistry monitoring stations. Samples were tested for toxic effects using four species: an algae (*Selenastrum capricornutum*), two aquatic invertebrates (*Ceriodaphnia dubia* and *Hyalella azteca*), and one fish species (*Pimephales promelas* or fathead minnow)[24]. Both acute and chronic endpoints (survival and reproduction/growth) were analyzed for *Ceriodaphnia dubia* and fathead minnow. *Selenastrum capricornutum* are tested only for the chronic (growth) endpoint and *Hyalella azteca* are tested only for the acute (survival) endpoint.

In the field, the required number of 4-L labeled amber glass bottles were filled and placed on ice to cool to < 6C. Bottle labels include station ID, sample code, matrix type analysis type, project ID, and date and time of collection. The laboratory was notified of the impending sampling delivery to meet 24-hour sample hold time. Procedures used for sampling and transporting samples are described in SOP FS-2 (BASMAA 2014b).

4.2.2 Sediment Toxicity and Chemistry

Sediment samples were collected during the dry season at the same subset of probabilistic sites and tested for sediment toxicity and an extensive list of sediment chemistry constituents. Sediment toxicity testing was performed with just one species, *Hyalella azteca*. Both acute and chronic endpoints (survival and growth) were analyzed. In WY2015 sediment chemistry analytes included metals, polycyclic aromatic hydrocarbons (PAHs), and organochlorine and pyrethroid pesticides[25].

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. Sediment samples were collected from the top 2 cm at each sub-site beginning at the downstream-most location and continuing upstream. 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 2014b). Sample jars were submitted to respective laboratories per SOP FS-13 (BASMAA 2014b).

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[24] MRP 2.0 adds the midge Chironomus dilutus which is highly sensitive to fipronil and neonicotinoid pesticides.

[25] MRP 2.0 adds the pesticides carbaryl and fipronil to the list of required analytes.

4.2.3 Data Evaluation

Water and Sediment Toxicity

Data evaluation involves first determining whether the samples are toxic to the test organisms relative to the laboratory control treatment via statistical comparison at $p < 0.5$. For samples with toxicity, the sample endpoints (survival, reproduction, growth) are then compared to the laboratory control endpoints to determine whether the trigger criteria from MRP 1.0 Table 8.1 and Table H-1 have been exceeded[26].

The laboratory determines whether a sample is toxic by statistical comparison of the results from multiple test replicates of the selected aquatic species in the environmental sample to multiple test replicates of those species in laboratory control water. The threshold for determining statistical significance between environmental samples and control samples is fairly small, with statistically significant toxicity often occurring for environmental test results that are as high as 90% of the Control. Therefore, there is a wide range of possible toxic effects that can be observed – from 0% to approximately 90% of the Control values.

For water sample toxicity tests, MRP 1.0 Table 8.1 identifies toxicity results of less than 50% of the Control as requiring follow-up action. For sediment sample tests, MRP 1.0 Table H-1 identifies toxicity results more than 20% less than the control as requiring follow-up action.[27] Therefore, samples that are identified by the lab as toxic (based on statistical comparison of samples vs. Control at $p = 0.05$) are evaluated to determine whether the result was less than 50% of the associated Control (for water samples) or statistically different and more than 20% less the Control (for sediment samples).

Sediment Chemistry

In compliance with MRP 2.0, sites are identified as candidate SSID projects if sediment chemistry results exceed probable effects concentrations (PECs) or the more conservative threshold effects concentrations (TECs).

For sediment chemistry trigger criteria, TECs and PECs are as defined in MacDonald et al., 2000. For all contaminants specified in MacDonald et al. (2000), the ratio of the measured concentration to the respective TEC value was computed as the TEC quotient. PEC quotients were also computed for all non-pyrethroid sediment chemistry constituents, using PEC 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. This is particularly true for sites located higher in the watersheds where contributing watersheds are underlain by a higher percent of natural sources. For this reason, SCVURPPP also analyzed the sediment chemistry data using the trigger criteria from MRP 1.0. Sites with three or more TEC quotients exceeding 1.0 and/or mean PEC quotients exceeding 0.5 were identified.

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[26] MRP 2.0 requires that toxicity is evaluated using the Test of Significant Toxicity (TST) statistical approach. The TST approach was not conducted in WY2015; therefore data is evaluated using MRP 1.0 trigger thresholds.

[27] Footnote #162 to Table H-1 of the MRP reads, “Toxicity is exhibited when Hyallela (sic) survival statistically different than and < 20 percent of control”; this is assumed to be intended to read “…statistically different than and more than 20 percent less than control”.

MRP 2.0 does not require consideration of pyrethroid sediment chemistry data for followup SSID projects, perhaps because they are ubiquitous in the urban environment. However, SCVURPPP followed MRP 1.0 data analysis procedures to compare pyrethroid contamination at the monitored sites. Pyrethroid toxicity unit (TU) equivalents were computed for individual pyrethroid results, based on available literature values for pyrethroids in sediment LC50 values.[28] Because organic carbon mitigates the toxicity of pyrethroid pesticides in sediments, the LC50 values were derived on the basis of TOC-normalized pyrethroid concentrations. Therefore, the pyrethroid 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 pyrethroid. For each site, the TU equivalents for the various individual pyrethroids were summed, and sites where the summed TU was equal to or greater than 1.0 were identified. 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.

4.3 Results and Discussion

4.3.1 Toxicity

Significant Toxicity Analysis

Table 4.1 provides a summary of toxicity testing results for wet weather and dry season **water** samples. Relative to laboratory controls, two of the three wet weather samples were found to be chronically toxic to *Ceriodaphnia dubia*. All three samples were found to be acutely toxic to *Hyalella azteca*. Toxicity was not observed in the dry season water samples.

Table 4.2 provides a summary of toxicity testing results for **sediment** samples. The sediment sample collected at site 205R01882 (Alamitos Creek) was found to be acutely and chronically toxic to *Hyalella azteca*. The cause of the sediment toxicity is unknown but may be influenced by high mercury concentrations (see Section 4.2.2 for sediment chemistry results)

Trigger Comparison

Table 4.3 details results for the water and sediment tests that were found to have significant reductions in *Ceriodaphnia dubia* and *Hyalella azteca* survival and reproduction/growth relative to the laboratory controls, along with comparisons to the relevant trigger criteria from MRP 1.0. None of the **water** samples exceeded the MRP 1.0 trigger criteria of more than 50% less than the laboratory control. There was complete mortality to *Hyalella azteca* in the 205R01882 (Alamitos Creek) **sediment** sample resulting in an exceedance of the MRP 1.0 trigger criteria of 20% less than laboratory control.

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

Table 4.1. Summary of SCVURPPP water toxicity results for WY2015, wet weather and dry season.

SCVURPPP Water Samples			Toxicity relative to the Lab Control treatment?					
Sample Station	Creek	Sample Date	*Selenastrum capricornutum*	*Ceriodaphnia dubia*		*Hyalella azteca*	Fathead Minnow	
			Growth	Survival	Reproduction	Survival	Survival	Growth
Wet Weather								
205R01411	San Tomas Aquino Creek	2/26/15	No	No	Yes	Yes	No	No
205R01706	Saratoga Cr	2/26/15	No	No	No	Yes	No	No
205R01882	Alamitos Cr	2/26/15	No	No	Yes	Yes	No	No
Dry Season								
205R01411	San Tomas Aquino Creek	7/7/15	No	No	No	No	No	No
205R01706	Saratoga Cr	7/7/15	No	No	No	No	No	No
205R01882	Alamitos Cr	7/7/15	No	No	No	No	No	No

Table 4.2. Summary of SCVURPPP sediment toxicity results for WY2015, dry season.

Dry Season Sediment Samples			Toxicity relative to the Lab Control treatment?	
Sample Station	Creek	Collection Date	*Hyalella azteca*	
			Survival	Growth
205R01411	San Tomas Aquino Creek	7/7/15	No	No
205R01706	Saratoga Creek	7/7/15	No	No
205R01882	Alamitos Creek	7/7/15	Yes	Yes

Table 4.3. Comparison between laboratory control and SCVURPPP water and sediment receiving sample toxicity results in the context of MRP 1.0 trigger criteria.

Treatment/ Sample ID	Creek	Sample Date	Species Tested	Mean % Survival	Mean Reproduction/ Mean Dry Weight	Comparison to MRP 1.0 Trigger Criteria
Water						
Lab Control	*N/A*	2/6/15	*Ceriodaphnia dubia*	--	*36.5*	*N/A*
205R01411	San Tomas Aquino Cr			--	30.4	Not <50% of Lab Control
205R01882	Alamitos Cr			--	30.4	Not <50% of Lab Control
Lab Control	*N/A*	2/6/15	*Hyalella azteca*	*98*	--	*N/A*
205R01411	San Tomas Aquino Cr			82	--	Not <50% of Lab Control
205R01706	Saratoga Cr			54		Not <50% of Lab Control
205R01882	Alamitos Cr			64	--	Not <50% of Lab Control
Sediment						
Lab Control	*N/A*	7/7/15	*Hyalella azteca*	*91.3*	*0.13*	*N/A*
205R01882	Alamitos Cr			0	0	<20% of Lab Control

N/A = Not Applicable

4.3.2 Sediment Chemistry

Sediment chemistry results are evaluated as potential stressors based on TEC quotients, PEC quotients, and TU equivalents, according to criteria in MRP 1.0 and MRP 2.0.

Table 4.4 lists TEC quotients for all non-pyrethroid sediment chemistry constituents, calculated as the measured concentration divided by the highly conservative TEC value, per MacDonald et al. (2000). TECs are intended to identify concentrations below which harmful effects on sediment-dwelling organisms are unlikely to be observed. Table 4.4 provides a count of the number of constituents that exceed TEC values for each site, as evidenced by a TEC quotient greater than or equal to 1.0. The number of TEC quotients exceeded per site ranges from two to five, out of 27 constituents included in MacDonald et al. (2000). All of the sites exceeded the relevant trigger criterion from MRP 2.0. Two of the three sites (205R01882 – Alamitos Creek and 205R01411 – San Tomas Aquino) exceeded the relevant trigger criterion from MRP 1.0, which is interpreted to stipulate three or more constituents with TEC quotients greater than or equal to 1.0.

Table 4.5 provides PEC quotients for all non-pyrethroid 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. Mean PEC quotients are calculated to evaluate the combined effects of multiple contaminants in sediment. All sites had at least one PEC quotient equal to or greater than 1.0. Two of the sites (205R01411 – San Tomas Aquino and 205R01706 – Saratoga Creek) are within the same watershed and the high PEC quotients were limited to serpentinite associated metals (chromium, nickel). The remaining site (205R01882 - Alamitos Creek) had a very high PEC quotient for mercury (10). As described in Section 4.2.1, there was complete mortality to *Hyalella azteca* in this sample. Its location within the Guadalupe River watershed downstream of portions of the former New Almaden Mercury Mining District is the likely explanation for these results. Mercury contamination in the Guadalupe River watershed and throughout the region is being investigated and controlled through implementation of the San Francisco Bay and Guadalupe River Watershed Mercury Total Maximum Daily Load (TMDL) water quality restoration program.

Table 4.6 provides a summary of the calculated TU equivalents for the pyrethroids for which there are published LC50 values in the literature, as well as a sum of TU equivalents for each site. Because organic carbon mitigates the toxicity of pyrethroid pesticides in sediments, the LC50 values were derived on the basis of TOC-normalized pyrethroid concentrations. Similarly, the pyrethroid 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 for each pyrethroid. The individual TU equivalents were summed to produce a total pyrethroid TU equivalent value for each site. None of the sites meet the MRP 1.0 action criterion of TU sums greater than or equal to 1.0. The highest TU equivalent sum (0.85) was calculated for site 205R01411 (San Tomas Aquino) which is the most urban of the three sites sampled in WY2015. Bifenthrin was measured in TOC-normalized concentrations exceeding one half the LC50. Bifenthrin is considered to be the leading cause of pyrethroid-related toxicity in urban areas (Ruby 2013).

Table 4.4. Threshold Effect Concentration (TEC) quotients for WY2015 sediment chemistry constituents. Bolded and shaded values indicate TEC quotient ≥ 1.0.

Site ID / Creek	TEC	205R01882 Alamitos Cr	205R01411 San Tomas Aquino	205R01706 Saratoga Cr
Metals (mg/kg DW)				
Arsenic	9.79	0.64	0.26	0.55
Cadmium	0.99	0.17	0.13	0.10
Chromium	43.4	**4.4**	**1.2**	**2.5**
Copper	31.6	0.79	**1.1**	0.92
Lead	35.8	0.23	0.24	0.20
Mercury	0.18	**61**	0.36	0.48
Nickel	22.7	**13**	**2.2**	**2.3**
Zinc	121	0.77	0.83	0.54
PAHs (ug/kg DW)				
Anthracene	57.2	0.03 [a]	0.03 [a]	0.03 [a]
Fluorene	77.4	0.02 [a]	0.02 [a]	0.02 [a]
Naphthalene	176	0.01 [a]	0.01 [a]	0.02 [b]
Phenanthrene	204	0.05	0.10	0.05
Benz(a)anthracene	108	0.04 [b]	0.09	0.01 [a]
Benzo(a)pyrene	150	0.01 [a]	0.07	0.01 [a]
Chrysene	166	0.03	0.18	0.04
Dibenz[a,h]anthracene	33.0	0.05 [a]	0.05 [a]	0.05 [a]
Fluoranthene	423	0.01 [b]	0.07	0.01
Pyrene	195	0.03	0.15	0.03
Total PAHs	1,610	0.04 [c]	0.16 [c]	0.04 [c]
Pesticides (ug/kg DW)				
Chlordane	3.24	0.31 [a]	0.31 [a]	0.31 [a]
Dieldrin	1.9	0.32 [a]	0.32 [a]	0.32 [a]
Endrin	2.22	0.23 [a]	0.23 [a]	0.23 [a]
Heptachlor Epoxide	2.47	0.22 [a]	0.22 [a]	0.22 [a]
Lindane (gamma-BHC)	2.37	0.15 [a]	0.15 [a]	0.15 [a]
Sum DDD	4.88	0.29 [c]	0.29 [c]	0.29 [c]
Sum DDE	3.16	0.73 [c]	**1.2** [c]	0.51 [c]
Sum DDT	4.16	0.36 [c]	0.36 [c]	0.36 [c]
Total DDTs	5.28	0.99 [c]	**1.3** [c]	0.85 [c]
Number of constituents with TEC quotient >= 1.0		**3**	**5**	**2**

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 (DNQ-flagged).

c. Total calculated using 1/2 MDLs.

Table 4.5. Probable Effect Concentration (PEC) quotients for WY2015 sediment chemistry constituents. Bolded and shaded values indicate PEC quotient ≥ 1.0. Mean PEC quotients did not exceed 0.5.

Site ID / Creek	PEC	205R01882 / Alamitos Cr	205R01411 / San Tomas Aquino	205R01706 / Saratoga Cr
Metals (mg/kg DW)				
Arsenic	33.0	0.19	0.08	0.16
Cadmium	4.98	0.03	0.03	0.02
Chromium	111	**1.7**	0.46	**1.0**
Copper	149	0.17	0.23	0.19
Lead	128	0.07	0.07	0.06
Mercury	1.06	**10**	0.06	0.08
Nickel	48.6	**6.2**	**1.0**	**1.1**
Zinc	459	0.20	0.22	0.14
PAHs (ug/kg DW)				
Anthracene	845	0.00 [a]	0.00 [a]	0.00 [a]
Fluorene	536	0.00 [a]	0.00 [a]	0.00 [a]
Naphthalene	561	0.00 [a]	0.00 [a]	0.01 [b]
Phenanthrene	1170	0.01	0.02	0.01
Benz(a)anthracene	1050	0.00 [b]	0.01	0.00 [a]
Benzo(a)pyrene	1450	0.00 [a]	0.01	0.00 [a]
Chrysene	1290	0.00	0.02	0.01
Fluoranthene	2230	0.00 [b]	0.01	0.00
Pyrene	1520	0.00	0.02	0.00
Total PAHs	22,800	0.00 [c]	0.01 [c]	0.00 [c]
Pesticides (ug/kg DW)				
Chlordane	17.6	0.06 [a]	0.06 [a]	0.06 [a]
Dieldrin	61.8	0.01 [a]	0.01 [a]	0.01 [a]
Endrin	207.0	0.00 [a]	0.00 [a]	0.00 [a]
Heptachlor Epoxide	16	0.03 [a]	0.03 [a]	0.03 [a]
Lindane (gamma-BHC)	4.99	0.07 [a]	0.07 [a]	0.07 [a]
Sum DDD	28	0.05 [c]	0.05 [c]	0.05 [c]
Sum DDE	31.3	0.07 [c]	0.12 [c]	0.05 [c]
Sum DDT	62.9	0.02 [c]	0.02 [c]	0.02 [c]
Total DDTs	572	0.01 [c]	0.01 [c]	0.01 [c]
Mean PEC Quotient		**0.71**	**0.10**	**0.11**

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 4.6. Calculated pyrethroid toxic unit (TU) equivalents for WY2015 pyrethroid concentrations.

Pyrethroid	Units	LC50	WY2015		
			205R01882	205R01411	205R01706
			Alamitos Cr	San Tomas Aquino	Saratoga Cr
Bifenthrin	µg/g dw	0.52	0.26	0.54	0.03 [a]
Cyfluthrin	µg/g dw	1.08	0.01 [a]	0.08	0.02 [a]
Cypermethrin	µg/g dw	0.38	0.02 [a]	0.06 [b]	0.04 [a]
Deltamethrin	µg/g dw	0.79	0.01 [a]	0.12	0.03 [a]
Esfenvalerate	µg/g dw	1.54	0.01 [a]	0.01 [a]	0.01 [a]
Lambda-Cyhalothrin	µg/g dw	0.45	0.01 [a]	0.03 [b]	0.02 [a]
Permethrin	µg/g dw	10.83	0.01 [b]	0.01 [b]	0.00 [a]
Sum of Toxic Unit Equivalents per Site			**0.32**	**0.85**	**0.16**

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 (DNQ-flagged).

4.4 Conclusions and Recommendations

Statistically significant toxicity to *Ceriodaphnia dubia* and/or *Hyalella azteca* was observed in all wet weather **water samples;** however, the magnitude of the toxic effects in the samples compared to laboratory controls were not great and did not exceed MRP 1.0 trigger criteria. No toxicity was observed in dry season water samples.

One of the three dry weather **sediment samples** had statistically significant toxicity with complete mortality to *Hyalella azteca* (Alamitos Creek). *Hyalella azteca* is particularly sensitive to pyrethroid pesticides; however, this sample had relatively few detected pyrethroids and none at concentrations exceeding the LC50 when normalized to TOC. The sample had high mercury concentrations which suggests heavy metal bioaccumulation as the cause of mortality and lack of reproduction. As a result of the toxicity and sediment chemistry observations, station 205R01882 (Alamitos Creek) will be placed on the list of candidate SSID projects. Mercury contamination in the watershed (Guadalupe River) is being addressed through implementation of the San Francisco Bay and Guadalupe River Watershed Mercury Total Maximum Daily Load (TMDL) water quality restoration program.

TEC and PEC quotients were calculated for all non-pyrethroid constituents measured in **sediment samples**. All three sites had at least one TEC or PEC quotient exceeding 1.0. In compliance with MRP 2.0, all 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.

5.0 CHLORINE MONITORING

5.1 Introduction

Chlorine is added to potable water supplies and wastewater to kill microorganisms that cause waterborne diseases. However, the same chlorine can be toxic to the aquatic species. Chlorinated water may be 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.

To assess whether the chlorine in receiving waters is potentially toxic to the aquatic life living there, SCVURPPP field staff 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 is remains unbound.

5.2 Methods

In accordance with the BASMAA RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012), WY2015 field testing for free chlorine and total chlorine residual was conducted at all 20 probabilistic sites concurrent with spring bioassessment sampling (April-May), and at a subset (three) of the sites concurrent with dry season toxicity sampling (July). 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 2014b), which are comparable to those specified in the SWAMP QAPP. Per SOP FS-3 (BASMAAS 2014b), 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 0.08 mg/L, the site was immediately resampled. Per MRP 1.0, if the resample is still greater than 0.08 mg/L, the site is considered as a candidate for a followup SSID project. MRP 1.0 requirements were followed in WY2015.

MRP 2.0 increases the trigger criteria to 0.1 mg/L and requires different followup actions. Provision C.8.d.ii of MRP 2.0 requires that Permittees report free and total chlorine concentrations exceeding 0.1 mg/L “to the appropriate Permittee central contact point for illicit discharges to that the illicit discharge staff can investigate and abate the associated discharge in accordance with its provision C.5.e – Spill and Dumping Complaint Response Program.”

5.3 Results

Twenty-three chlorine measurements were collected in WY2015. These measurements were compared to the MRP 1.0 trigger threshold of 0.08 mg/L.

None of the samples exceeded the threshold of 0.08 mg/L for free chlorine. One sample exceeded the threshold of 0.08 mg/L for total chlorine residual (4% of all samples). The one exceedance was measured in Lower Penitencia Creek and immediately resampled for both free and total chlorine residual. The second free chlorine sample was non-detect. However, the second total chlorine residual measurement also exceeded the 0.08 mg/L trigger.

Table 5.1. Summary of SCVURPPP chlorine testing results compared to MRP 1.0 trigger of 0.08 mg/L, WY2015.

Station Code	Date	Creek	Free Chlorine (mg/L)[1, 2]	Total Chlorine Residual (mg/L)[1, 2]	Exceeds Trigger Threshold? [3] (0.08 mg/L)
204R00253	4/20/2015	Isabel Creek	< 0.02	0.06	No
205R01315	5/18/2015	Coyote Creek	< 0.02	< 0.02	No
205R01411	5/19/2015	San Thomas Aquino	0.03	0.03	No
205R01411	7/7/2015	San Thomas Aquino	0.05	0.07	No
205R01562	4/16/2015	Shannon Creek	< 0.02	0.02	No
205R01610	4/28/2015	Los Gatos Creek	0.02	0.02	No
205R01669	5/20/2015	Coyote Creek	< 0.02	< 0.02	No
205R01706	4/28/2015	Saratoga Creek	0.02	0.02	No
205R01706	7/7/2015	Saratoga Creek	< 0.02	0.03	No
205R01715	4/29/2015	Hale Creek	0.02	0.03	No
205R01738	4/27/2015	Ross Creek	< 0.02	0.02	No
205R01747	5/18/2015	Lower Silver Creek	0.06	0.06	No
205R01882	4/27/2015	Alamitos Creek	0.02	< 0.02	No
205R01882	7/7/2015	Alamitos Creek	< 0.02	0.06	No
205R01923	5/21/2015	Lower Penitencia Creek	0.08 / < 0.02	0.1 / 0.14	Yes
205R01930	5/26/2015	Los Gatos Creek	0.03	0.04	No
205R01962	4/21/2015	Sobey Creek	< 0.02	< 0.02	No
205R02051	5/19/2015	Guadalupe River	< 0.02	0.02	No
205R02074	4/21/2015	Golf Creek	0.04	0.05	No
205R02119	4/29/2015	Los Trancos Creek	0.04	0.03	No
205R02154	4/16/2015	Wildcat Creek	< 0.02	< 0.02	No
205R02211	5/14/2015	Stevens Creek	0.04	0.04	No
205R02307	5/26/2015	Los Gatos Creek	0.02	0.03	No
Number of samples exceeding 0.08 mg/L:			0	1	--
Percentage of samples exceeding 0.08 mg/L:			0	4%	--

[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] This MRP 1.0 trigger threshold applies to both free and total chlorine measurements.

5.4 Conclusions and Recommendations

While chlorine residual is generally not a concern in Santa Clara Valley urban creeks, WY2015 and prior monitoring results suggest there may be chlorine discharges to Lower Penitencia Creek. The total chlorine residual concentrations in the two samples at the Lower Penitencia Creek site in WY2015 were slightly elevated above the trigger threshold in MRP 1.0. Free and total chlorine residual were measured at a different site in Lower Penitencia Creek (farther downstream) during WY2012, and these measurements also exceeded the trigger (0.16 mg/L and 0.12 mg/L, respectively).

Because of the multiple trigger exceedances, Lower Penitencia Creek will be added to the list of candidate sites for possible followup SSID projects.

6.0 CONCLUSIONS AND RECOMMENDATIONS

In WY2015, in compliance with provision C.8.c of MRP 1.0 and the BASMAA RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012), SCVURPPP continued to implement a two-component monitoring design that was initiated in WY2012. The strategy includes a regional ambient/probabilistic monitoring component and a component based on local “targeted” monitoring. 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 Monitoring conducted during WY2015 in Santa Clara County are based on the management questions presented in Section 1.0:

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 in MRP 2.0. 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

Probabilistic Survey Design

- Between WY2012 and WY2015, a total of 92 probabilistic sites were sampled by SCVURPPP (n=80) and SWAMP (n=12)[29] in Santa Clara County, including 70 urban and 22 non-urban sites. 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).

- A larger dataset is needed to estimate biological condition at more local scales (e.g., watershed and jurisdictional areas).

Biological Condition Assessment

- The California Stream Condition Index (CSCI) tool was used to assess the biological condition for benthic macroinvertebrate data collected at probabilistic sites. Of the 20 sites monitored in WY2015, three sites were rated in good condition (CSCI scores ≧ 0.795); four sites rated as likely altered condition (CSCI score 0.635 – 0.795) and thirteen sites rated as very likely altered condition (≤ 0.635).
- The 17 sites with CSCI scores less than the trigger threshold of 0.795 will be added to the list of candidate SSID projects.

[29] The data from three SWAMP samples collected in WY2015 were not available for analyses in this report. Data results from nine probabilistic sites sampled by SWAMP are included in this report.

- Three algae IBI metrics were used to evaluate benthic algae data collected synoptically with BMIs at probabilistic sites. These include D18 (diatoms), S2 (soft algae, and H20 (combination of diatoms and algae). The algae IBI results should be considered preliminary until additional research shows that these tools perform well for data collected in Santa Clara County.
- Five sites were ranked in good condition based on D18 scores (D18 ≥ 62). Two of these sites (204R00253 and 205R02154) were ranked in good condition for each of the three algae IBIs (D18, S2 and H20).
- The five urban sites that were ranked in good condition based on either CSCI or D18 scores had similar characteristics: limited urban influence (1-5% impervious area); foothill region of Santa Cruz Mountains (sites ranged between 400 and 750 feet in elevation); not located below a major dam. Three of the five sites had non-perennial flow status.
- There was very little difference in CSCI or algae IBI scores between perennial (n=14) and non-perennial (n=6) sites. Both CSCI scores and algae IBI scores had were responsive to different levels of urbanization (calculated as percent impervious area).
- CSCI scores were better correlated with site elevation ($R^2 = 0.7561$) compared to D18 scores ($R^2 = 0.1308$), suggesting at these sites, 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

- Nutrients, algal biomass indicators, and other conventional analytes were measured in samples collected concurrently with bioassessments which are conducted in the spring season.
- Land use variables (percent impervious and urban), specific conductivity, unionized ammonia and SSC showed significant negative correlation with CSCI scores. Two PHAB parameters (epifaunal substrate score and channel alteration score) were significantly positively correlated with CSCI scores.
- Thresholds for water quality objectives were generally not exceeded. Thresholds for physical habitat and nutrient variables from published sources were also used to evaluate stressor data. Several nutrient constituents (total nitrogen, total phosphorus, AFDM and chlorophyll a) frequently exceeded these thresholds. Additional study is needed to evaluate suitable reference-based thresholds for streams in Santa Clara County.

Trend Assessment

- Trend analysis for the RMC probabilistic survey will require more than four 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.

Potential Impacts to Aquatic Life

- Potential impacts to aquatic life were assessed through analysis of continuous temperature data collected at nine targeted stations and continuous general water quality data (pH, dissolved oxygen, specific conductance, temperature) collected at three targeted stations. Stations were deliberatively selected using the Directed Monitoring Design Principle.
- Four of the five temperature stations in Stevens Creek and three of the four temperature stations in Guadalupe Creek exceeded the MRP 2.0 trigger threshold of having two or more weeks where the maximum weekly average temperature (MWAT) exceeded 17°C. Furthermore, two of the three general water quality stations in Stevens Creek exceeded the MWAT trigger. 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 Stevens Creek.
- Values for pH measured at the three Stevens Creek sites in WY2015 were within WQOs (6.5 to 8.5).
- Specific conductivity concentrations recorded at the three Stevens Creek sites in WY2015 were below the trigger threshold of 2000 us/cm.
- Field testing for free chlorine and total chlorine residual was conducted at all 20 probabilistic sites concurrent with spring bioassessment sampling (April-May), and at a subset (three) of the sites concurrent with dry season toxicity sampling (July). The MRP 1.0 trigger threshold of 0.08 mg/L was exceeded at one site on Lower Penitencia Creek. This site will be added to the list of candidate SSID projects.

Potential Impacts to Water Contact Recreation

- Pathogen indicator densities were measured at five targeted sites during WY2015. 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. Threshold triggers for fecal coliform and *E. coli* were exceeded at one site in Saratoga Creek Saratoga Creek (205SAR005). This site 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. 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

Water Toxicity

- Water toxicity samples were collected from three sites during two sample events (winter storm event and summer). Although all three wet weather samples were toxic relative to the Lab Control treatment, no water toxicity samples exceeded MRP 1.0 trigger thresholds.

Sediment Toxicity and Chemistry

- Sediment toxicity and chemistry samples were collected concurrently with the summer water toxicity samples. There was complete mortality to *Hyalella azteca* in the sample from Alamitos Creek (205R01882).
- All three sediment samples exceeded the trigger threshold from MRP 2.0 with at least one Threshold Effect Concentration (TEC) quotient or Probable Effect Concentration (PEC) quotient greater than or equal to 1.0. Therefore, all sites will be added to the list of candidate SSID projects. However, these findings were not unexpected in Santa Clara County where naturally occurring chromium and nickel from serpentinite geology often results in high concentrations of these metals in receiving water sediments.
- The Alamitos Creek (205R01882) sediment sample had a relatively high concentration of mercury, likely due to its location downstream of the former New Almaden Mercury Mining District. Mercury contamination in the Guadalupe River watershed (which contains Alamitos Creek) and throughout the region is being investigated and controlled through implementation of the San Francisco Bay and Guadalupe River Watershed Mercury TMDL water quality restoration program

6.2 Trigger Assessment

The MRP requires analysis of the monitoring data to identify candidate sites for SSID projects. Creek Status Monitoring data were collected pursuant to MRP 1.0 but were evaluated and reported pursuant to MRP 2.0 which became effective January 1, 2016. Trigger thresholds against which to compare the data are provided for most monitoring parameters in MRP 2.0 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. In compliance with provision C.8.e.i of MRP 2.0, all monitoring results exceeding trigger thresholds are added to a list of candidate SSID projects that will be maintained throughout the permit term. Followup SSID projects will be selected from this list. Table 6.1 lists of candidate SSID projects based on WY2015 Creek Status 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.

Table 6.1. Summary of SCVURPPP Trigger Threshold Exceedance Analysis, WY2015. "No" indicates samples were collected but did not exceed the MRP trigger; "Yes" indicates an exceedance of the MRP trigger.

Station Number	Creek	Bioassessment [1]	Nutrients [2]	Chlorine	Water Toxicity	Sediment Toxicity	Sediment Chemistry	Continuous Temperature	Continuous WQ	Pathogen Indicators
204R00253	Isabella Creek	Yes	No	No	--	--	--	--	--	--
205R01315	Coyote Creek	Yes	No	No	--	--	--	--	--	--
205R01411	San Thomas Aquino	Yes	No	No	No	No	Yes	--	--	--
205R01562	Shannon Creek	Yes	No	No	--	--	--	--	--	--
205R01610	Los Gatos Creek	No	No	No	--	--	--	--	--	--
205R01669	Coyote Creek	Yes	No	No	--	--	--	--	--	--
205R01706	Saratoga Creek	No	No	No	No	No	Yes	--	--	--
205R01715	Hale Creek	Yes	No	No	--	--	--	--	--	--
205R01738	Ross Creek	Yes	No	No	--	--	--	--	--	--
205R01747	Lower Silver Creek	Yes	No	No	--	--	--	--	--	--
205R01882	Alamitos Creek	Yes	No	No	No	Yes	Yes	--	--	--
205R01923	Lower Penitencia Creek	Yes	No	Yes	--	--	--	--	--	--
205R01930	Los Gatos Creek	Yes	No	No	--	--	--	--	--	--
205R01962	Sobey Creek	Yes	No	No	--	--	--	--	--	--
205R02051	Guadalupe River	Yes	No	No	--	--	--	--	--	--
205R02074	Golf Creek	Yes	Yes	No	--	--	--	--	--	--
205R02119	Los Trancos Creek	Yes	No	No	--	--	--	--	--	--
205R02154	Wildcat Creek	No	No	No	--	--	--	--	--	--
205R02211	Stevens Creek	Yes	No	No	--	--	--	--	--	--
205R02307	Los Gatos Creek	Yes	No	No	--	--	--	--	--	--
205SAR005	Saratoga Creek	--	--	--	--	--	--	--	--	Yes
205STE064	Stevens Creek	--	--	--	--	--	--	Yes	--	No
205STE065	Stevens Creek	--	--	--	--	--	--	Yes	Yes	No
205STE070	Stevens Creek	--	--	--	--	--	--	Yes	--	--
205STE071	Stevens Creek	--	--	--	--	--	--	--	Yes	No
205STE095	Stevens Creek	--	--	--	--	--	--	Yes	--	--
205STE105	Stevens Creek	--	--	--	--	--	--	No	No	--
204GUA225	Arroyo Calero	--	--	--	--	--	--	--	--	No
205GUA205	Guadalupe Creek	--	--	--	--	--	--	Yes	--	--
205GUA210	Guadalupe Creek	--	--	--	--	--	--	Yes	--	--
205GUA213	Guadalupe Creek	--	--	--	--	--	--	Yes	--	--
205GUA218	Guadalupe 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. Station 205R02074 > unionized ammonia threshold.

6.3 Management Implications

The Program's Creek Status Monitoring program (consistent with MRP 1.0 provision C.8.c) focuses 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 WY2015 (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 WY2012 through WY2014 and will be included in a preliminary regional analysis of biological indicator and stressor data collected in Santa Clara County. Even considering WY2015 data alone, it is clear that 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, creek sediments in the vicinity of historic mining operations contain mercury at concentrations known to adversely affect sensitive aquatic organisms (i.e., PEC). Furthermore, 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 1.0 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 develop (LID) methods, such as rainwater harvesting and use, infiltration and biotreatment are required as part of development and redevelopment projects. These LID measures are expected to reduce the impacts of urban runoff and associated impervious surfaces on stream health. MRP 2.0 expands these requirements to include Green Infrastructure planning for all municipal projects
- In compliance with MRP 1.0 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. This work will continue under MRP 2.0.
- Trash loadings to local creeks have been reduced through implementation of new control measures in compliance with MRP 1.0 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. MRP 2.0 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 1.0 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. These programs will continue under MRP 2.0.
- In compliance with MRP 1.0 provision C.13, copper in stormwater runoff is reduced through implementation of controls such as architectural and site design requirements, street sweeping,

and participation in statewide efforts to significantly reduce the level of copper vehicle brake pads. These measures will be continued during the MRP 2.0 permit term.

- Mercury and polychlorinated biphenyls (PCBs) in stormwater runoff are being reduced through implementation of the respective TMDL water quality restoration plans. Under MPR 2.0, the Program will continue to identify sources of these pollutants and will implement control actions designed to achieve new minimum load reduction goals.

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 (e.g., Santa Clara Valley Water District Integrated Water Resources Master Plan (IWRMP) or “One Water Plan”). 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.

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ATTACHMENTS

Attachment 1
QA/QC Report

Attachment 1

Quality Assurance/Quality Control Report

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Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)

February 17, 2016

TABLE OF CONTENTS

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
QA/QC	Quality Assurance and Quality Control
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

LIST OF TABLES

1. INTRODUCTION

In Water Year 2015 (WY2015; October 1, 2014 through September 30, 2015), the Santa Clara Valley Urban Runoff Pollution Prevention (SCVURPPP) conducted Creek Status Monitoring in compliance with provision C.8.c of the National Pollutant Discharge Elimination System (NPDES) stormwater permit for Bay Area municipalities referred to as the Municipal Regional Permit (referred to as MRP 1.0). 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. Data QA/QC for data collected was performed according to procedures detailed in the Quality Assurance Project Plan (QAPP) developed by the BASMAA RMC (BASMAA 2014a) and BASMAA RMC Standard Operating Procedures (SOP; BASMAA 2014b), 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 2009).

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

1.2. Laboratories

Laboratories providing 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
- BioVir Laboratories, Inc. – pathogen indicators
- BioAsessment Services – benthic macroinvertebrate (BMI) identification
- 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 at a rate of 10% of all water quality samples for most chemical parameters, and 5% of all samples for bacteria samples and sediment chemistry samples. Field duplicates are not required for toxicity samples. The results of the duplicate analyses are reported by the laboratories and evaluated using RMC Database QA/QC Testing Tool. 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. Chemistry laboratories routinely analyze a series of duplicate samples that are generated internally. The RMC QAPP also requires collection and analysis of field blank samples at a rate of 5% for dissolved organic carbon.

2. METHODS

2.1. REPRESENTATIVENESS

To ensure representativeness, each member of the SCVURPPP field crew has received and reviewed the all applicable SOPs and QAPP. Field crew members also attended a two-day bioassessment and field sampling training session from the California Water Boards Training Academy. The course is taught by California Department of Fish and Wildlife, Aquatic Bioassessment Laboratory staff and covers procedures for sampling benthic macroinvertebrates, algae, and measuring physical habitat characteristics using the applicable SWAMP SOPs. As a result, each field crew member is knowledgeable of, and performs 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 participate in a biannual (even years) inter-calibration exercise with other stormwater programs prior to field assessments. During inter-calibration exercises, the field crews also review water chemistry (nutrient) sample collection and water quality field measurement methods. Close communication throughout the field season with other stormwater program field crews also ensures comparability.

Sub-contractors collecting samples and the laboratories performing analyses received copies of the RMC SOP and QAPP, and have acknowledged review of the documents. Data collection and analysis by these parties adhere to the RMC protocols and is 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 checks 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) are 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 follows SWAMP documentation specific to each data type, including the exclusion of qualitative values that do not appear on SWAMP's look up lists[1]. Completed templates are reviewed using SWAMP's online data checker[2], further ensuring SWAMP-comparability.

2.3. COMPLETENESS

2.3.1. Data Collection

All efforts are 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 Table 8.1 of MRP 1.0, 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 is reviewed immediately following deployment, and if data are rejected, samplers are redeployed immediately.

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

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

The benthic macroinvertebrate taxonomist, BioAssessment Services, confirmed that organisms were identified to SAFIT STE Level I.

2.4.2. Chemical Analysis

The reporting limits for chemical analysis were compared to the target reporting limits in Appendix E (RMC Target Method Reporting Limits) of the RMC QAPP. Results with reporting limits exceeding 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 the California Department of Fish and Wildlife (CDFW) Aquatic Bioassessment Laboratory for independent assessment of taxonomic accuracy, enumeration of organisms, and conformance to standard taxonomic level. For SCVURPPP, two samples were evaluated for QC purposes.

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 measurement quality objectives (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 is calculated as:

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

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

For matrix spikes, percent recovery is 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 is calculated, and if a logger has a mean difference exceeding 0.2 ºC, it is replaced.

2.6. PRECISION

2.6.1. Field Duplicates

Duplicate biological and water chemistry samples were collected at 10% (two) of the 20 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 samples at a rate of 5% of total samples collected for the project. For WY2015, one of SCVURPPP's RMC partners (the Contra Costa Clean Water Program) collected one sediment sample field duplicate to account for the 10 sediment sites monitored by the RMC in WY2015. 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. The RPD for the two sediment sample field duplicates was calculated for each analyte and compared to the MQOs (RPD < 25%) set by Tables 26-6 and 26-7 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 RPD is calculated as:

$$RPD = ABS\left([X1-X2] / [(X1+X2)/2]\right)$$

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 dissolved organic carbon. This equates to a total of three such samples for the RMC total of 60 samples region-wide.

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 are trained in SWAMP and RMC protocols, and receive significant supervision from the local monitoring coordinator and QA officer. As a result, creek status monitoring data is considered to be representative of conditions in Santa Clara Valley Creeks.

3.2. Overall Project Comparability

SCVURPPP creek status monitoring data is 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 communications.

3.3. Bioassessments and Physical Habitat Assessments

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

3.3.1. Completeness

The SCVURPPP program completed 20 of 20 planned/required bioassessments and physical habitat assessments for WY2015 for a 100% completion rate. Benthic macroinvertebrate and algae samples were collected at all 11 transects for all 20 sites. Physical habitat assessments could not be performed at four transects/intertransects for two sites – 205R01930 (one transect) and 205R01562 (three transects/intertransects). As a result, the completion rate for biological samples was 100% and the completion rate for physical habitat assessments was 99.0%.

3.3.2. Sensitivity

The benthic macroinvertebrate taxonomic identification met sensitivity objectives; the taxonomy laboratory, BioAssessment Services, confirmed that organisms were identified to SAFIT STE Level I.

3.3.3. Accuracy

The two BMI samples submitted to the CDFW Aquatic Bioassessment Laboratory for QC had no major taxonomic discrepancies. The QC report is available upon request.

3.3.4. Precision

Duplicate algae and BMI samples were collected at two sites in WY2015. Few major taxonomic discrepancies were found between the field duplicates.

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 are 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) is 0.02 mg/L. There is, however, no established 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 taken.

3.5. Water Chemistry

Water chemistry samples were collected by SCVURPPP staff concurrently with bioassessment samples, between April 16 and May 26, 2015, 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 Tables 26-1, 26-2, 26-5, and 26-7.

3.5.1. Completeness

All 20 water chemistry samples and the two duplicate 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. The reporting limit for 18 of 20 chloride samples exceeded the target reporting limit due to sample dilutions. Chloride concentrations were much higher than reporting limits and the elevated reporting limits do not decrease confidence in the measurements. Target and actual reporting limits are shown in Table 1.

Table 1. Target and actual reporting limits for nutrients analyzed in SCVURPPP creek status monitoring.

Analyte	Target RL mg/L	Actual RL mg/L
Ammonia	0.1	0.1
Chloride	1	1-20
Total Kjeldahl Nitrogen	0.5	0.1
Nitrate	0.05	0.05
Nitrite	0.03	0.03
Dissolved Organic Carbon	0.6	0.5
Orthophosphate	0.01	0.01
Silica	1	1
Phosphorus	0.01	0.01
Suspended Sediment Concentration	3	3

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. Three MS/MSD percent recoveries exceeded the MQO range listed in the RMC QAPP for various conventional analytes, including nitrate, total Kjeldahl nitrogen (TKN), and silica. The affected samples have been assigned the appropriate SWAMP flag.

The PR range on laboratory reports was as 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 duplicate and matrix spike duplicate pairs were within the MQO target of < 25%. However, several constituents exceeded the RPD MQO for conventional analytes for the field duplicates. The MQO for RPD was exceeded for three constituents (ammonia, suspended sediment concentration, and chlorophyll a) at the first site and three constituents (total Kjeldahl nitrogen, ash free dry mass and, chlorophyll a) at the second site. Due to the nature of chlorophyll a and AFDM collection, discrepancies are 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). In past years of sampling, TKN was commonly among the analytes that exceed the field duplicate RPD MQOs. Discrepancies between other constituents are attributed to timing, i.e., not collecting the duplicate at the exact moment the original sample is collected. Field crews will continue to make an effort in subsequent years to collect the original and duplicate samples in an identical fashion.

The two field duplicate samples and their RPDs are shown in Tables 2 and 3. 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. However, some QA samples that were flagged by the laboratory were not flagged by the local QA officer; the laboratory report cited a maximum RPD of 20%, while the RPD limit in the RMC QAPP is 25% for all conventional analytes in water. This discrepancy only impacts the ash free dry mass field duplicates at site 205R02211.

Table 2. Field duplicate water chemistry results for site 205R02211, collected on April 14, 2015. Data in highlighted rows exceed monitoring quality objectives in RMC QAPP.

Analyte Name	Fraction Name	Unit	Original Result	Duplicate Result	RPD	Exceeds MQO (>25%)
Alkalinity as CaCO3	Total	mg/L	181	176	3%	No
Ammonia as N	Total	mg/L	0.16	0.25	44%	Yes
Chloride	None	mg/L	17	16	6%	No
Dissolved Organic Carbon	None	mg/L	5.8	5.4	7%	No
Nitrate as N	None	mg/L	0.33	0.33	0%	No
Nitrite as N	None	mg/L	< 0.005	< 0.005	N/A[a]	No
Nitrogen, Total Kjeldahl	None	mg/L	0.66	0.75	13%	No
Ortho Phosphate as P	Dissolved	mg/L	0.029	0.029	0%	No
Phosphorus as P	Total	mg/L	0.052	0.050	4%	No
Silica as SiO2	Total	mg/L	18	18	0%	No
Suspended Sediment Concentration	None	mg/L	4.4	5.7	26%	Yes
Chlorophyll a	Particulate	mg/m^2	73.12	166.34	78%	Yes
Ash Free Dry Mass	Fixed	g/m^2	761.61	607.77	22%	No

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

Table 3. Field duplicate water chemistry results for site 205R01669, collected on April 20, 2015. Data in highlighted rows exceed monitoring quality objectives in RMC QAPP.

Analyte Name	Fraction Name	Unit	Original Result	Duplicate Result	RPD	Exceeds MQO (>25%)
Alkalinity as CaCO3	Total	mg/L	89	90	1%	No
Ammonia as N	Total	mg/L	0.044	< 0.04	N/A[a]	No
Chloride	None	mg/L	100	100	0%	No
Dissolved Organic Carbon	None	mg/L	4.2	4.4	5%	No
Nitrate as N	None	mg/L	0.64	0.65	2%	No
Nitrite as N	None	mg/L	< 0.005	< 0.005	N/A[a]	No
Nitrogen, Total Kjeldahl	None	mg/L	0.4	0.57	35%	Yes
Ortho Phosphate as P	Dissolved	mg/L	0.088	0.084	5%	No
Phosphorus as P	Total	mg/L	0.096	0.094	2%	No
Silica as SiO2	Total	mg/L	16	17	6%	No
Suspended Sediment Concentration	None	mg/L	3.6	3.6	0%	No
Chlorophyll a	Particulate	mg/m^2	55.52	116.52	71%	Yes
Ash Free Dry Mass	Fixed	g/m^2	174.78	75.43	79%	Yes

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

3.5.5. Contamination

None of the target analytes were detected in any of the laboratory blanks or in the one water chemistry field blank sample collected in Santa Clara County in WY2015.

3.6. Sediment Chemistry

Sediment chemistry samples were collected by Kinnetic Laboratories, Inc (KLI) concurrently with dry season toxicity samples on July 7, 2015. 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 26-4, 26-6, and 26-7.

3.6.1. Completeness

All three planned samples were analyzed for all requested analytes, and 100% of results were reported. Sediment chemistry data were flagged when necessary, but none were rejected.

3.6.2. Sensitivity

Laboratory reporting limits were generally much higher than target reporting limits for metals, while RLs for polycyclic aromatic hydrocarbons (PAHs) and grain size distribution categories were much lower than target RLs. Organochlorine and pyrethroid pesticide RLs generally met or were slightly lower than target RLs. Target and actual reporting limits for analytes with higher reporting limits than designated in the QAPP are shown in Table 4. All metals and total organic carbon were detected at concentrations above the RLs; therefore, the method provided adequate sensitivity.

Table 4. Target and actual reporting limits for metals in sediment analyzed in SCVURPPP creek status monitoring.

Analyte	Target RL mg/kg	Actual RL mg/kg
Arsenic	0.3	0.51
Cadmium	0.01	0.04
Chromium	0.1	0.2-1
Copper	0.01	0.2
Lead	0.01	0.1
Mercury	0.03	0.02-0.82
Nickel	0.02	0.2-1
Zinc	0.1	2-4.1
Heptachlor epoxide	1	2
Gamma-HCH	1	2
Permethrin (cis and trans)	0.33	0.4-0.41
Total organic carbon	0.01%	0.12%

3.6.3. Accuracy

Inorganic Analytes
The PR MQO for inorganic analytes in sediment (metals) listed in the RMC QAPP and in the laboratory reported is 75-125%. No QA samples exceeded the MQO for LCS or MS percent recovery for metals.

Synthetic Organic Compounds
The recovery MQO for synthetic organic compounds in sediment (PAHs, organochlorine and pyrethroid pesticides) is 70-130% for LCS and 50-150% for matrix spikes 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.

The laboratory control sample PR exceeded the RMC MQO lower limit for several of the target PAHs (acenaphthene, anthracene, benz(a)anthracene, benzo(a)pyrene, biphenyl, 2,6-dimethylnaphthalene,1-methylnaphthalene, 2-methylnaphthalene, naphthalene, and perylene) and two of the 12 target organochlorine pesticides, including DDD(p,p') and DDT(p,p'). The MS/MSD percent recoveries exceeded the RMC MQO range for one pyrethroid pesticide (cypermethrin), three organochlorine pesticides (DDT(o,p'), DDT(p,p'), and endrin), and three PAHs (benzo(g,h,i)perylene, 2,6-dimethylnaphthalene, and indeno(1,2,3-c,d)pyrene). Analytes that exceeded RMC MQOs were flagged, but no data were rejected.

3.6.4. 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, and are much higher for gamma-BHC (Lindane) and p,p'-DDT at 52% and 59%,respectively. However, the RMC QAPP lists the MQO as less than 25% RPD for all synthetic organics. The RPD for duplicates was evaluated using the RMC MQO of < 25%, and as a result, several

analytes that were not flagged by the laboratory were flagged by the local QA officer. The RPD for MS/MSDs exceeded the RMC QAPP MQOs for one pyrethroid pesticide (cypermethrin) and several PAHs (benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, benzo(e)pyrene, chrysene, fluoranthene, phenanthrene, pyrene, biphenyl, fluoranthene, 1-methylnaphthalene, 2-methylnaphthalene, and naphthalene).

Field Duplicates
A sediment sample field duplicate was collected in Contra Costa County on July 7, 2015, and evaluated for precision. The field duplicate sample and corresponding RPDs are shown in Table 5. 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 coarse sand (0.5-1.0 mm), cyfluthrin, benz(a)anthracene, deltamethrin/tralomethrin, 1-methylnaphthalene, nitrobenzene-d5 (surrogate), and phenanthrene. Given the inherent variability associated with field duplicates, the low number of analytes whose RPDs fall outside of the MQO limits is remarkable. However, the method used to collect sediment field duplicates provides more insight to laboratory precision than precision of field methods, but the results do suggest that field methods are very precise.

3.6.5. Contamination

None of the target analytes were detected in any of the blanks.

Table 5. Sediment chemistry duplicate field results for site 206R01024, collected on July 7, 2015 in Contra Costa County. Data in highlighted rows exceed monitoring quality objectives in RMC QAPP.

	Analyte	Unit	Original	Duplicate	RPD	Exceeds MQO? (<25%)
Grain Size Distribution	Clay: <0.0039 mm	%	29.96	29.46	2%	No
	Silt: 0.0039 to <0.0625 mm	%	49.68	48.4	3%	No
	Granule: 2.0 to <4.0 mm	%	0.46	< 0.01	N/A	N/A
	Sand: Coarse 0.5 to <1.0 mm	%	0.54	0.39	32%	Yes
	Sand: Fine 0.125 to <0.25 mm	%	4.9	5.29	8%	No
	Pebble: Large 16 to <32 mm	%	< 0.01	< 0.01	N/A	N/A
	Sand: Medium 0.25 to <0.5 mm	%	1.48	1.18	23%	No
	Pebble: Medium 8 to <16 mm	%	< 0.01	< 0.01	N/A	N/A
	Pebble: Small 4 to <8 mm	%	0.8	< 0.01	N/A	N/A
	Sand: V. Coarse 1.0 to <2.0 mm	%	0.47	0.52	10%	No
	Sand: V. Fine 0.0625 to <0.125 mm	%	12.97	14.76	13%	No
	Pebble: V. Large 32 to <64 mm	%	< 0.01	< 0.01	N/A	N/A
Metals	Arsenic	mg/Kg dw	5.8	5.7	2%	No
	Cadmium	mg/Kg dw	0.52	0.51	2%	No
	Chromium	mg/Kg dw	17	17	0%	No
	Copper	mg/Kg dw	16	16	0%	No
	Lead	mg/Kg dw	9.3	9.3	0%	No
	Mercury	mg/Kg dw	0.056	0.055	2%	No
	Nickel	mg/Kg dw	28	28	0%	No
	Zinc	mg/Kg dw	70	67	4%	No
Organochlorine Compounds	Chlordane, cis-	ng/g dw	< 1.1	< 1.1	N/A	N/A
	Chlordane, trans-	ng/g dw	< 1.1	< 1.1	N/A	N/A
	DDD(o,p')	ng/g dw	< 2.2	< 2.2	N/A	N/A
	DDD(p,p')	ng/g dw	< 0.86	< 0.87	N/A	N/A
	DDE(o,p')	ng/g dw	< 2.2	< 2.2	N/A	N/A
	DDE(p,p')	ng/g dw	< 1.3	< 1.3	N/A	N/A
	DDT(o,p')	ng/g dw	< 2.2	< 2.2	N/A	N/A
	DDT(p,p')	ng/g dw	< 1.1	< 1.1	N/A	N/A
	Dieldrin	ng/g dw	< 1.3	< 1.3	N/A	N/A
	Endrin	ng/g dw	< 1.1	< 1.1	N/A	N/A
	HCH, gamma-	ng/g dw	< 0.76	< 0.76	N/A	N/A
	Heptachlor Epoxide	ng/g dw	< 1.2	< 1.2	N/A	N/A
Pyrethroids	Bifenthrin	ng/g dw	2.7	2.4	12%	No
	Cyfluthrin, total	ng/g dw	0.72	0.96	29%	Yes
	Cyhalothrin, Total lambda-	ng/g dw	0.16	< 0.065	N/A	N/A
	Cypermethrin, total	ng/g dw	0.21	0.22	5%	No
	Permethrin, cis-	ng/g dw	1	0.99	1%	No
	Permethrin, trans-	ng/g dw	0.45	0.41	9%	No
	Total Organic Carbon	%	2.4	2.4	0%	No
Polycyclic Aromatic Hydrocarbons	Acenaphthene	ng/g dw	< 3.2	< 3.3	N/A	N/A
	Acenaphthylene	ng/g dw	< 3.2	< 3.3	N/A	N/A
	Anthracene	ng/g dw	5.4	4.3	23%	No
	Benz(a)anthracene	ng/g dw	22	11	67%	Yes
	Benzo(a)pyrene	ng/g dw	65	54	18%	No
	Benzo(b)fluoranthene	ng/g dw	< 3.2	< 3.3	N/A	N/A

Table 5. Sediment chemistry duplicate field results for site 206R01024, collected on July 7, 2015 in Contra Costa County. Data in highlighted rows exceed monitoring quality objectives in RMC QAPP.

Analyte	Unit	Original	Duplicate	RPD	Exceeds MQO? (<25%)
Benzo(e)pyrene	ng/g dw	86	76	12%	No
Benzo(g,h,i)perylene	ng/g dw	43	43	0%	No
Benzo(k)fluoranthene	ng/g dw	< 3.2	< 3.3	N/A	N/A
Biphenyl	ng/g dw	4.3	< 3.6	N/A	N/A
Chrysene	ng/g dw	65	76	16%	No
Decachlorobiphenyl(Surrogate)	% Recovery	107	95	12%	No
Deltamethrin/Tralomethrin	ng/g dw	0.68	0.3	78%	Yes
Dibenz(a,h)anthracene	ng/g dw	22	< 3.3	N/A	N/A
Dibenzothiophene	ng/g dw	< 3.6	< 3.6	N/A	N/A
Dimethylnaphthalene, 2,6-	ng/g dw	65	65	0%	No
Esfenvalerate/Fenvalerate, total	ng/g dw	< 0.14	< 0.14	N/A	N/A
Esfenvalerate-d6-1(Surrogate)	% Recovery	85	89	5%	No
Esfenvalerate-d6-2(Surrogate)	% Recovery	85	88	3%	No
Fluoranthene	ng/g dw	< 3.2	< 3.3	N/A	N/A
Fluorene	ng/g dw	< 3.2	< 3.3	N/A	N/A
Fluorobiphenyl, 2-(Surrogate)	% Recovery	66	58	13%	No
Indeno(1,2,3-c,d)pyrene	ng/g dw	< 3.2	< 3.3	N/A	N/A
Methylnaphthalene, 1-	ng/g dw	4.3	3.3	26%	Yes
Methylnaphthalene, 2-	ng/g dw	7.6	6.5	16%	No
Methylphenanthrene, 1-	ng/g dw	< 3.2	< 3.3	N/A	N/A
Naphthalene	ng/g dw	5.4	4.3	23%	No
Nitrobenzene-d5(Surrogate)	% Recovery	53	39	30%	Yes
Perylene	ng/g dw	< 16	< 3.3	N/A	N/A
Phenanthrene	ng/g dw	22	11	67%	Yes
Pyrene	ng/g dw	< 3.2	< 3.3	N/A	N/A
Terphenyl-d14(Surrogate)	% Recovery	48	52	8%	No
Tetrachloro-m-xylene(Surrogate)	% Recovery	61	52	16%	No

3.7. Toxicity Testing

Water samples were collected at three Santa Clara County sites twice during WY2015 – once during a rain event (February 6, 2015) and a once during the dry season (July 7, 2015). Sediment samples were collected at the three sites during the dry season event. The water samples were analyzed for toxicity to four organisms – *Selenastrum capricornutum, Ceriodaphnia dubia, Pimephales promelas, and Hyalella azteca* – and the sediment samples were analyzed for toxicity to *Hyalella azteca.* 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. No toxicity results were rejected.

3.8. Pathogen Indicators

Pathogen indicator samples collected by KLI were analyzed by BioVir. Samples were collected on the morning of June 30, 2015 and were analyzed on later that day. *E. coli*, fecal coliform, and total coliform were reported for 5 field samples, along with a laboratory duplicate and a method blank.

3.8.1. Completeness

The five pathogen samples that were planned for WY2015 were to be collected at the five WY2014 sites. However, the Los Gatos Creek site, 205GUA050, was dry and was immediately replaced by an additional Stevens Creek site, ensuring 100% completeness.

3.8.2. Sensitivity

All reported coliform reporting limits were above the target RL 2 MPN/100mL listed in the project QAPP.

3.8.3. Accuracy

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

3.8.4. Precision

One laboratory duplicate was run for the three pathogen indicators. However, the QAPP requires a minimum of 15 duplicate samples before MQO measurements can be made. As a result, pathogen samples could not be evaluated for precision, and no samples were flagged.[3]

3.8.5. Contamination

One method blank was run in the batch for E. coli, fecal coliform, and total coliform. All three analytes were less than the MDL/RL (2 MPN/100mL).

3.9. Continuous Water Quality

Continuous water quality measurements were recorded at three sites once during the beginning of the monitoring index period in May 2015 and again at the end of the index period in September 2015, for a total of six events. 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)

3.9.1. Completeness

All data were reviewed immediately following sonde retrieval for both events. During the review of the first event, the dissolved oxygen data from site below the Stevens Creek Reservoir was flagged and immediately rejected due to erroneous and incomplete data. The site appeared to have a sensor malfunction as diurnal patterns were missing and did not follow the same trends as the other sites. A sonde was immediately redeployed at that site for another two-week deployment, and the replacement event was submitted in lieu of the rejected data set. Since the rejected data set was replaced, the continuous water quality data are 100% complete.

3.9.2. 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.

3.9.3. Accuracy

A summary of the drift measurements is shown in Table 6. The dissolved oxygen drift at the site directly below Stevens Creek Reservoir, 205STE071, exceeded the measurement quality objective. All dissolved oxygen measurements for that site have been flagged, but not rejected.

[3] For the one set of duplicates run, the RPDs for the E. coli and fecal coliform were 67%, while the RPD for total coliform was 93%.

Table 6. Drift measurements for two continuous water quality monitoring events in Santa Clara Valley urban creeks during WY 2015. Bold and highlighted values exceeded measurement quality objectives.

Parameter	Measurement Quality Objectives	205STE065		205STE071		205STE105	
		Event 1	Event 2	Event 1	Event 2	Event 1	Event 2
Dissolved Oxygen (mg/l)	± 0.5 mg/L or 10%	0.27	-0.09	-0.01	-0.79	0.02	-0.2
pH 7.0	± 0.2	-0.08	-0.02	0.05	-0.08	-0.01	0.07
pH 10.0	± 0.2	-0.08	0.04	0.01	0.05	-0.04	-0.13
Specific Conductance (uS/cm)	± 10%	1.3%	1.6%	0.1%	2.2%	0.5%	0.2%

3.9.4. Precision

A quick test not required by the RMC QAPP was run to evaluate the precision of the sondes. Following the final monitoring event, all three sondes were placed in a water bath and allowed to run for an hour at a 30-second recording interval. The median of each parameter (temperature, pH, dissolved oxygen, and conductivity) for each sonde was compared to the overall median. The only parameter with a non-zero RPD was conductivity. However, all of the RPDs were less than 15% and attributed to the fact that potable water is below the conductivity probe's minimum detection limit.

3.10. Continuous Temperature Monitoring

Continuous temperature monitoring was conducted from April through September 2015 at nine sites in Santa Clara. Onset HOBO Water Temperature Data loggers recorded one measurement per hour.

3.10.1. Completeness

Anticipating a lost HOBO temperature logger or premature stream desiccation, SCVURPPP deployed two extra temperature loggers, for a total of ten loggers. When the loggers were retrieved in September 2015, the logger deployed in the Guadalupe Creek at the convergence with Rincon Creek, 205GUA229, could not be found. However, given that there was still one more site than what was required by the MRP and no data were rejected, continuous temperature data was over 100% complete.

3.10.2. Sensitivity

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

3.10.3. Accuracy

A pre-deployment accuracy check was run on the temperature loggers, and five slightly exceeded the 0.2 °C mean difference for the room temperature bath (<0.25 °C). Two of these loggers also exceeded 0.2 °C mean difference for the ice bath (0.27 °C). It was determined that the water baths were not sufficiently mixed thus causing to the range of readings. The loggers were deployed and no data were flagged.

3.10.4. Precision

There are no precision protocols for continuous temperature monitoring.

4. CONCLUSIONS

All data that were planned were collected, and data that exceeded measurement quality objectives were flagged. No data were rejected other than the first long-term, continuous water quality monitoring event below the Stevens Creek dam that was replaced.

5. REFERENCES

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