Urban Creeks Monitoring Report

Water Quality Monitoring

Water Year 2018 (October 2017 – September 2018)

Submitted in Compliance with
NPDES Permit No. CAS612008 (Order No. R2-2015-0049),
Provision C.8.h.iii

SAN MATEO COUNTYWIDE
Water Pollution
Prevention Program

A Program of the City/County Association of Governments

March 31, 2019

CREDITS

This report is submitted by the participating agencies in the

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	City of Redwood City	

Prepared for:

San Mateo Countywide Water Pollution Prevention Program (SMCWPPP)
555 County Center, Redwood City, CA 94063
A Program of the City/County Association of Governments (C/CAG)

Prepared by:

EOA, Inc.
1410 Jackson St., Oakland, CA 94610

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 San Francisco Bay Area regional municipal stormwater permit, which is a National Pollutant Discharge Elimination System (NPDES) permit (in this document the permit is referred to as the Municipal Regional Permit, or MRP)[1]. The RMC is comprised of the following participants:

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

This Urban Creeks Monitoring Report complies with MRP provision C.8.h.iii for reporting of all data in Water Year 2018 (October 1, 2017 through September 30, 2018). Data were collected pursuant to Provision C.8 of the MRP. Data presented in this report were generated by water quality monitoring programs conducted under the direction of the RMC and the San Mateo Countywide Water Pollution Prevention Program (SMCWPPP), using probabilistic and targeted monitoring designs as described herein.

Monitoring data were collected in accordance with the BASMAA RMC Quality Assurance Project Plan (QAPP; BASMAA 2016a) and the BASMAA RMC Standard Operating Procedures (SOPs; BASMAA 2016b). Where applicable, monitoring data were derived using methods comparable with methods specified by the California Surface Water Ambient Monitoring Program (SWAMP) Quality Assurance Program Plan (QAPrP)[2]. Data presented in this report were also submitted in electronic SWAMP-comparable formats by SMCWPPP to the San Francisco Bay Regional Water Quality Control Board (Regional Water Board) on behalf of SMCWPPP Permittees and pursuant to Provision C.8.h.ii of the MRP.

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

[2] The current SWAMP QAPrP, dated May 2017, is available at: https://www.waterboards.ca.gov/water_issues/programs/swamp/qapp/swamp_QAPrP_2017_Final.pdf

List of Acronyms

ACCWP	Alameda County Clean Water Program
AFDM	Ash Free Dry Mass
AFR	Alternative Flame Retardant
ASCI	Algae Stream Condition Index
BASMAA	Bay Area Stormwater Management Agency Association
BAHM	Bay Area Hydrological Model
BMI	Benthic Macroinvertebrate
BMP	Best Management Practice
BSM	Bioretention Soil Media
CADDIS	Causal Analysis/Diagnosis Decision Information System
C/CAG	San Mateo City/County Association of Governments
CCCWP	Contra Costa Clean Water Program
CEC	Chemicals of Emerging Concern
CEDEN	California Environmental Data Exchange Network
CSCI	California Stream Condition Index
CW4CB	Clean Watersheds for a Clean Bay
DO	Dissolved Oxygen
DPR	California Department of Pesticide Regulation
ECWG	Emerging Contaminant Workgroup
FIB	Fecal Indicator Bacteria
FSURMP	Fairfield Suisun Urban Runoff Management Program
GIS	Geographic Information system
HDS	Hydrodynamic Separator
IBI	Index of Biological Integrity
IMR	Integrated Monitoring Report
IPI	Index of Physical Habitat Integrity
IPM	Integrated Pest Management
LID	Low Impact Development
MPC	Monitoring and Pollutants of Concern Committee
MRP	Municipal Regional Permit
MS4	Municipal Separate Storm Water Sewer System
MST	Microbial Source Tracking
MWAT	Maximum Weekly Average Temperature
NPDES	National Pollution Discharge Elimination System
PAHs	Polycyclic Aromatic Hydrocarbons
PBDEs	Polybrominated Diphenyl Ethers
PCBs	Polychlorinated Biphenyls
PEC	Probable Effect Concentration
PFAS	Perfluoroalkyl Sulfonates
PFOS	Perfluorooctane Sulfonates
PHAB	Physical Habitat
POC	Pollutant of Concern
QAPP	Quality Assurance Project Plan
QAPrP	Quality Assurance Program Plan
RAA	Reasonable Assurance Analysis
RCD	San Mateo Resource Conservation District
RMC	Regional Monitoring Coalition

RMP	Regional Monitoring Program for Water Quality in San Francisco Bay
RWSM	Regional Watershed Spreadsheet Model
S&T	Status and Trends
SCCWRP	Southern California Coastal Water Research Project
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SFEI	San Francisco Estuary Institute
SFRWQCB	San Francisco Regional Water Quality Control Board
SMCWPPP	San Mateo Countywide Water Pollution Prevention Program
SOP	Standard Operating Procedures
SPLWG	Sources, Pathways, and Loadings Work Group
SPoT	Statewide Stream Pollutant Trend Monitoring
SRP	San Mateo Countywide Stormwater Resource Plan
SSC	Suspended sediment concentration
SSID	Stressor/Source Identification
STLS	Small Tributaries Loading Strategy
SWAMP	Surface Water Ambient Monitoring Program
SWPP	DPR Surface Water Protection Program
TEC	Threshold Effect Concentration
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TRC	Technical Review Committee
TRE	Toxicity Reduction Evaluation
TU	Toxic Unit (equivalent)
UCD	University of California, Davis
UCMR	Urban Creeks Monitoring Report
USEPA	Environmental Protection Agency
USEPA	US Environmental Protection Agency
USGS	US Geological Survey
WLA	Waste Load Allocation
WMA	Watershed Management Areas
WQO	Water Quality Objective
WY	Water Year

Table of Contents

List of Figures

List of Tables

List of Appendices

Table E.1. Water Year 2018 Creek Status Monitoring Stations

In compliance with Provision C.8.h.iii.(1), this table of all creek status monitoring stations sampled in Water Year 2018 is provided immediately following the Table of Contents. See Section 3.0 for additional information on creek status monitoring.

Map ID [1]	Station ID	Bayside or Coastside	Watershed	Creek Name	Land Use [2]	Latitude	Longitude	Probabilistic	Targeted				
								Bioassessment, Nutrients, General WQ	Chlorine	Pesticides & Toxicity	Temp [3]	Cont WQ [4]	Pathogen Indicators
584	202R00584	Coastal	Pilarcitos Creek	Pilarcitos Creek	NU	37.49547	-122.38512	X	X				
614	202R00614	Coastal	Pescadero Creek	Pescadero Creek	NU	37.27410	-122.28860	X	X				
3404	202R03404	Coastal	San Pedro Creek	San Pedro Creek	U	37.58203	-122.48719	X	X				
3656	202R03656	Coastal	Pilarcitos Creek	Pilarcitos Creek	U	37.46781	-122.42269	X	X				
3880	202R03880	Coastal	San Gregorio Cr	La Honda Creek	U	37.38759	-122.27219	X	X				
3916	202R03916	Coastal	San Pedro Creek	San Pedro Creek	U	37.59144	-122.50333	X	X				
3508	204R03508	Bayside	Mills Creek	Mills Creek	U	37.59105	-122.37406	X	X				
3528	204R03528	Bayside	San Mateo Creek	San Mateo Creek	U	37.54808	-122.34661	X	X				
3624	205R03624	Bayside	San Francisquito Cr	Bear Creek	U	37.41883	-122.26498	X	X				
3864	205R03864	Bayside	San Francisquito Cr	Hamms Gulch	U	37.36498	-122.22906	X	X				
5	202SPE005	Coastside	San Pedro Creek	San Pedro Creek	U	37.59441	-122.50520			X			
10	204COR010	Bayside	Cordilleras Creek	Cordilleras Creek	U	37.47977	-122.25986			X			
138	202PES138	Coastside	Pescadero Creek	Pescadero Creek	NU	37.27410	-122.28860						X
142	202PES142	Coastside	Pescadero Creek	McCormick Creek	NU	37.27757	-122.28635						X
144	202PES144	Coastside	Pescadero Creek	Pescadero Creek	NU	37.27592	-122.28550						X
150	202PES150	Coastside	Pescadero Creek	Jones Gulch	NU	37.27424	-122.26811						X
154	202PES154	Coastside	Pescadero Creek	Pescadero Creek	NU	37.27446	-122.26798						X
19	202SPE019	Coastside	San Pedro Creek	San Pedro Creek	U	37.58853	-122.49943				X		
40	202SPE040	Coastside	San Pedro Creek	San Pedro Creek	U	37.58200	-122.48708				X	X	
50	202SPE050	Coastside	San Pedro Creek	San Pedro Creek	U	37.58198	-122.47819				X		
70	202SPE070	Coastside	San Pedro Creek	San Pedro Creek	NU	37.57974	-122.47371				X	X	
85	202SPE085	Coastside	San Pedro Creek	San Pedro Creek	NU	37.57826	-122.47156				X		

[1] Map ID applies to Figure 3.1.
[2] U = urban, NU = non-urban
[3] Temperature monitoring was conducted continuously (i.e., hourly) April through September.
[4] Continuous water quality monitoring (temperature, dissolved oxygen, pH, specific conductivity) was conducted during two 2-week periods (spring and late summer).

Executive Summary

This Urban Creeks Monitoring Report (UCMR) was prepared by the San Mateo Countywide Water Pollution Prevention Program (SMCWPPP) in compliance the National Pollutant Discharge Elimination System stormwater permit for Bay Area municipalities referred to as the Municipal Regional Permit (MRP; Order No. R2-2015-0049). This report, including all appendices and attachments, fulfills the requirements of Provision C.8.h.iii of the MRP for reporting of all data collected in Water Year 2018 (WY 2018; October 1, 2017 through September 30, 2018) pursuant to Provision C.8 of the MRP. Data presented in this report were also submitted in electronic SWAMP-comparable formats by SMCWPPP to the San Francisco Bay Regional Water Quality Control Board (Regional Water Board) on behalf of SMCWPPP Permittees and pursuant to Provision C.8.h.ii of the MRP.

Water quality monitoring required by Provision C.8 of the MRP is intended to

- assess the condition of water quality in Bay Area receiving waters (creeks and the Bay);
- identify and prioritize stormwater runoff associated impacts, stressors, sources, and loads;
- identify appropriate management actions; and
- detect trends in water quality over time and the effects of stormwater control measure implementation.

The organization of this Executive Summary follows the sub-provisions of Provision C.8 (Water Quality Monitoring) of the MRP. Each section very briefly describes what was done and summarizes key results. More details are provided in the body of the report and in its corresponding appendices.

Compliance Options (C.8.a)

Provision C.8.a (Compliance Options) of the MRP allows Permittees to address monitoring requirements through a “regional collaborative effort,” their countywide stormwater program, and/or individually. On behalf of San Mateo County Permittees, SMCWPPP conducts creek water quality monitoring and monitoring projects in San Mateo County in collaboration with the Bay Area Stormwater Management Agency Association (BASMAA) Regional Monitoring Coalition (RMC), and actively participates in the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP), which focuses on assessing Bay water quality and associated impacts.

Monitoring Protocols and Data Quality (C.8.b)

Creek status and pesticides & toxicity monitoring data were collected in accordance with the BASMAA RMC Quality Assurance Project Plan (QAPP) and the BASMAA RMC Standard Operating Procedures (SOP). Where applicable, and in compliance with Provision C.8.b, methods described in the QAPP and SOP are comparable with methods specified by the California Surface Water Ambient Monitoring Program (SWAMP) Quality Assurance Program Plan (QAPrP).

San Francisco Estuary Receiving Water Monitoring (C.8.c)

In accordance with Provision C.8.c of the MRP, Permittees are required to provide financial contributions towards implementing an Estuary receiving water monitoring program on an annual basis that, at a minimum, is equivalent to the RMP. SMCWPPP complies with this provision by making financial contributions to the RMP. Additionally, SMCWPPP and other BASMAA RMC representatives actively participate in RMP committees, workgroups, and strategy teams, such as the Small Tributaries Loading Strategy (STLS), to help oversee RMP activities and look out for MRP Permittee interests.

Creek Status Monitoring (C.8.d)

The RMC's creek status monitoring strategy includes both a regional ambient/probabilistic monitoring design and a local "targeted" monitoring design. The probabilistic monitoring design was developed to remove bias from site selection such that ecosystem conditions can be objectively assessed on local (i.e., San Mateo County) and regional (i.e., RMC) scales. 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. Monitoring results are compared to "triggers" listed in Provision C.8.d of the MRP. Some triggers are equivalent to regulatory Water Quality Objectives (WQOs); others are thresholds above (or below) which potential impacts to aquatic life or other beneficial uses may occur. Sites were triggers are exceeded (or not met) are considered for future stressor/source identification (SSID) projects.

During WY 2018, SMCWPPP conducted biological assessments at ten probabilistic sites. Bioassessments include the collection of benthic macroinvertebrate and algae samples, physical habitat measurements, collection of grab creek water samples for water chemistry (i.e., nutrient analyses), and measurement of general water quality parameters using a pre-calibrated multi-parameter field probe. The California Stream Condition Index (CSCI), a statewide tool that translates benthic macroinvertebrate data into an overall measure of stream health, was used to assess biological condition at all probabilistic sites. Of the ten sites monitored in WY 2018, five sites (50%) scored below the CSCI threshold score of 0.795 and were rated as altered or degraded. Low CSCI scores are related to impacts to physical habitat typical for urbanized areas, such as creek channel modifications (e.g., lining with concrete) and contributing watersheds with a high percentages of impervious surface.

Targeted monitoring parameters consist of water temperature, general water quality, and pathogen indicators. In WY 2018, continuous temperature data were collected at five targeted stations in San Pedro Creek and continuous general water quality data (pH, dissolved oxygen, specific conductance, and temperature) were collected at two targeted stations in this creek. San Pedro Creek, located in the City of Pacifica, was targeted for temperature and general water quality monitoring because it contains the northern-most population of naturally producing steelhead trout (*Oncorhynchus mykiss*) in San Mateo County. There were no exceedances of the MRP trigger thresholds for temperature or any of the general water quality parameters, which is consistent with water quality conditions that support relevant aquatic habitat beneficial uses of the creek (e.g., juvenile steelhead rearing and spawning life stages).

In WY 2018, pathogen indicator (i.e., enterococci, *E. coli*) grab water samples were collected at five stations in the Pescadero Creek watershed. The MRP trigger threshold for *E. coli* was not exceeded at any site in WY 2018; however, the MRP trigger threshold for enterococci was exceeded at two sites.

Impacts to urban streams identified through creek status monitoring are likely the result of long-term changes in stream hydrology, channel geomorphology, in-stream habitat complexity, and other modifications associated with the urban development, and, to a lesser extent, pollutant discharges typically found in urban watersheds. SMCWPPP 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. Through the continued implementation of MRP-associated and other watershed stewardship programs, SMCWPPP anticipates that stream conditions and water quality in local creeks will continue to improve over time.

Stressor/Source Identification (SSID) Projects (C.8.e)

Provision C.8.e of the MRP requires that Permittees evaluate creek status (Provision C.8.d) and pesticides and toxicity (Provision C.8.g) monitoring data with respect to triggers defined in the MRP and maintain a list of all results exceeding trigger thresholds. Sites where triggers are exceeded may indicate potential impacts to aquatic life or other beneficial uses and are therefore considered as candidates for future SSID projects. The MRP requires SMCWPPP and its RMC partners to collectively initiate a region-wide minimum of eight SSID projects. In WY 2018, SMCWPPP worked with the San Mateo Resource Conservation District (RCD) to implement the Pillar Point Watershed Pathogen Indicator SSID Project Work Plan. The field investigation included sample collection from up to 14 stations during four monitoring events to identify spatial and biotic sources of fecal indicator bacteria. Based on the WY 2018 field results, several additional field investigations were recommended and are being implemented in WY 2019. These include targeted dye studies of sanitary sewer lines, pet waste reconnaissance visits, and additional microbial source tracking (MST) sampling.

Pollutants of Concern Monitoring (C.8.f)

Pollutants of Concern (POC) monitoring is required by Provision C.8.f of the MRP. POC monitoring is intended to assess inputs of POCs to the Bay from local tributaries and urban runoff, provide information to support implementation of Total Maximum Daily Load (TMDL) water quality restoration plans and other pollutant control strategies, assess progress toward achieving wasteload allocations (WLAs) for TMDLs, and help resolve uncertainties associated with loading estimates for POCs. In WY 2018, SMCWPPP met or exceeded the MRP's minimum yearly requirements for all POC monitoring parameters.

The MRP requires that Permittees provide a list of management areas in which new PCBs and mercury control measures will be implemented during the permit term. These management areas are designated "Watershed Management Areas" (WMAs), and are defined as all San Mateo County catchments containing high interest parcels (i.e., properties with land uses associated with PCBs such as old industrial, electrical and recycling) and/or existing or planned PCBs and mercury controls. During WY 2018, SMCWPPP collected 13 composite samples of stormwater runoff from outfalls at the bottom of WMAs and 50 samples of urban sediments (from manholes, storm drain inlets, driveways, streets, and sidewalks) within WMAs. As part of continuing to develop strategies for reducing PCBs and mercury loads in stormwater runoff, SMCWPPP evaluated these data, along with additional WY 2018 stormwater runoff sample data collected through the STLS, and data from previous water years collected by SMCWPPP and through the STLS. Objectives included attempting to identify source properties within WMAs, identifying which WMAs provide the greatest opportunities for implementing cost-effective PCBs controls, and prioritizing WMAs for future investigations. Each WMA was provisionally designated as high, medium, or low priority. It is important to emphasize the provisional nature of these prioritizations, and especially the uncertainty surrounding designating a WMA as low priority due to a single bottom-of-catchment composite stormwater runoff sample having a low PCBs particle ratio. Low PCBs concentrations in any single stormwater runoff sample could be a false negative, especially if the storm was too small to mobilize sediments with associated PCBs. For example, based upon WY 2018 resampling results, two WY 2016 RMP STLS stormwater runoff samples located in South San Francisco may have been false negatives.

The PCBs monitoring data collected to-date has informed identification of several potential source properties located in the City of San Carlos. The Countywide Program is working with the City regarding next steps at these sites. This included recently developing and submitting to the Regional Water Board referrals of two areas for potential further PCBs investigation and abatement:

- 270 Industrial Road (Delta Star) / 495 Bragato Road (Tiegel), which are adjacent properties in San Carlos.
- 977 and 1007/1011 Bransten Road, another set of adjacent properties in San Carlos.

The mean and median PCBs concentrations in WY 2018 sediment samples (n = 50) were somewhat lower than in previous years. In addition, in WY 2018 only 1 of the 50 sediment samples collected had a PCBs concentration that exceeded 1.0 mg/kg. One other sample had a PCBs concentration between 0.5 and 1.0 mg/kg. All of the remaining samples had a PCBs concentration below 0.5 mg/kg. In general, the WY 2018 POC monitoring data suggest that the PCBs monitoring program in the public ROW in San Mateo County may be approaching diminishing returns in terms of identifying new source properties.

However, the stormwater runoff resamples in South San Francisco suggest the possibility of false negatives for PCBs in some WMAs provisionally designated low priority based on stormwater runoff data from previous years. The RMP's ongoing "Advanced Data Analysis" is evaluating normalizing results based upon storm intensity and the results may help inform planning any future stormwater runoff monitoring of this type.

In WY 2018, two creeks were sampled for copper and nutrient analyses during two types of flow events (storm event and baseflow) for a total of four grab water samples. Copper and nutrients were higher in the storm event samples compared to the baseflow samples, suggesting an influence of stormwater runoff. The similarity in the magnitude of concentrations between the sites was consistent with a lack of localized sources of copper or nutrients.

None of the WY 2018 POC monitoring water samples exceeded applicable WQOs.

Pesticides and Toxicity Monitoring (C.8.g)

In WY 2018, SMCWPPP conducted pesticides and toxicity monitoring in compliance with Provision C.8.g of the MRP and in coordination with the RMC. The monitoring was conducted at two stations, one near the mouth of Cordilleras Creek and the other near the mouth of San Pedro Creek. Dry weather pesticides and toxicity monitoring was conducted at the Cordilleras Creek station (one water sample for toxicity and one sediment sample for toxicity, pesticides and other pollutants including metals). Wet weather pesticides and toxicity monitoring was conducted during a January 2018 storm event at both stations (one water sample from each station for toxicity and pesticides).

Statistically significant toxicity to *C. dubia* was observed in the water sample collected from Cordilleras Creek during the dry season. During wet weather monitoring, statistically significant toxicity to *H. azteca* was observed in the water samples collected from both creeks and toxicity to *P. promelas* was observed in the water sample collected from San Pedro Creek. However, the magnitude of the toxic effects in the samples compared to laboratory controls did not exceed MRP trigger criteria of 50 Percent Effect. The cause of the observed toxicity is unknown. Pesticide concentrations in the sediment and water samples were all relatively low, with most below the method detection limits (MDLs). Toxic Unit (TU) equivalents were also relatively low. Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) quotients were calculated for all metals and total poly aromatic hydrocarbons (PAHs) measured in the sediment sample. TEC and PEC trigger exceedances were observed for chromium and nickel but are likely related to natural occurrences of these metals associated with the area's serpentine geology.

1.0 Introduction

This Urban Creeks Monitoring Report (UCMR), was prepared by the San Mateo Countywide Water Pollution Prevention Program (SMCWPPP), on behalf of the 22 San Mateo County MRP Permittees (20 cities/towns, the County of San Mateo, and the San Mateo County Flood Control District) subject to the National Pollutant Discharge Elimination System (NPDES) stormwater permit for Bay Area municipalities referred to as the Municipal Regional Permit (MRP).

The MRP was first adopted by the San Francisco Regional Water Quality Control Board (SFRWQCB or Regional Water Board) on October 14, 2009 as Order R2-2009-0074 (SFRWQCB 2009). On November 19, 2015, the SFRWQCB updated and reissued the MRP as Order R2-2015-0049 (SFRWQCB 2015). This report fulfills the requirements of Provision C.8.h.iii of the MRP for comprehensively interpreting and reporting all monitoring data collected during the foregoing October 1 – September 30 period (i.e., Water Year 2018). Data were collected pursuant to water quality monitoring requirements in Provision C.8 of the MRP. Monitoring data presented in this report were submitted electronically to the Regional Water Board by SMCWPPP and, if collected from a receiving water, may be obtained via the San Francisco Bay Area Regional Data Center of the California Environmental Data Exchange Network (CEDEN).[3]

Major sections in this report are organized according to the following topics and MRP sub-provisions. Some topics are summarized briefly in this report but described more fully in the appendices.

- 1.0 Introduction
- 2.0 San Francisco Estuary Receiving Water Monitoring (MRP Provision C.8.c)
- 3.0 Creek Status Monitoring (MRP Provision C.8.d) and Pesticides and Toxicity Monitoring (MRP Provision C.8.g) (**Appendix A**)
- 4.0 Stressor/Source Identification (SSID) Projects (MRP Provision C.8.e) (**Appendix B**)
- 5.0 Pollutants of Concern (POC) Monitoring (MRP Provision C.8.f) (**Appendices C, D, E and F**)
- 6.0 Recommendations and Next Steps

Figure 1.1 maps locations of monitoring stations associated with Provision C.8 compliance in Water Year (WY) 2018, including creek status monitoring, pesticides and toxicity monitoring, the SSID Project, and POC monitoring conducted by SMCWPPP and the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP). This figure shows the geographic extent of monitoring conducted in San Mateo County in WY 2018.

[3] http://www.ceden.org/

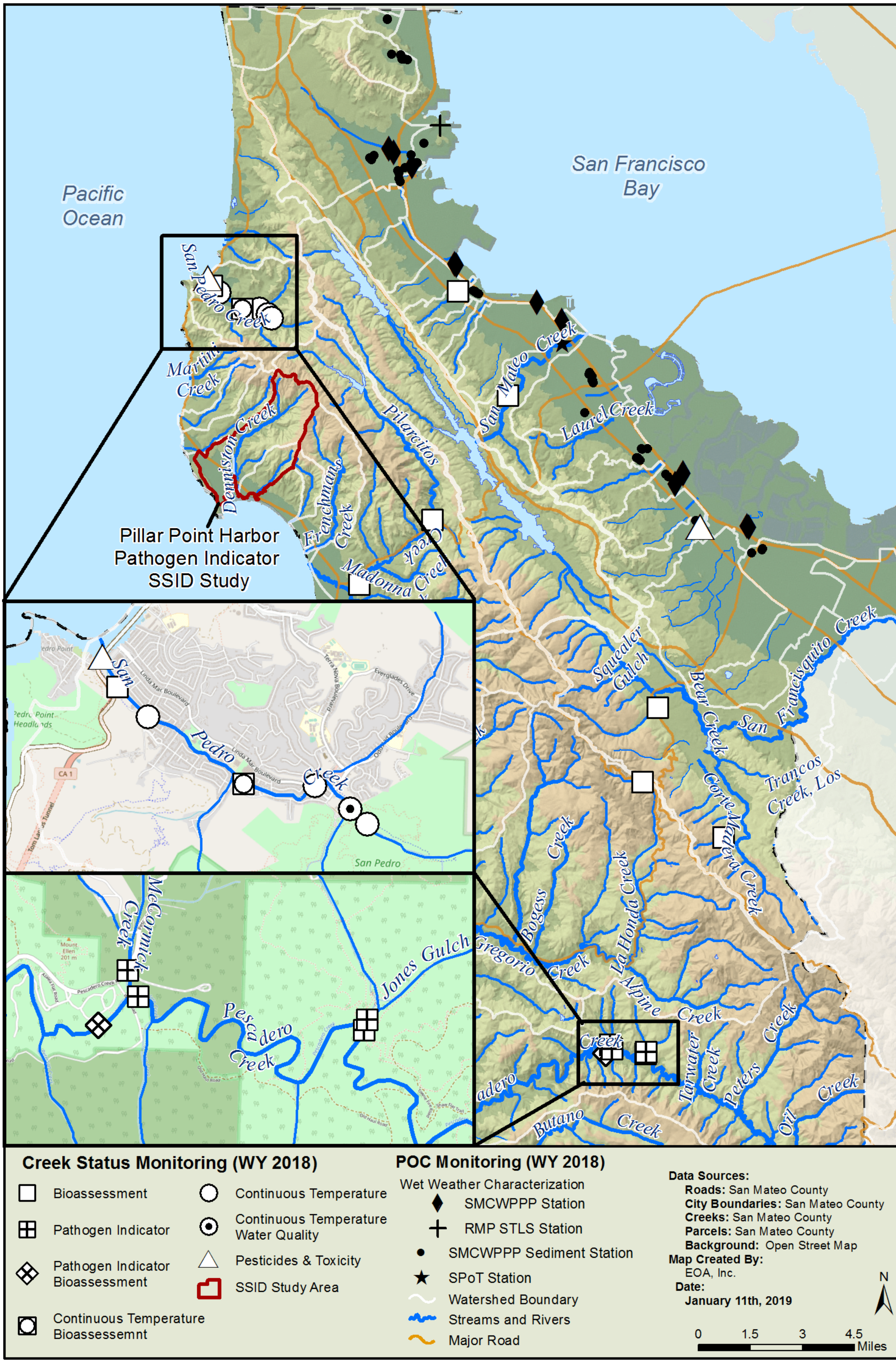

Figure. 1.1. San Mateo County MRP Provision C.8 monitoring locations: Creek Status Monitoring, Pesticides and Toxicity Monitoring, Stressor/Source Identification (SSID), and POC Monitoring, WY 2018.

1.1 RMC Overview (C.8.a)

Provision C.8.a (Compliance Options) of the MRP allows Permittees to address monitoring requirements through a “regional collaborative effort,” their countywide stormwater program, and/or individually. In June 2010, Permittees notified the Regional Water Board in writing of their agreement to participate in a regional monitoring collaborative to address requirements in Provision C.8. The regional monitoring collaborative is referred to as the Bay Area Stormwater Management Agency Association (BASMAA) Regional Monitoring Coalition (RMC). In a November 2, 2010 letter to the Permittees, the Regional Water Board’s Assistant Executive Officer (Dr. Thomas Mumley) acknowledged that all Permittees have opted to conduct monitoring required by the MRP through a regional monitoring collaborative, the BASMAA RMC. Participants in the RMC are listed in Table 1.1.

In February 2011, the RMC developed a Multi-Year Work Plan (RMC Work Plan; BASMAA 2011) to provide a framework for implementing regional monitoring and assessment activities required under Provision C.8 of the 2009 MRP. The RMC Work Plan summarizes RMC projects planned for implementation between Fiscal Years 2009-10 and 2014-15 (BASMAA 2011). Projects were collectively developed by RMC representatives to the BASMAA Monitoring and Pollutants of Concern Committee (MPC), and were conceptually agreed to by the BASMAA Board of Directors (BASMAA BOD). Although there are no plans to update the Multi-Year Work Plan, several additional regional projects were identified to be conducted in compliance with the 2015 MRP. Current regional projects relevant to Provision C.8 compliance include projects to maintain and update the regional database, coordinate the RMC Workgroup meetings, conduct POC monitoring, and develop/implement a regional SSID study.

Regionally implemented activities in the RMC Work Plan are conducted under the auspices of BASMAA, a 501(c)(3) non-profit organization that represents the municipal stormwater programs in the San Francisco Bay Area. Scopes, budgets, and contracting or in-kind project implementation mechanisms for BASMAA regional projects follow BASMAA’s Operational Policies and Procedures and are approved by the BASMAA BOD. MRP Permittees, often through their stormwater program representatives on the BOD and its subcommittees, collaboratively authorize and participate in BASMAA regional projects or tasks. Regional project costs are usually shared by either all BASMAA members or among those Phase I municipal stormwater programs that are subject to the MRP.

Table 1.1 Regional Monitoring Coalition (RMC) participants.

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

1.2 Coordination with Third-party Monitoring Programs

SMCWPPP strives to work collaboratively with its water quality monitoring partners to find mutually beneficial monitoring approaches. Provision C.8.a.iii of the MRP allows Permittees to use data collected by third-party organizations to fulfill monitoring requirements, provided the data are demonstrated to meet the required data quality objectives.

In WY 2018, SMCWPPP continued to coordinate with water quality monitoring programs conducted by third parties that supplement Bay Area stormwater monitoring conducted via the MRP. These programs include the RMP's Small Tributaries Loading Strategy (STLS), and the Stream Pollutant Trends (SPoT) monitoring conducted by the State of California's Surface Water Ambient Monitoring Program (SWAMP). Water quality data from these programs are reported in this document and were utilized to comply with or supplement MRP Provision C.8 monitoring, consistent with Provision C.8.a.iii.[4, 5] These data are described in Section 5.0 (POC Monitoring) of this report.

[4] Data reported by these programs are summarized in this report but are not included in the SMCWPPP electronic data submittal.

[5] In most years, the SPoT Program collects sediment samples from one station in San Mateo Creek and analyzes for one or more of the constituents required by Provision C.8.f of the MRP. In WY 2018, the SPoT station sample was analyzed for two of those constituents (mercury and copper).

2.0 San Francisco Estuary Receiving Water Monitoring (C.8.c)

In accordance with Provision C.8.c of the MRP, Permittees are required to provide financial contributions towards implementing an Estuary receiving water monitoring program on an annual basis that at a minimum is equivalent to the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP). Since the adoption of the 2009 MRP, SMCWPPP has complied with this provision by making financial contributions to the RMP. Additionally, SMCWPPP representatives actively participate in RMP committees, workgroups, and strategy teams as described in the following sections, which also provide a brief description of the RMP and associated monitoring activities conducted during WY 2018.

The RMP is a long-term (1993 – present) discharger-funded monitoring program that shares direction and participation by regulatory agencies and the regulated community with the goal of assessing water quality in San Francisco Bay. The regulated community includes municipal separate stormwater sewer systems (MS4s), publicly owned treatment works (POTWs), dredger, and industrial dischargers. The San Francisco Estuary Institute (SFEI) is the implementing entity for the RMP and the fiduciary agent for RMP stakeholder funds. SFEI helps identify stakeholder information needs, develops workplans that address these needs, and implements the workplans. SFEI's work is overseen by a Board and various committees that include representatives from the dischargers and regulators.

The RMP is intended to answer the following core management questions:

1. Are chemical concentrations in the Estuary potentially at levels of concern and are associated impacts likely?
2. What are the concentrations and masses of contaminants in the Estuary and its segments?
3. What are the sources, pathways, loadings, and processes leading to contaminant related impacts in the Estuary?
4. Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased?
5. What are the projected concentrations, masses, and associated impacts of contaminants in the Estuary?

The RMP budget is generally broken into two major program elements: (1) Status and Trends and (2) Pilot/Special Studies. The following sections provide a brief overview of these programs. The *RMP 2018 Detailed Workplan and Budget*[6] provides more details and establishes deliverables for each component of the current RMP budget. The RMP publishes annual summary reports. In odd years, the *Pulse of the Estuary/Bay Report* focuses on Bay water quality and summarizes information from all sources. In even years, the *RMP Update Report* has a narrower and specific focus on a selected topic. The *2018 RMP Update*[7] includes: a brief summary of noteworthy findings of the multifaceted RMP; a description of the management context that guides the RMP; and a summary of progress to date and future plans for

[6] https://www.sfei.org/documents/2018-rmp-detailed-workplan-and-budget

[7] https://www.sfei.org/documents/rmp-update-2018

addressing priority water quality topics. It also includes an article on per- and polyfluoroalkyl substances (PFAS) in San Francisco Bay wildlife, one of the pollutants of concern identified in MRP Provision C.8.f.

2.1 RMP Status and Trends Monitoring Program

The Status and Trends Monitoring Program (S&T Program) is the long-term contaminant-monitoring component of the RMP. The S&T Program was initiated as a pilot study in 1989, implemented thereafter, and was redesigned in 2007 based on a more rigorous statistical design that enables the detection of trends. The RMP Technical Review Committee (TRC), in which the BASMAA RMC participates, continues to assess the efficacy and value of the various elements of the S&T Program and to recommend modifications to S&T Program activities based on ongoing findings. The current S&T sampling schedule, established in 2014, is summarized in Table 2.1 with 2018 accomplishments and 2019 goals.

Table 2.1. RMP Status and Trends Monitoring Schedule.

Program Element	Schedule	2018 Sampling	2019 Sampling
Water	Every two years	No	Yes
Bird Eggs	Every three years	Yes	No
Sediment	Every four years	Yes	No
Sport Fish	Every five years	No	Yes
Bivalves	Every two years	Yes	No
Support to the USGS for suspended sediment, nutrient, and phytoplankton monitoring	Every year	Yes	Yes

Additional information on the S&T Program and associated monitoring data are available for download via the RMP website at http://www.sfei.org/content/status-trends-monitoring.

2.2 RMP Pilot and Special Studies

The RMP also conducts Pilot and Special Studies[8] on an annual basis. Studies are typically designed to investigate and develop new monitoring measures related to anthropogenic contamination or contaminant effects on biota in the Estuary. Special Studies address specific scientific issues that RMP committees, workgroups, and strategy teams identify as priority for further study. These studies are developed through an open selection process at the workgroup level and selected for funding through the TRC and the RMP Steering Committee.

In 2018, Pilot and Special Studies focused on the following topics:

- Nutrients Management Strategy
    - Continuous monitoring of nutrients, phytoplankton biomass, and dissolved oxygen at moored sensors

[8] Results and summaries of the most pertinent Pilot and Special Studies can be found on the RMP website (http://www.sfei.org/rmp/rmp_pilot_specstudies).

  - Continuous monitoring of dissolved oxygen in shallow margin habitats
  - Ship-based nutrient sampling
  - Data analysis and quantitative mechanistic interpretations to identify factors contributing to observed conditions
- Small Tributary Loadings Strategy (see Section 5.0 for more details)
  - Watershed characterization reconnaissance monitoring for Pollutants of Concern (POC)
  - Advanced analysis of PCBs data
  - Planning support for alternative flame retardants conceptual model
  - Development of a trends strategy
  - Regional Watershed Spreadsheet Model (RWSM) support
- Emerging Contaminant Strategy
  - Review and update of the RMP's Tiered Risk and Management Action Framework
  - Chemicals of emerging concern (CEC) monitoring (imidacloprid, fragrance ingredients, PFAS, nonionic surfactants, pharmaceuticals) in water, sediment, and/or wastewater
  - Non-targeted analysis of Bay sediment to help identify new CECs
- Monitoring of microplastics in bivalves
- Development of toxicity reference values for screening dredged material bioassay results
- Development of conceptual PCBs models for prioritized Bay margin units
- Hosting and support for Dredged Material Management Office (DMMO) database
- Improved Lower South Bay suspended sediment flux measurements
- San Leandro Bay fish diet analysis to help understand PCBs accumulation
- Development of the Selenium Strategy

Results and summaries of the most pertinent Pilot and Special Studies can be found on the RMP website (http://www.sfei.org/rmp/rmp_pilot_specstudies).

In WY 2018, the RMP continued to devote a considerable amount of resources towards overseeing and implementing Special Studies associated with the RMP's Small Tributary Loading Strategy (STLS). Pilot and Special Studies associated with the STLS are intended to fill data gaps associated with loadings of Pollutants of Concern (POC) from relatively small local tributaries to San Francisco Bay. Additional information on STLS-related studies is included in Section 5.0 (POC Monitoring) of this report.

2.3 Participation in Committees, Workgroups and Strategy Teams

In WY 2018, BASMAA and/or SMCWPPP representatives actively participated in the following RMP Committees and workgroups:

- Steering Committee (SC)
- Technical Review Committee (TRC)
- Sources, Pathways and Loadings Workgroup (SPLWG)
- Emerging Contaminant Workgroup (ECWG)
- Nutrient Technical Workgroup
- Strategy Teams (e.g., PCBs/Dioxins, Selenium, Microplastics, Small Tributaries)

Committee, workgroup, and strategy team representation was provided by Permittee, countywide stormwater program (including SMCWPPP) staff, and/or individuals designated by RMC participants and the BASMAA BOD. Representation typically includes participating in meetings, reviewing technical reports and work products, co-authoring or reviewing RMP articles and publications, and providing general program direction to RMP staff. Representatives of the RMC also provided timely summaries and updates to, and received input from, stormwater program and Permittee representatives during BASMAA Monitoring and Pollutants of Concern Committee (MPC) and/or BASMAA BOD meetings to ensure Permittees' interests were represented.

3.0 Creek Status Monitoring (C.8.d) and Pesticides and Toxicity Monitoring (C.8.g)

This section summarizes the results of creek status monitoring and pesticides and toxicity monitoring required by Provisions C.8.d and C.8.g of the MRP, respectively. Creek status and pesticides and toxicity monitoring stations are listed in Table E.1 and mapped in Figure 3.1. Detailed methods and results are provided in **Appendix A**. Consistent with Provision C.8.h.ii of the MRP, creek status and pesticides and toxicity monitoring data were submitted to the Regional Water Board by SMCWPPP in electronic SWAMP-comparable formats. These data were also provided to the Regional Data Center (i.e., SFEI) for upload to CEDEN.

Creek Status Monitoring (C.8.d)

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

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

Creek status monitoring parameters, methods, occurrences, durations and minimum number of sampling sites for each Bay Area countywide stormwater program are described in Provision C.8.d of the MRP. The RMC's regional monitoring strategy for complying with creek status monitoring requirements is described in the RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012). 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 countywide stormwater 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). Implementation began in WY 2012.

The probabilistic monitoring design was developed to remove bias from site selection such that ecosystem conditions can be objectively assessed on local (i.e., San Mateo County) and regional (i.e., RMC) scales. Probabilistic parameters consist of bioassessments, nutrients, and conventional analytes conducted according to methods described in the SWAMP SOP (Ode et al. 2016). Free chlorine and total chlorine residual were also measured at probabilistic sites. Ten probabilistic sites were sampled by SMCWPPP in WY 2018 (Table E.1).

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. Targeted monitoring parameters consist of water temperature, general water quality, and pathogen indicators using methods, sampling frequencies, and numbers of stations required in Provision C.8.d of the MRP. Hourly water temperature measurements were recorded during the dry season at five sites using HOBO® temperature data loggers in the San Pedro Creek watershed. General water quality monitoring (temperature, dissolved oxygen, pH and specific conductivity) was conducted using YSI® continuous water quality equipment (sondes) for two 2-week periods (spring and late summer) at two sites in the same watershed. Water samples for analysis of pathogen indicators (*E. coli* and enterococcus) were collected at five sites located in the Pescadero Creek watershed.

Pesticides and Toxicity Monitoring (C.8.g)

Provision C.8.g of the MRP requires Permittees to conduct wet weather and dry weather pesticides and toxicity monitoring. Test methods, sampling frequencies, and number of stations required are described in the MRP. In WY 2018, SMCWPPP conducted dry weather pesticides and toxicity monitoring at one bottom-of-the-watershed station. SMCWPPP also coordinated with its RMC partners to complete the wet weather monitoring requirements. SMCWPPP conducted wet weather pesticides and toxicity monitoring at two of the eight regional stations.

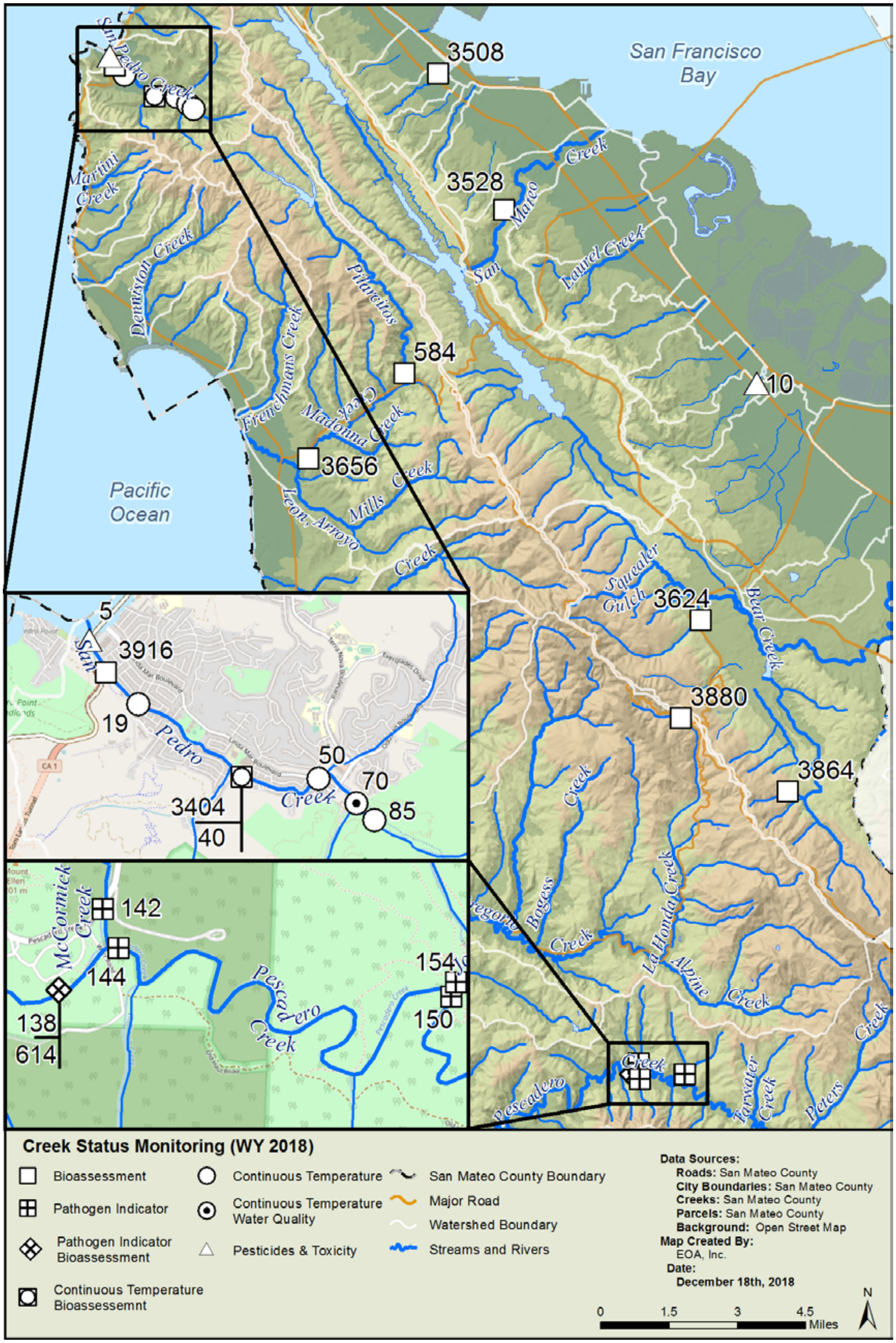

Figure 3.1. SMCWPPP Creek Status and Pesticides and Toxicity monitoring stations, WY 2018.

3.1 Approach to Management Questions

The first MRP creek status management question (*Are water quality objectives, both numeric and narrative, being met in local receiving waters, including creeks, rivers and tributaries?*) is addressed primarily through the evaluation of probabilistic and targeted monitoring data with respect to the triggers defined in the MRP. The MRP also defines triggers for pesticides and toxicity monitoring data. A summary of trigger exceedances observed for each site is presented below in Table 3.1. Sites where triggers are exceeded may indicate potential impacts to aquatic life or other beneficial uses and are considered for future stressor/source identification (SSID) projects (see Section 4.0 for a discussion of SSID projects).

The second MRP creek status management question (*Are conditions in local receiving waters supportive of or likely supportive of beneficial uses?*) is addressed primarily by assessing indicators of aquatic biological health using benthic macroinvertebrate (BMI) and algae bioassessment data collected at probabilistic sites. The indices of biological integrity based on BMI and algae data (i.e., CSCI and ASCI, see Section 3.2.1) are direct measures of aquatic life beneficial uses. Biological condition scores were compared to physical habitat and water quality data collected synoptically with bioassessments to evaluate whether any correlations exist that may explain the variation in biological condition scores. Continuous monitoring data (temperature, dissolved oxygen, pH, and specific conductance) are evaluated with respect to COLD and WARM Beneficial Uses. And pathogen indicator data are used to assess REC-1 (water contact recreation) Beneficial Uses. Although a total of 70 probabilistic sites in San Mateo County have been sampled since WY 2012, the analysis presented in **Appendix A** is limited to the ten sites monitored in WY 2018.

The BASMAA RMC recently completed a *regional* analysis of biological condition using a five-year dataset (WY 2012 – WY 2016). The BASMAA regional study included the following analyses:

- Assessed the biological condition of streams in the region and each county using indices of biological integrity (IBIs) based on benthic macroinvertebrate and algae data collected by each countywide program and SWAMP.
- Evaluated IBIs in distinct groupings such as type of stream (urban/non-urban).
- Assessed stressors associated with poor stream condition using multivariate modeling analyses (i.e., random forest).
- Evaluated the five-year dataset for trends.
- Introduced the analyses that will be needed to evaluate and potentially recommend changes to the probabilistic monitoring design.

The BASMAA RMC Five-Year Bioassessment Report (5-Year Report) is summarized in and attached to the WY 2018 Creek Status Monitoring Report **(Appendix A)**.

3.2 Monitoring Results and Conclusions

3.2.1 Bioassessment Monitoring Results/Conclusions

Bioassessment monitoring in WY 2018 was conducted in compliance with Provision C.8.d.i of the MRP. Ten sites were sampled for benthic macroinvertebrates, benthic algae, and nutrients. Physical habitat was also assessed at each of the 10 stations, and general water quality parameters were measured using a pre-calibrated multi-parameter field probe. All of this work was conducted using methods consistent with the BASMAA RMC QAPP (BASMAA 2016a) and SOPs (BASMAA 2016b). Stations were randomly selected using a probabilistic monitoring design. Eight of the sites (80%) were classified as urban and two (20%) were classified as non-urban.

The following conclusions are based on the WY 2018 data. An assessment of biological condition is provided and potential stressors are compared to applicable water quality objectives (WQOs) and triggers identified in the MRP. Sites with monitoring results that exceed WQOs and triggers are considered as candidates for further investigation as SSID projects, consistent with Provision C.8.e of the MRP. See **Appendix A** for detailed explanations of the findings.

Biological Condition Assessment

Stream condition was assessed using three different types of indices/tools: the BMI-based California Stream Condition Index (CSCI), the draft benthic algae-based Algae Stream Condition Index (ASCI), and the Index of Physical Habitat Integrity (IPI). Of these three, the CSCI is the only tool with a MRP trigger threshold for follow-up SSID consideration.

- **CSCI** – The benthic (i.e., bottom-dwelling) macroinvertebrates collected through bioassessment monitoring are organisms that live on, under, and around the rocks and sediment in the stream bed. Examples include dragonfly and stonefly larvae, snails, worms, and beetles. Each BMI species has a unique response to water chemistry and physical habitat condition. Some are relatively sensitive to poor habitat and pollution; others are more tolerant. Therefore, the abundance and variety of BMIs in a stream are used as an indicator of the biological condition of the stream. The CSCI is a statewide tool that translates the BMI taxa data into an overall measure of stream health. The CSCI is currently the most robust method available for assessing aquatic biological health in California.
    - Five of the ten (50%) sites monitored in WY 2018 had CSCI scores in the two higher condition categories: “possibly intact” and “likely intact”. These higher scoring sites were relatively undeveloped, with imperviousness in their drainage areas ranging between 1% and 5%.
- **ASCI** – Similar to BMI’s, the abundance and type of benthic algae species living on a streambed can indicate stream health. When evaluated with the CSCI, biological indices based on benthic algae can provide a more complete picture of the streams biological condition because algae respond more directly to nutrients and water chemistry. In contrast, BMIs are more responsive to physical habitat. The State Water Board and the Southern California Coastal Water Research Project (SCCWRP) recently developed the draft ASCI which uses benthic algae data as a measure of biological condition for streams in California (Theroux et al. in prep.). The ASCI is a non-predictive scoring tool that consists of three multimetric indices: diatoms, soft algae, and the combined “hybrid.” The ASCI is currently under review by the Biostimulatory-Biointegrity Policy Science Advisory Panel and the State Water Board. Therefore, scores presented in this report are considered provisional.
    - Seven of the ten (70%) bioassessment sites had hybrid ASCI scores that were classified as “possibly intact” or “likely intact” condition. The higher scoring sites occurred primarily in drainages with low levels of urbanization, ranging from 1% to 7% impervious area.

- **IPI** - The State Water Board recently developed the IPI as an overall measure of physical habitat condition. Similar to the CSCI, the IPI is calculated using a combination of physical habitat data collected in the field and environmental data generated in GIS following the methods described in Rehn et al. (2018).
    - Seven of the ten sites (70%) had IPI scores in the two upper condition categories. IPI scores were positively correlated with CSCI scores, and slightly less so with hybrid ASCI scores.
- **Overall Condition** - The number of sites in the top two condition categories varied substantially by index, with as many as 9 of 10 sites for the diatom ASCI to as few as 5 of 10 sites for the CSCI and 4 of 8 sites for the soft algae ASCI. Excluding the soft algae ASCI, for sites with lower urbanization (< 5% impervious area) there was relatively good consistency among the indices in terms of which sites were placed in the top two condition categories. However, all three ASCI indices and the IPI were relatively variable (i.e., both high and low scoring) at the more developed sites. Further evaluation of the newer indices and their association with stressor data is needed to better understand how these indicators can be used to effectively assess site conditions.

Stressor Assessment

Relationships between potential stressors (water chemistry, physical habitat, landscape variables such as imperviousness) and biological condition were explored using the WY 2018 dataset. Potential correlations were evaluated using simple regression models. Sites with stressor levels exceeding applicable WQOs and triggers identified in the MRP will be considered as candidates for SSID projects. The correlations between biological condition and stressor indicators are not expected to be very strong due to small sample size.

- **General water quality** - pH, temperature, dissolved oxygen, specific conductance. None of the water quality measurements exceeded WQOs or MRP trigger thresholds. None of the water quality measurements were correlated with CSCI or hybrid ASCI scores.

- **Nutrients and conventional analytes** - ammonia, unionized ammonia, chloride, Ash-Free Dry Mass (AFDM), chlorophyll a, nitrate, nitrite, TKN, ortho-phosphate, phosphorus, silica. There were no water quality objective exceedances for the water chemistry parameters (unionized ammonia as N, nitrate, chloride). Total nitrogen concentrations ranged from 0.22 to 1.1 mg/L. Total phosphorus concentrations ranged from <0.01 to 0.12 mg/L. None of the nutrient parameters were correlated with CSCI or hybrid ASCI scores.

- **Physical habitat metric scores** were generated from the physical habitat data. CSCI scores were positively correlated with flow type and negatively correlated with filamentous algae cover. Hybrid ASCI scores were poorly correlated with all 11 physical habitat metrics.

- **Landscape variables** were calculated for each of the watershed areas draining into the bioassessment sites. CSCI scores were moderately correlated (negatively) with impervious area and road density.

BASMAA RMC Five Year Bioassessment Study

A comprehensive analysis of bioassessment data collected by the RMC partners is included in the RMC 5-Year Report (BASMAA 2019) (Attachment 2 of Appendix A). The BASMAA-funded study evaluated bioassessment data collected throughout the Bay Area by the RMC over the first five years of monitoring (WY 2012 – WY 2016). Bioassessment data from 354 sites were compiled and evaluated to address the three study questions:

1) What is the biological condition of streams in the region?
2) What stressors are associated with poor condition?
3) Are conditions changing over time?

The findings of the BASMAA study are intended to help stormwater programs better understand the current condition of wadable streams, prioritize stream reaches in need of protection or restoration, and identify stressors that are likely to pose the greatest risk to the health of streams in the Bay Area.

The BASMAA report also evaluated the existing RMC probabilistic monitoring design and identified a range of potential options for revising the design (if desired) to better address the questions posed. These redesign options are intended to inform discussions of water quality monitoring requirements during the reissuance of the Municipal Regional Permit, which expires at the end of 2020.

Biological Condition Assessment

Results of the survey indicate that much of the stream length in the RMC area is in poor biological condition. Aquatic life uses may not be fully supported at a majority of sites sampled by the RMC. Two biological indicators were used to assess conditions:

- The BMI-based CSCI shows that 58% of the stream length region-wide was ranked in the lowest CSCI condition category ("very likely altered"), and 74% of the sampled stream length exhibited CSCI scores below 0.795, the MRP trigger for potential follow-up activity.

- The Southern California algae indices for diatoms (D18) and soft algae (S2) were evaluated for biological conditions[9]. Based on D18 and S2 scores, stream conditions region-wide appear somewhat less degraded than the CSCI scores indicated, with approximately 40% ranked in the lowest algae condition category. The algal indices also had greater stream length in the "likely intact" condition class (19-21%) compared to CSCI score (15%).

These findings should be interpreted with the understanding that the survey focused on urban stream conditions. Approximately 80% of the samples (284 of 354) were collected at urban sites. Although the low non-urban sample size precludes making any definitive comparisons, bioassessment scores in the non-urban area were generally higher than scores in the urban area for each County.

[9] The ASCI was not yet available during development of the RMC 5-Year Report.

Stressor Assessment

The association between biological indicators (CSCI and D18) and stressor data was evaluated in the RMC 5-Year study using random forest statistical analyses. The results indicate that each of the biological indicators respond to different types of stressors.

- Biological condition, based on CSCI scores, was correlated with physical habitat and land use variables. Overall, the largest influence on CSCI scores in the random forest model was percent impervious area in a 5 km radius of the bioassessment sampling site.
- Biological condition, based on D18 scores, was moderately correlated with water quality variables and poorly correlated with the physical or landscape variables.

In general, CSCI scores at urban sites were consistently low, indicating that degraded physical habitat conditions do not support healthy BMI assemblages. D18 scores at urban sites were more variable, indicating that healthy diatom assemblages potentially can occur at sites with poor habitat.

None of the nutrient variables (e.g., nitrate, total nitrogen, orthophosphate, phosphorus) correlated strongly with CSCI scores, or were highly ranked variables in the CSCI random forest analysis. Phosphorus and ash-free dry mass (which increases in response to biostimulation) were important in predicting D18 scores based on the random forest analysis; however, no statistically significant relationships were observed. This finding suggests that the nutrient targets being developed by the State Water Board as part of the Biostimulatory/Biointegrity Project may not be appropriate in urban streams in the Bay Area.

Trend Assessment

The short time frame of the survey (five years) limited the ability to detect trends. However, the five-year bioassessment dataset does provide a baseline to compare with future assessments.

A potential application of bioassessment monitoring may be to assess trends in stream conditions as additional stormwater treatment (e.g., green infrastructure) and creek restoration projects are implemented across the urban landscape over time. Peak flow volumes and intensities will be reduced following the implementation of stormwater treatment via green infrastructure and low impact development (LID), as required by the MRP. Future creek status monitoring may provide insight into the potential positive impacts of green infrastructure and creek restoration to support WQOs and beneficial uses in urban creeks.

Assessment of the RMC Monitoring Design

Over the first five years of monitoring, the RMC evaluated about 25% (1,455 out of 5,740) of the sites in the sample frame to obtain 354 samples. Approximately 46% (873 out of 1,896) of the total number of urban sites in the sample frame were evaluated during that time. Based on rejection rates from previous years, the sample frame is anticipated to be exhausted during WY 2019. Revision of the RMC monitoring design could seek to reduce the future rejection rate through development of a new sample frame that excludes areas of low management interest or regions that would not be candidates for sampling (such as due to lack of permissions or physical barriers to access). This would improve the spatial balance of samples that more closely represents the proportion of the sample frame that can be reliably assessed.

The RMC sample design was created to probabilistically sample all streams within the RMC area, which resulted in a master list with 33% urban sites and 67% non-urban sites. However, because participating municipalities are primarily concerned with runoff from urban areas, the RMC focused sampling efforts on urban sites (80%) over non-urban sites (20%). As a result, non-urban samples are under-represented in the dataset resulting in much lower overall biological condition scores than would be expected for a spatially balanced dataset.

Based on evaluation of data collected during the first five years of the survey, there are several options to revise the RMC Monitoring Design. The RMC will assess the options during discussions with Regional Water Board staff during the MRP reissuance process beginning in 2019.

3.2.2 Continuous Monitoring for Temperature and General Water Quality

Continuous monitoring of water temperature and general water quality in WY 2018 was conducted in compliance with Provisions C.8.d.iii – iv of the MRP. Hourly temperature measurements were recorded at five sites in the San Pedro Creek watershed from April through September. Continuous (15-minute) general water quality measurements (pH, DO, specific conductance, temperature) were recorded at two sites in the San Pedro Creek watershed during two 2-week periods in May (Event 1) and August (Event 2). Targeted monitoring stations were deliberately selected and were the same as those monitored in WY 2017.

Conclusions and recommendations from targeted monitoring in WY 2018 are listed below. The sections below are organized on the basis of two management questions. See **Appendix A** for detailed explanations of the findings.

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

Sites with targeted monitoring results exceeding the MRP trigger criteria and/or WQOs are identified as candidate SSID projects. San Pedro Creek, located in the City of Pacifica, was targeted for temperature and general water quality monitoring because it contains the northern-most population of naturally producing steelhead trout (*Oncorhynchus mykiss*) in San Mateo County. Overall, water quality appears to be consistent with conditions that support relevant aquatic habitat beneficial uses of the creek (e.g., juvenile steelhead rearing and spawning life stages).

Spatial and Temporal Variability of Water Quality Conditions

- **Spatial**. There was minimal spatial variability in water temperature across the five stations in the San Pedro Creek watershed. Temperature increased slightly at each downstream site but remained 4 to 7 °C below the MRP instantaneous maximum trigger threshold. Likewise, pH and specific conductivity increased slightly in the downstream direction and dissolved oxygen decreased slightly in the downstream direction.
- **Temporal**. Water temperature increased gradually at all five stations between April and early-September, likely in response to periods of warmer air temperatures. Differences in general water quality measurements (pH, specific conductivity, dissolved oxygen) between the two two-week monitoring periods (May/June and August/September) were less pronounced. WY 2018 monitoring results were very similar to those recorded in WY 2017 at the same stations.

Potential Impacts to Aquatic Life

- Potential impacts to aquatic life were assessed through analysis of continuous temperature data collected at five targeted stations and continuous general water quality data (pH, dissolved oxygen, specific conductance, and temperature) collected at two targeted stations in San Pedro Creek. San Pedro Creek, located in the City of Pacifica, was targeted for temperature and general water quality monitoring because it contains the northern-most population of naturally producing steelhead trout (*Oncorhynchus mykiss*) in San Mateo County.
- None of the temperature stations in San Pedro Creek exceeded the MRP trigger threshold for the Maximum Weekly Average Temperature of 17°C. None of the stations exceeded the MRP instantaneous maximum trigger threshold of 24°C.
- None of the general water quality parameters (temperature, pH, dissolved oxygen, and specific conductance) exceeded any of the MRP trigger thresholds.

3.2.3 Pathogen Indicator Monitoring Results/Conclusions

Pathogen indicator monitoring in WY 2018 was conducted in compliance with Provision C.8.d.v of the MRP. Pathogen indicator grab samples were collected at five sites in the Pescadero Creek watershed during a sampling event on July 27, 2018.

- The selection of sites was based on information provided by County Parks staff about high bacteria concentrations previously found in creeks within Memorial County Park. All three creeks sampled by SMCWPPP in WY 2018 are designated for both contact (REC-1) and non-contact (REC-2) recreation Beneficial Uses and several swimming holes are located along Pescadero Creek in and around Memorial County Park.
- The MRP trigger threshold for *E. coli* was not exceeded at any site in WY 2018; however, the MRP trigger threshold for enterococci was exceeded at two sites. These sites will be added to the list of candidate SSID projects.
- Pathogen indicator data should be interpreted cautiously due to the high variability found in creeks. In addition, wildlife sources in the WY 2018 monitoring area may contribute to the elevated concentrations of pathogen indicators in the creek but pose very little human health risk to recreators, relative to human sources of fecal contamination.

3.2.4 Chlorine Monitoring Results/Conclusions

Free chlorine and total chlorine residual were measured concurrently with bioassessments at the ten probabilistic sites in compliance with Provision C.8.c.ii. While chlorine residual has generally not been a concern in San Mateo County creeks, prior monitoring results suggest there are occasional trigger exceedances of free chlorine and total chlorine residual in the County. Trigger exceedances may be the result of one-time potable water discharges, and it is generally challenging to determine the source of elevated chlorine from such episodic discharges. Furthermore, chlorine in surface waters can dissipate from volatilization and reaction with dirt and organic matter. In WY 2018, there were no exceedances of the MRP trigger for chlorine (0.1 mg/L). SMCWPPP will continue to monitor chlorine in compliance with the MRP and, as in the past, will follow-up with municipal illicit discharge staff as needed.

3.2.5 Pesticides and Toxicity Monitoring Results/Conclusions

In WY 2018, SMCWPPP conducted pesticides and toxicity monitoring in compliance with Provision C.8.g of the MRP and in coordination with the RMC. The monitoring was conducted at two stations, one near the mouth of Cordilleras Creek and the other near the mouth of San Pedro Creek. Dry weather pesticides and toxicity monitoring was conducted at the Cordilleras Creek station (one water sample for toxicity and one sediment sample for toxicity, pesticides and other pollutants including metals). Wet weather pesticides and toxicity monitoring was conducted during a January 2018 storm event at both stations (one water sample from each station for toxicity and pesticides).

Statistically significant toxicity to *C. dubia* was observed in the water sample collected from Cordilleras Creek during the dry season. During wet weather monitoring, statistically significant toxicity to *H. azteca* was observed in the water samples collected from both creeks and toxicity to *P. promelas* was observed in the water samples collected from San Pedro Creek. However, the magnitude of the toxic effects in the samples compared to laboratory controls did not exceed MRP trigger criteria of 50 Percent Effect. The cause of the observed toxicity is unknown. Pesticide concentrations in the sediment sample were all very low, most below the MDL, and TU equivalents, with the exception of bifenthrin, did not exceed 0.1. Likewise, all pesticides (except fipronil and its degradates) analyzed in the wet weather samples were below the MDL.

Sediment chemistry results are evaluated to identify potential stressors based on TEC quotients and PEC quotients, according to criteria in Provision C.8.g.iv of the MRP. SMCWPPP also evaluated TU equivalents of pyrethroids and fipronil. TEC and PEC quotients were calculated for all metals and total polyaromatic hydrocarbons (PAHs) measured in the sediment sample. Two TEC quotients exceeded the MRP threshold of 1.0 (chromium and nickel), but no PEC quotients exceeded this threshold. Decisions about which SSID projects to pursue should be informed by the fact that the TEC and PEC quotient exceedances are likely related to naturally occurring chromium and nickel due to serpentine soils in local watersheds. Except for bifenthrin (with a TU equivalent of 0.251), all of the calculated TU equivalents were less than 0.1. Bifenthrin is considered to be the leading cause of pyrethroid-related toxicity in urban areas (Ruby 2013) and the most-commonly detected insecticide monitored by the California Department of Pesticide Regulation (DPR) Surface Water Protection Program (SWPP) (Ensminger 2017).

Pesticide analytes targeted by wet weather monitoring in WY 2018 were generally found at concentrations below the MDL, except for bifenthrin and fipronil compounds. As no WQOs are specified in the Water Quality Control Plan for the San Francisco Bay Region (Basin Plan) (SFRWQCB 2017) for these pollutants, they are not currently being used to identify SSID project locations. The wet weather pesticide monitoring data in WY 2018 was compared to pesticide data collected by the DPR SWPP and the United States Environmental Protection Agency (USEPA) aquatic benchmarks used in DPR SWPP studies to allow for interpretation of the WY 2018 results in the context of larger statewide datasets (see Appendix A for further details). However, sites sampled during the WY 2018 wet weather pesticide monitoring where exceedances of the USEPA benchmarks were observed were not added to the list of candidate SSID projects. In future years, data collected by the DPR SWPP and contained on the DPR SURF database can be queried to allow for comparison of MRP pesticide monitoring results.

SMCWPPP will continue to sample one station per year for dry weather pesticides and toxicity throughout the remainder of the permit term.

3.3 Trigger Assessment

The MRP requires analysis of the monitoring data to identify candidate sites for SSID projects. Trigger thresholds against which to compare the data are provided for most monitoring parameters in the MRP and are described in the foregoing sections of this report. Stream condition was assessed based on CSCI scores that were calculated using BMI data. Nutrient data were evaluated using applicable water quality standards from the Basin Plan (SFRWQCB 2017). Water and sediment chemistry and toxicity data were evaluated using numeric trigger thresholds specified in the MRP. In compliance with Provision C.8.e.i of the MRP, all monitoring results exceeding trigger thresholds are added to a list of candidate SSID projects maintained throughout the permit term. Follow-up SSID projects will be selected from this list. Table 3.1 lists candidate SSID projects based on WY 2018 creek status and pesticides and toxicity monitoring data.

Additional data analysis 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 greater understanding of the trigger exceedances.

Table 3.1. Summary of SMCWPPP MRP trigger threshold exceedance analysis, WY 2018. “No” indicates samples were collected but did not exceed the MRP trigger; “Yes” indicates an exceedance of the MRP trigger.

Station Number	Creek Name	Bioassessment [1]	Nutrients [2]	Chlorine [3]	Water Toxicity [4]	Water Chemistry [5]	Sediment Toxicity [4]	Sediment Chemistry [5]	Continuous Temperature [6]	Dissolved Oxygen [7]	pH [8]	Specific Conductance [9]	Pathogen Indicators [10]
202R00584	Pilarcitos Creek	No	No	No	--	--	--	--	--	--	--	--	--
202R00614	Pescadero Creek	No	No	No	--	--	--	--	--	--	--	--	--
202R03404	San Pedro Creek	Yes	No	No	--	--	--	--	--	--	--	--	--
202R03656	Pilarcitos Creek	Yes	No	No	--	--	--	--	--	--	--	--	--
202R03880	La Honda Creek	No	No	No	--	--	--	--	--	--	--	--	--
202R03916	San Pedro Creek	Yes	No	No	--	--	--	--	--	--	--	--	--
204R03508	Mills Creek	Yes	No	No	--	--	--	--	--	--	--	--	--
204R03528	San Mateo Creek	Yes	No	No	--	--	--	--	--	--	--	--	--
205R03624	Bear Creek	No	No	No	--	--	--	--	--	--	--	--	--
205R03864	Hamms Gulch	No	No	No	--	--	--	--	--	--	--	--	--
202SPE005	San Pedro Creek	--	--	--	No	No		--	--	--	--	--	--
204COR010	Cordilleras Creek	--	--	--	No	No	No	Yes	--	--	--	--	--
202PES138	Pescadero Creek	--	--	--	--	--	--	--	--	--	--	--	Yes
202PES142	McCormick Creek	--	--	--	--	--	--	--	--	--	--	--	Yes
202PES144	Pescadero Creek	--	--	--	--	--	--	--	--	--	--	--	No
202PES150	Jones Gulch	--	--	--	--	--	--	--	--	--	--	--	No
202PES154	Pescadero Creek	--	--	--	--	--	--	--	--	--	--	--	No
202SPE019	San Pedro Creek	--	--	--	--	--	--	--	No	--	--	--	--
202SPE040	San Pedro Creek	--	--	--	--	--	--	--	No	No	No	No	--
202SPE050	San Pedro Creek	--	--	--	--	--	--	--	No	--	--	--	--
202SPE070	San Pedro Creek	--	--	--	--	--	--	--	No	No	No	No	--
202SPE085	San Pedro Creek	--	--	--	--	--	--	--	No	--	--	--	--

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

3.4 Recommendations

The following recommendations are based on findings from WY 2018 creek status and pesticides and toxicity monitoring conducted by SMCWPPP, as well as reflections on other monitoring, data analysis, and policy development projects being conducted in the region (e.g., RMC 5-Year Report) and statewide.

- In WY 2019, SMCWPPP will continue to coordinate with RMC partners on implementation of monitoring requirements in MRP Provisions C.8.d and C.8.g.
- A major component of the WY 2019 monitoring will be bioassessment surveys and data assessment. In WY 2019, SMCWPPP will conduct biological assessments at both probabilistic and targeted sites. To date, a total of 80 probabilistic sites have been monitored by SMCWPPP (n=7) and SWAMP (n=10). This exceeds the number of samples necessary for a statistically representative dataset. Therefore, SMCWPPP has the option to select up to 20 percent of sample locations on a targeted basis to evaluate trends or address other aquatic life related concerns.
- In WY 2018, BASMAA funded a study to evaluate five years of regional bioassessment data (WY 2012 – WY 2016). Findings from the RMC 5-Year Report are summarized in this report and included as Attachment 2 to Appendix A. In WY 2019, SMCWPPP will apply some of the tools used in the RMC 5-Year Report (i.e., random forest models) to analyze bioassessment data collected in San Mateo County over all eight years of MRP monitoring (WY 2012 – WY 2019). Results of the analyses will be described in the Integrated Monitoring Report (IMR) which will be developed following WY 2019 and must be submitted by March 31, 2020 (the fifth year of the Permit term) in lieu of an annual UCMR.
- For the past two years (WY 2017 and WY 2018), SMCWPPP has conducted continuous temperature and water quality monitoring in the San Pedro Creek Watershed. In WY 2019, SMCWPPP will work with San Mateo County MRP Permittees to select a different creek or reach to target, perhaps where targeted bioassessment monitoring sites are located.
- Provision C.8.g pesticides and toxicity monitoring will be conducted during the dry season at a bottom-of-the-watershed station. In order to expand the geographic extent of these data, a new station will be selected.

3.5 Management Implications

The creek status and pesticides and toxicity monitoring programs (consistent with MRP Provisions C.8.d and C.8.g, respectively) focus on assessing the water quality condition of urban creeks in San Mateo County and identifying stressors and sources of impacts observed. The bioassessment station sample size from WY 2018 (overall n=10; urban n=8) was not sufficient to develop statistically representative conclusions regarding the overall condition of all creeks, but more comprehensive analysis that includes data from previous years is included in the BASMAA RMC 5-Year Report (Section 3.2.1 and Attachment 2 to Appendix A).

Like previous years, WY 2018 data suggest that most urban streams have likely or very likely altered populations of aquatic life indicators (e.g., benthic 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.

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

- In compliance with MRP Provision C.3, new and redevelopment projects in the Bay Area are now designed to more effectively reduce water quality and hydromodification impacts associated with urban development. Low impact development (LID) methods, such as rainwater harvesting and use, infiltration and biotreatment are required as part of development and redevelopment projects. In addition, planning for and implementing green infrastructure projects in the public right-of-way (e.g., during street projects) is increasingly being incorporated into the municipal master planning process. All of these measures are expected to reduce the impacts of urbanization on stream health.
- In compliance with MRP Provision C.9, 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, supporting the adoption of formal State pesticide registration procedures, and sustainable landscaping requirements for new and redevelopment projects. These efforts should reduce pyrethroids and other pesticides in urban stormwater runoff and reduce the magnitude and extent of toxicity in local creeks.
- Trash loadings to local creeks have been reduced through implementation of new control measures in compliance with MRP Provision C.10 and other efforts by Permittees to reduce the impacts of illegal dumping directly into waterways. These actions include the installation and maintenance of trash capture systems, the adoption of ordinances to reduce the impacts of litter prone items, enhanced institutional controls such as street sweeping, and the on-going removal and control of direct dumping. The MRP establishes a mandatory trash load reduction schedule, minimum areas to be treated by full trash capture systems, and requires development of receiving water monitoring programs for trash.
- In compliance with MRP Provisions C.2 (Municipal Operations), C.4 (Industrial and Commercial Site Controls), C.5 (Illicit Discharge Detection and Elimination), and C.6 (Construction Site Controls), Permittees continue to implement Best Management Practices (BMPs) that are designed to prevent non-stormwater discharges during dry weather and reduce the exposure of stormwater runoff to contaminants during rainfall events.
- In compliance with MRP Provision C.13, copper in stormwater runoff is reduced through implementation of controls such as architectural and site design requirements, prohibition of discharges from water features treated with copper, and industrial facility inspections.
- Mercury and polychlorinated biphenyls (PCBs) in stormwater runoff are being reduced through implementation of the respective TMDL water quality restoration plans. In compliance with MRP Provisions C.11 (mercury) and C.12 (PCBs), the Countywide Program will continue to identify sources of these pollutants and will implement control actions designed to achieve load reduction goals. Monitoring activities conducted in WY 2018 that specifically target mercury and PCBs are described in Section 5.0 of this report.

In addition to controls implemented in compliance with the MRP, numerous other efforts and programs designed to improve the biological, physical and chemical condition of local creeks are underway. For example, C/CAG finalized the San Mateo Countywide Stormwater Resource Plan

(SRP) in 2017 to satisfy state requirements and guidelines to ensure C/CAG and San Mateo county MRP Permittees are eligible to compete for future voter-approved bond funds for stormwater or dry weather capture projects. The SRP identifies and prioritizes opportunities to better utilize stormwater as a resource in San Mateo County through a detailed analysis of watershed processes, surface and groundwater resources, input from stakeholders and the public, and analysis of multiple benefits that can be achieved through strategically planned stormwater management projects. These projects aim to capture and manage stormwater more sustainably, reduce flooding and pollution associated with runoff, improve biological functioning of plants, soils, and other natural infrastructure, and provide many community benefits, including cleaner air and water and enhanced aesthetic value of local streets and neighborhoods.

Through the continued implementation of MRP-associated and other watershed stewardship programs, SMCWPPP anticipates that stream conditions and water quality in local creeks will continue to improve over time. In the near term, toxicity observed in creeks should decrease as pesticide regulations better incorporate water quality concerns during the pesticide registration process. In the longer term, control measures implemented to “green” the “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.

4.0 Stressor/Source Identification Projects (C.8.e)

Provision C.8.e of the MRP requires that Permittees evaluate creek status (Provision C.8.d) and pesticides and toxicity (Provision C.8.g) monitoring data with respect to triggers defined in the MRP. Permittees are required to maintain a list of all results exceeding trigger thresholds. Table 3.1 lists the results of the trigger evaluation for WY 2018 data. Sites where triggers are exceeded may indicate potential impacts to aquatic life or other beneficial uses and are therefore considered as candidates for future Stressor/Source Identification (SSID) projects. SSID projects are selected from the list of trigger exceedances based on criteria such as magnitude of threshold exceedance, parameter, and likelihood that stormwater management action(s) could address the exceedance. Pollutants of concern monitoring results (Provision C.8.f) may be considered as appropriate.

The MRP requires that Permittees initiate a minimum number of SSID projects during the permit term. As a regional collaborative, SMCWPPP and its RMC partners must collectively initiate a region-wide minimum of eight new SSID projects during the permit term, with a minimum of one for toxicity. RMC programs have agreed that the distribution of the eight required SSID projects will be as follows, with most projects conducted by individual Programs addressing local needs and one conducted regionally:

- 2 each: ACCWP and SCVURPPP
- 1 each: CCCWP and SMCWPPP
- 1 jointly: FSURMP and Vallejo Permittees
- 1 regionally: all RMC partners

In compliance with Provision C.8.e.iii, half of the required number of SSID projects (i.e., four) were initiated with a work plan by the third year of the permit term (i.e., 2018). All SSID projects initiated in compliance with the 2015 MRP are summarized in the BASMAA RMC Regional SSID Report (**Appendix B**).

SSID projects must identify and isolate potential sources and/or stressors associated with observed water quality impacts. They are intended to be oriented to taking action(s) to alleviate stressors and reduce sources of pollutants. The MRP describes the stepwise process for conducting SSID projects:

- Step 1: Develop a work plan for each SSID project that defines the problem to the extent known, describes the SSID project objectives, considers the problem within a watershed context, lists candidate causes of the problem, and establishes a schedule for investigating the cause(s) of the trigger exceedance. The MRP recommends study approaches for specific triggers. For example, toxicity studies should follow guidance for Toxicity Reduction Evaluations (TRE) or Toxicity Identification Evaluations (TIE), physical habitat and conventional parameter (e.g., dissolved oxygen, temperature) studies should generally follow Step 5 (Identify Probable Causes) of the Causal Analysis/Diagnosis Decision Information System (CADDIS), and pathogen indicator studies should generally follow the *California Microbial Source Identification Manual* (Griffith et al. 2013).

- Step 2: Conduct SSID investigation according to the schedule in the SSID work plan and report on the status of SSID investigations annually in each UCMR.

- Step 3: Conduct follow-up actions based on SSID investigation findings. These may include development of an implementation schedule for new or improved BMPs. If a

> Permittee determines that MS4 discharges are not contributing to an exceedance of a water quality standard, the Permittee may end the SSID project upon written concurrence of the Executive Officer. If the SSID investigation is inconclusive, the Permittee may request that the Executive Officer consider the SSID project complete.

In 2017, SMCWPPP initiated the Pillar Point Watershed Pathogen Indicator SSID Project. In 2018, BASMAA began development of a regional SSID project addressing releases and spills of PCBs from electrical utility equipment. The status of these projects are summarized below.

4.1 Pillar Point Watershed Pathogen Indicator SSID Project

The Pillar Point Watershed Pathogen Indicator SSID Project was triggered by fecal indicator bacteria (FIB) densities exceeding WQOs that have been measured in receiving waters and tributaries to Pillar Point Harbor. A SSID work plan (SMCWPPP 2018a) was submitted with the SMCWPPP WY 2017 UCMR dated March 31, 2018. The work plan describes steps to investigate urban sources of fecal indicator bacteria in the Pillar Point Watershed. SMCWPPP implemented the work plan in WY 2018 with assistance from and in close coordination with the San Mateo County Resource Conservation District (RCD). Consistent with Provision C.8.e.iii.(1)(g), the study generally follows the *California Microbial Source Identification Manual* (Griffith et al. 2013).

The objective of the SSID study is to build on a Proposition 50 Clean Beaches Initiative Grant-funded study that was conducted by the RCD and University of California, Davis (UCD) in 2008 and 2011-12. The RCD/UCD study indicated that high FIB measured at Pillar Point beaches was likely due to influences from storm drains and creeks rather than from sources at the beaches and within the harbor itself. The Pillar Point SSID study was designed to identify whether urban areas drained by the MS4 in the urban community of El Granada are an important source of bacteria to Pillar Point Harbor and whether the sources of bacteria are controllable (especially human and dog, as opposed to wildlife sources). These are key steps towards the longer-term goal of reducing FIB densities in Pillar Point Harbor and, more specifically, reducing the risk of illness for recreators at the local beaches. The study includes a desktop analysis consisting of historical data review and mapping and a water sampling program that targets multiple sites in study area watersheds (Figure 4.1).

The WY 2018 field investigation included two wet weather sampling events and two dry season sampling events at 14 stations. Samples were analyzed for *E. coli* and bacteroidales associated with humans and dogs (two sources considered controllable). Preliminary review of the field and analytical data suggest that human and dog sources are rare at the sampled stations. In general, *E. coli* densities are higher during wet weather compared to the dry season and increase in the downstream direction; however, these findings are not consistent throughout the study area. Based on the WY 2018 field results, several additional field investigations were identified and are being implemented in WY 2019. These include targeted dye studies of sanitary sewer lines, pet waste reconnaissance visits, and additional microbial source tracking (MST) sampling.

It is anticipated that the SSID Project Report will be finalized by June 30, 2019 and will be submitted to the Regional Water Board with the Integrated Monitoring Report on March 31, 2020.

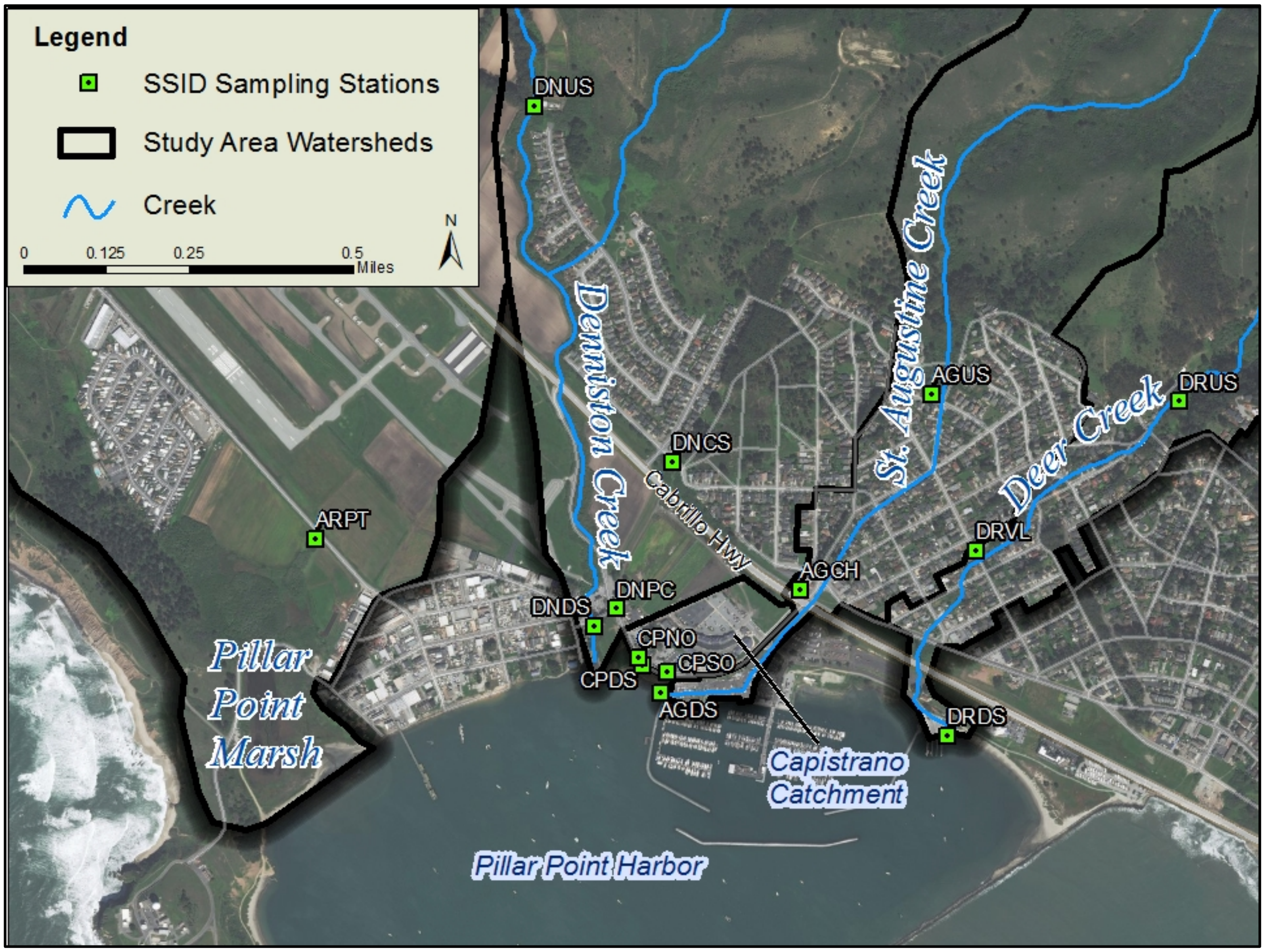

Figure 4.1. Pillar Point Watershed Pathogen Indicator SSID Project monitoring stations.

4.2 Electrical Utilities as a Potential PCBs Source SSID Project

During WY 2018, BASMAA scoped and budgeted for conducting a regional SSID project addressing releases and spills of PCBs from electrical utility equipment. The Regional SSID Project – Electrical Utilities as a Potential PCBs Source to Stormwater in the San Francisco Bay Area – is one of many efforts responding to the Bay being designated as impaired on the Clean Water Act Section 303(d) list and the adoption of a TMDL for PCBs in 2008. Subsequent PCBs monitoring by the BASMAA RMC partners and the RMP suggests that diffuse sources of PCBs to stormwater runoff are present throughout the region. One potential source of PCBs to stormwater runoff is releases and spills from electrical utility equipment.

PCBs were historically used as insulator fluids in several types of electrical utility equipment, some of which still contain PCBs. Although much of the PCB-containing oils and/or equipment with PCBs oils have been removed from service, some remain in use, and PCBs loadings in stormwater runoff associated with releases and spills from the equipment could potentially exceed the TMDL waste load allocation for stormwater runoff. However, the information currently available is not adequate to fully quantify the scope and magnitude of electrical utility releases as a source of PCBs to stormwater runoff. This information gap is partially because PCBs levels typically used for reporting and cleanup of PCBs spills may exceed the levels needed to address the PCBs TMDL requirements. Furthermore, stormwater Programs don’t have the authority to compel electrical utilities to provide information about spills, equipment replacement programs, and cleanup protocols, or to implement additional controls. Therefore, BASMAA identified the need to develop and implement a regional SSID work plan to further understand the magnitude and extent of this potential PCBs source, and identify controls (if necessary) that utilities could be compelled to implement to reduce the water quality impacts of this source.

The work plan is included as **Appendix G**. It presents a framework for working with the Regional Water Board, which does have jurisdictional authority in relation to water quality issues over electrical utility companies. Implementation of the regional SSID work plan will begin in WY 2019.

5.0 Pollutants of Concern Monitoring (C.8.f)

Pollutants of Concern (POC) monitoring is required by Provision C.8.f of the MRP. POC monitoring is intended to assess inputs of POCs to the Bay from local tributaries and urban runoff, provide information to support implementation of Total Maximum Daily Load (TMDL) water quality restoration plans and other pollutant control strategies, assess progress toward achieving wasteload allocations (WLAs) for TMDLs, and help resolve uncertainties associated with loading estimates for POCs. The MRP identifies five priority POC management information needs that need to be addressed though POC monitoring:

1. **Source Identification** – identifying which sources or watershed source areas provide the greatest opportunities for reductions of POCs in urban stormwater runoff;
2. **Contributions to Bay Impairment** – identifying which watershed source areas contribute most to the impairment of San Francisco Bay beneficial uses (due to source intensity and sensitivity of discharge location);
3. **Management Action Effectiveness** – providing support for planning future management actions or evaluating the effectiveness or impacts of existing management actions;
4. **Loads and Status** – providing information on POC loads, concentrations, and presence in local tributaries or urban stormwater discharges; and
5. **Trends** – evaluating trends in POC loading to the Bay and POC concentrations in urban stormwater discharges or local tributaries over time.

MRP Provision C.8.f requires monitoring of the following POCs: polychlorinated biphenyls (PCBs), mercury, copper, emerging contaminants, and nutrients.[10] The MRP defines yearly and total (i.e., over the MRP permit term) minimum number of samples for each POC and specifies the minimum number of samples for each POC that must address each information need.

To help meet these requirements, and to develop mutually beneficial monitoring approaches, SMCWPPP continued to work collaboratively with other organizations and projects that conduct water quality monitoring in the Bay Area. Provision C.8.a.iii of the MRP allows Permittees to use data collected by third-party organizations to fulfill monitoring requirements, provided the data are demonstrated to meet the required data quality objectives. Samples collected in San Mateo County through the Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP), Clean Watersheds for a Clean Bay (CW4CB), a recently completed project that was funded by a grant from USEPA), and the State's Stream Pollution Trends (SPoT) Monitoring Program supplemented SMCWPPP's efforts towards achieving Provision C.8.f monitoring requirements.

In particular, SMCWPPP continued to be an active participant in the RMP's Small Tributary Loading Strategy (STLS). The STLS typically conducts annual monitoring for POCs on a region-wide basis, including collecting composite samples of stormwater runoff and analyzing for PCBs and mercury. As in past years, during WY 2018 SMCWPPP helped the STLS select its PCBs and mercury monitoring stations that are located in San Mateo County and evaluated the data from those stations along with PCBs and mercury data collected directly by SMCWPPP.

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[10] Emerging contaminant monitoring requirements will be met through participation in RMP special studies and will address at least PFOS, PFAS, and alternative flame retardants being used to replace PBDEs.

5.1 SMCWPPP POC Monitoring

In WY 2018, SMCWPPP complied with Provision C.8.f of the MRP by conducting POC monitoring for PCBs, mercury, copper, and nutrients. Specific activities included:

- Collection of stormwater runoff samples from the bottom of selected urban catchments for PCBs and mercury analysis (n=13);
- Collection of grab sediment samples in selected urban catchments for PCBs and mercury analysis (n=50);
- Collection of wet and dry weather creek water samples for nutrients and copper analysis (n=4);
- Participation in BASMAA regional study to analyze infrastructure caulk and sealant samples for PCBs (n=5; ¼ of project total) (see Section 5.2);
- Participation in BASMAA regional study to evaluate the PCBs and mercury removal effectiveness of hydrodynamic separator (HDS) units and biochar-amended bioretention soil media (BSM) (n = 8; ¼ of project total) (see Section 5.2);
- Participation in SWAMP's Stream Pollutant Trends monitoring program; and
- Continued participation in the RMP's STLS (see Section 5.3).

Progress toward POC monitoring requirements accomplished in WY 2018 and the planned allocation of effort for WY 2019 are described in a report dated October 15, 2018 (SMCWPPP 2018c) which was submitted to the Regional Water Board in compliance with MRP Provision C.8.h.iv. The yearly minimum number of samples specified in MRP Provision C.8.f was exceeded for all POCs. A report with further details about WY 2018 POC monitoring conducted by SMCWPPP is included as **Appendix C**. Reports describing the results of BASMAA's BMP effectiveness studies are summarized in Section 5.2 and included as **Appendices D** and **E**. A report documenting the WY 2015 – 2018 POC monitoring conducted by the STLS is summarized in Section 5.3 and included as **Appendix F**.

General methods employed for POC monitoring and quality assurance/quality control (QA/QC) procedures were similar to previous years (SMCWPPP 2015, 2017, 2018b). A comprehensive QA/QC program was implemented by SMCWPPP covering all aspects of POC monitoring with similar protocols to previous years. Overall, the results of the QA/QC review suggested that most of the POC monitoring data generated during WY 2018 were of sufficient quality. Although some data were flagged in the project database, none were rejected according to Data Quality Objectives (DQOs). Additional details about the QA/QC review are provided in **Appendix C.**

5.1.1 PCBs and Mercury

MRP Provisions C.11.a.iii and C.12.a.iii require that Permittees provide a list of management areas in which new PCBs and mercury control measures will be implemented during the permit term. These management areas are designated "Watershed Management Areas" (WMAs) in this report, and are defined as all catchments containing high interest parcels (i.e., properties with land uses associated with PCBs such as old industrial, electrical and recycling) and/or existing or planned PCBs and mercury controls.

WMAs are the framework used by SMCWPPP to plan its current PCBs and mercury monitoring program in San Mateo County. During WY 2018, SMCWPPP collected 13 composite samples of stormwater runoff from outfalls at the bottom of WMAs and 50 sediment samples (of which 5 were duplicates) within WMAs. As part of continuing to develop strategies for reducing PCBs and mercury loads in stormwater runoff, SMCWPPP evaluated these data, along with additional WY 2018 stormwater runoff sample data collected through the STLS, and data from previous water years collected by SMCWPPP and through the STLS. Objectives included attempting to identify source properties within WMAs, identifying which WMAs provide the greatest opportunities for implementing cost-effective PCBs controls, and prioritizing WMAs for future investigations.

Stormwater Runoff Monitoring

During WY 2018, SMCWPPP collected 13 composite samples of stormwater runoff from outfalls at the bottom of WMAs that contain high interest parcels. An additional two stormwater runoff samples were collected in San Mateo County through the RMP's STLS, also from WMAs with high interest parcels. These combined 15 samples primarily help to address Management Questions #1 (Source Identification) and #2 (Contributions to Bay Impairment). Data will also be used by the RMP STLS to improve calibration of the Regional Watershed Spreadsheet Model (RWSM) which is a land use based planning tool for estimation of overall POC loads from small tributaries to San Francisco Bay at a regional scale (i.e., Management Question #4 – Loads and Status).

WMAs were identified and prioritized for stormwater runoff sampling by evaluating several types of data, including: land use data, PCBs and mercury concentrations from prior sediment and stormwater runoff sampling efforts, municipal storm drain data showing pipelines and access points (e.g., manholes, outfalls, pump stations), and logistical/safety considerations. Composite samples, consisting of six to eight aliquots collected during the rising limb and peak of the storm hydrograph (as determined through field observations), were analyzed for the 40 PCBs congeners designated by the RMP as those most likely to be found in the Bay[11] (method EPA 1668C, total PCBs were calculated as the sum of these 40 congeners), total mercury (method EPA 1631E), and suspended sediment concentration (SSC; method ASTM D3977-97). Detailed results are presented in **Appendix C**.

Sediment Sampling

During WY 2018, SMCWPPP collected 50 grab sediment samples (of which 5 were duplicates) as part of the program to attempt to identify source properties within WMAs, potentially for referral to the Regional Water Board for further investigation and potential abatement. These samples were collected in the public right-of-way (ROW), including locations adjacent to high interest parcels with land uses associated with PCBs such as old industrial, electrical and recycling and/or other characteristics potentially associated with pollutant discharge (e.g., poor housekeeping, unpaved areas). Individual and composite sediment samples were collected from manholes, storm drain inlets, driveways, streets, and sidewalks.

Each sample was analyzed for total mercury and for the 40 PCBs congeners designated by the RMP as those most likely to be found in the Bay (see the previous section). Total PCBs were

[11] PCBs congeners 8, 18, 28, 31, 33, 44, 49, 52, 56, 60, 66, 70, 74, 87, 95, 97, 99, 101, l05, 110, 118, 128, 132, 138, 141, 149, l51, 153, 156, 158, 170, 174, 177, 180, 183, 187, 194, 195, 201, 203.

calculated as the sum of the 40 congeners. The laboratory sieved all samples to 2 mm prior to analysis. Detailed results are presented in **Appendix C**.

Watershed Management Area Prioritization

The Countywide Program evaluated PCBs stormwater runoff and sediment monitoring data to help prioritize WMAs for further investigation and control measure implementation. Based upon the data collected in San Mateo County to-date by the Countywide Program and other parties (e.g., the RMP's STLS), WMAs with one or more sediment and/or stormwater runoff samples with PCBs concentrations (particle ratios for stormwater runoff) greater than 0.5 mg/kg (or 500 ng/g) were provisionally designated high priority. WMAs with samples in the 0.2 – 0.5 mg/kg (200 – 500 ng/g) range were provisionally designated medium priority. WMAs with stormwater runoff sample PCBs particle ratios less than 0.2 mg/kg (200 ng/g) were provisionally designated low priority. It is important to emphasize the provisional nature of these prioritizations, and especially designating a WMA as low priority due to a single stormwater runoff sample having a low PCBs particle ratio. Low PCBs results in any single stormwater runoff sample could be a "false negative" in that they result from the storm not being large enough to mobilize sediments with associated PCBs, or other factors. For example, based upon WY 2018 resampling results, two WY 2016 RMP STLS stormwater runoff samples located in South San Francisco may have been false negatives. In addition, sediment sample results were not used to designate a WMA lower priority due to the high potential for false negatives. Figure 5.1 is a map illustrating the current status of WMAs in San Mateo County, based on this provisional prioritization scheme and sediment and stormwater runoff monitoring results to-date.12 Only WMAs with high interest parcels were included in Figure 5.1.

[12] Where sediment and stormwater runoff particle ratio analysis results conflict, the higher result was conservatively applied.

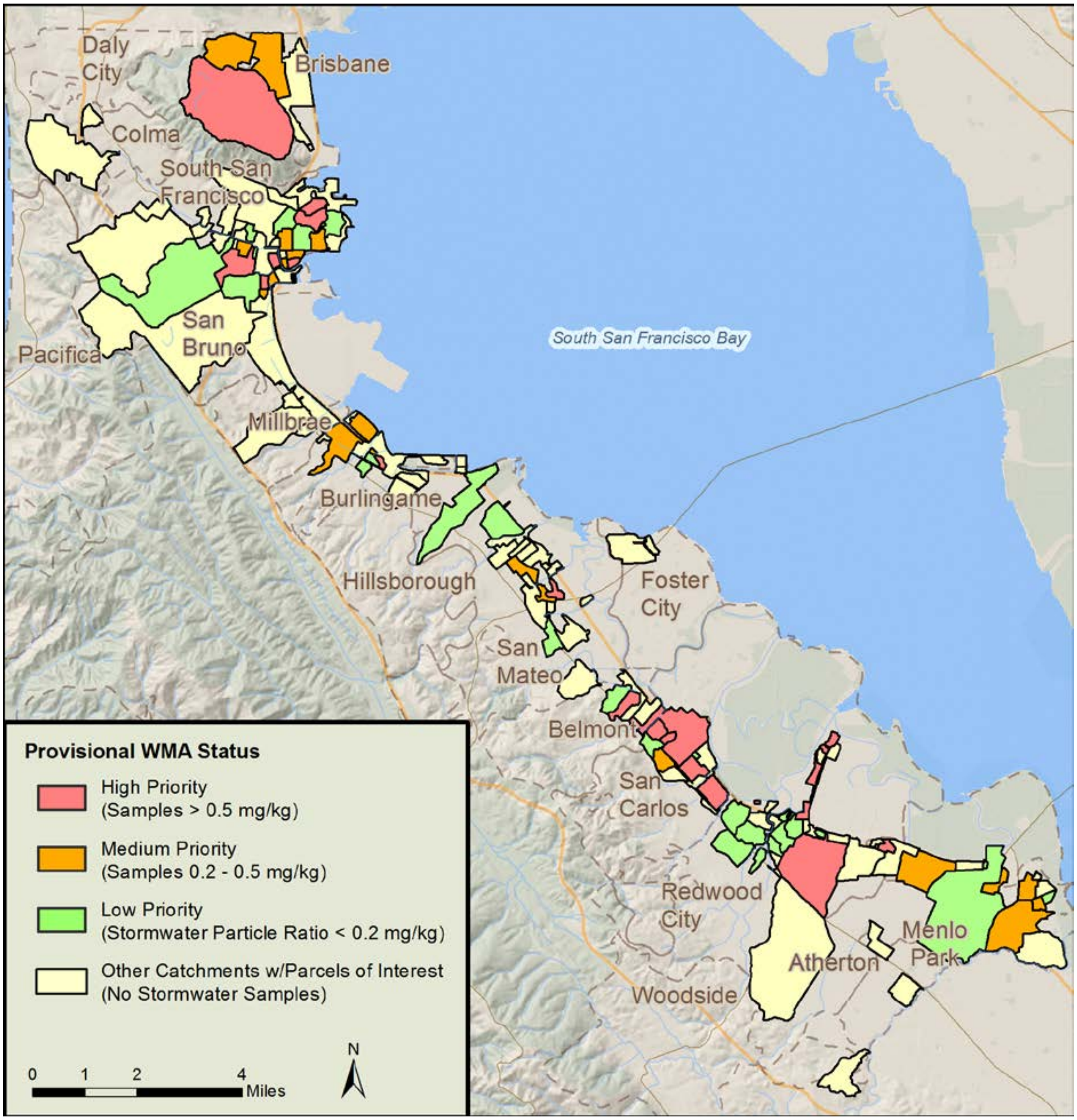

Figure 5.1. San Mateo County PCBs WMA status based on sediment and stormwater runoff data collected through WY 2018.

5.1.2 Copper

In WY 2018, the Countywide Program collected a total of four grab creek water samples for copper analysis. Bottom-of-the-watershed stations on San Pedro Creek and Cordilleras Creek were sampled during a large storm event on January 8, 2018, concurrent with nutrient POC monitoring and Provision C.8.g.iii Wet Weather Pesticides and Toxicity Monitoring. The same two stations were sampled again during dry season base flows. The goal of this approach is to address Management Question #5 (Trends) by comparing copper concentrations during different seasonal flow events. Management Question #4 (Loads and Status) is also addressed by characterizing copper concentrations in mixed-use watersheds.

Based on the laboratory results, the following findings were noted:

- As expected, dissolved copper concentrations are lower than total copper concentrations. The dissolved portion of the total copper concentration is higher in the spring base flow samples compared to the storm samples. This finding is consistent with copper's affinity to suspended sediment. Suspended sediment concentration is generally higher during storm events.
- Copper concentrations at both stations were higher during the January storm event compared to the spring base flow event, suggesting an influence by stormwater runoff.
- Copper concentrations were similar (i.e., within the same order of magnitude) in both creeks. This finding is consistent with a lack of local sources of copper.
- All dissolved copper concentrations were below hardness-dependent acute and chronic WQOs.

5.1.3 Nutrients

In WY 2018, SMCWPPP collected four nutrient samples (concurrent with the above copper sampling) from bottom-of-the-watershed stations on San Pedro Creek and Cordilleras Creek. Samples were collected during the January 8, 2018 storm event and during dry season base flows. Nutrient analyses include: ammonium[13], nitrate, nitrite, total Kjeldahl nitrogen (TKN), dissolved orthophosphate, and total phosphorus. The goal was to address loads and status (Management Question #4).

Based on the laboratory results, the following findings were noted:

- Concentrations of all nutrient at both stations were higher during the January storm event compared to the spring base flow event, suggesting an influence by stormwater runoff. This finding is consistent with the draft conceptual model developed by the San Francisco Bay Nutrient Management Strategy which suggests that nutrient loads to San Francisco Bay from creeks are highest during the wet season, but considerably less than loads from publicly owned wastewater treatment works (POTWs) (Senn and Novick 2014).
- Organic nitrogen (TKN) made up a greater proportion of the total nitrogen concentration during the January storm event compared to the May event. It is likely that organically-

[13] Ammonium was calculated as the difference between ammonia and un-ionized ammonia. Un-ionized ammonia was calculated using the formula provided by the American Fisheries Society Online Resources (http://fishculture.fisheries.org/resources/fish-hatchery-management-calculators/).

bound nitrogen that washed off surfaces during the January storm had not yet had time to cycle through the ammonification and nitrification processes before samples were collected.

- No applicable WQOs were exceeded.

5.1.4 SMCWPPP WY 2018 POC Monitoring - Conclusions

In WY 2018, SMCWPPP collected and analyzed POC samples in compliance with Provision C.8.f of the MRP. Yearly minimum requirements were met for all monitoring parameters. In addition, SMCWPPP continued helping the RMP's STLS to select its WY 2018 PCBs and mercury monitoring stations that are located in San Mateo County. The data from those stations were evaluated along with PCBs and mercury data collected directly by SMCWPPP. Conclusions from WY 2018 POC monitoring included the following:

- SMCWPPP's PCBs and mercury monitoring focuses on San Mateo County WMAs containing high interest parcels with land uses potentially associated with PCBs such as old industrial, electrical and recycling. During WY 2018 SMCWPPP collected 13 composite samples of stormwater runoff from outfalls at the bottom of WMAs and 50 grab sediment samples within the WMAs. SMCWPPP evaluated the PCBs stormwater runoff and sediment monitoring data to help prioritize WMAs for further investigation and identify which WMAs provide the greatest opportunities for implementing cost-effective PCBs controls.
- Based on the sediment and stormwater runoff monitoring data collected to-date in San Mateo County by SMCWPPP and other parties (e.g., the RMP's STLS), WMAs were provisionally designated as high, medium, or low priority. Figure 5.1 is a map illustrating the current status of WMAs in San Mateo County, based on this provisional prioritization scheme.
- The PCBs monitoring data collected to-date has informed identification of several potential source properties located in the City of San Carlos. The Countywide Program is working with the City regarding next steps at these sites. This included recently developing and submitting to the Regional Water Board referrals of two areas for potential further PCBs investigation and abatement:
    - 270 Industrial Road (Delta Star) / 495 Bragato Road (Tiegel), which are adjacent properties in San Carlos.
    - 977 and 1007/1011 Bransten Road, another set of adjacent properties in San Carlos.
- The mean and median PCBs concentrations in WY 2018 sediment samples (n = 50) were somewhat lower than in previous years. In addition, in WY 2018 only 1 of the 50 sediment samples collected had a PCBs concentration that exceeded 1.0 mg/kg. One other sample had a PCBs concentration between 0.5 and 1.0 mg/kg. All of the remaining samples had a PCBs concentration below 0.5 mg/kg. In general, the WY 2018 POC monitoring data suggest that the PCBs monitoring program in the public ROW in San Mateo County may be approaching diminishing returns in terms of identifying new source properties.
- However, the stormwater runoff resamples in South San Francisco suggest the possibility of false negatives for PCBs in some WMAs provisionally designated low priority based on stormwater runoff data from previous years. The RMP's ongoing "Advanced Data Analysis" is evaluating normalizing results based upon storm intensity

and the results may help inform planning any future stormwater runoff monitoring of this type.

- Four creek water samples were collected for copper analysis from two creeks (San Pedro and Cordilleras Creeks) during a large January 2018 storm event and during spring base flows. Copper concentrations were higher in both creeks during the storm event compared to the base flow event, suggesting an influence by stormwater runoff.
- The San Pedro and Cordilleras Creek stations were concurrently sampled for nutrients during the large January 2018 storm event and the spring base flow event. Nutrient concentrations in both creeks were higher during the January storm sampling event compared to the spring baseflow event, suggesting that nutrient loads to San Francisco Bay from these creeks is higher during storm events.
- None of the WY 2018 water samples exceeded applicable water quality objectives (WQOs).

5.1.5 POC Monitoring Planned by SMCWPPP in WY 2019

In WY 2019, SMCWPPP will continue to collect and analyze POC samples in compliance with Provision C.8.f of the MRP. Yearly minimum requirements will be met for all monitoring parameters. In addition, SMCWPPP will continue helping the RMP's STLS to select its WY 2019 PCBs and mercury monitoring stations that are located in in San Mateo County. POC monitoring activities in WY 2019 will include the following:

- SMCWPPP, in coordination with the RMP STLS, will continue conducting PCBs and mercury monitoring that focuses on San Mateo County WMAs containing high interest parcels with land uses potentially associated with PCBs such as old industrial, electrical and recycling. This will include collecting additional composite samples of stormwater runoff from outfalls at the bottom of WMAs and grab sediment samples within the WMAs. Objectives will include attempting to identify source properties within WMAs, identifying which WMAs provide the greatest opportunities for implementing cost-effective PCBs controls, and prioritizing WMAs for potential future investigations.
- SMCWPPP will continue to participate in the STLS Trends Strategy Team in developing a regional monitoring strategy to assess trends in POC loading to San Francisco Bay from small tributaries (see Section 5.2.3). The STLS Trends Strategy will initially focus on PCBs and mercury, but will not be limited to those POCs. Analysis of recent and historical data collected at region-wide loadings stations suggests that PCB concentrations are highly variable. Therefore, a monitoring design to detect trends with statistical confidence may require more samples than is feasible with current resources. The STLS Trends Strategy Team is continuing to evaluate available data from the Guadalupe River watershed to explore more economical monitoring opportunities. The Team is also considering modeling options that could be used in concert with monitoring to detect and predict trends in POC loadings.
- SMCWPPP will also continue to work with the State's Stream Pollution Trends (SPoT) Monitoring Program to help address Management Question #5 (Trends). SPoT conducts annual dry season monitoring (subject to funding constraints) of sediments collected from a statewide network of large rivers. The goal of the SPoT Monitoring Program is to investigate long-term trends in water quality. Sites are targeted in bottom-of-the-watershed locations with slow water flow and appropriate micromorphology to allow deposition and accumulation of sediments, including a station near the mouth of San

Mateo Creek. In most years, sediment analytes include PCBs, mercury, toxicity, pesticides (Phillips et al. 2014).

- SMCWPPP will collect at least two copper and nutrient water samples in WY 2019.
- SMCWPPP will continue to participate in the RMP, including the RMP's STLS and CEC Strategy (see Section 2.5).

5.2 BASMAA Monitoring

In WY 2018, SMCWPPP participated in the BASMAA "POC Monitoring Project for Source Identification and Management Action Effectiveness" project. This regional project includes two somewhat independent monitoring studies designed during WY 2017 and implemented during WY 2018. BASMAA developed two study designs to implement these projects and a shared Sampling and Analysis Plan and Quality Assurance Project Plan (SAP/QAPP). The SAP/QAPP describes field and laboratory methods, measurement quality objectives, quality control procedures, and data management aspects. As one of four largest Countywide Programs subject to provision C.8.f POC Monitoring requirements, SMCWPPP's POC monitoring accomplishments include ¼ of the total number of samples collected through these regional studies.

5.2.1 PCBs in Infrastructure Caulk Study

The BASMAA Regional Infrastructure Caulk and Sealant Sampling Program was developed to satisfy the provision C.12.e requirement to collect 20 composite caulk/sealant samples throughout the MRP permit area and evaluate (at a screening level) whether PCBs are present in right-of-way infrastructure caulk and sealants in the Bay Area. This study also helps to address Management Question #1 (Source Identification). The sampling program was designed to specifically target roadway and storm drain structures that were constructed during the most recent time period when PCBs were potentially used in caulk and sealant materials (i.e., prior to 1980, with a focus on the 1960s and 1970s).

In WY 2018, the BASMAA project team collected 54 samples of caulk/sealant materials from ten types of roadway and storm drain infrastructure in the public right-of-way (ROW). Structures sampled included concrete bridges/overpasses, sidewalks, curbs and gutters, roadway surfaces, above and below ground storm drain structures (i.e., flood control channels and storm drains accessed from manholes), and electrical utility boxes or poles attached to concrete sidewalks. The individual samples were grouped by structure type and sample appearance (color and texture) into 20 composites and analyzed for the RMP 40 PCB congeners using a modified method EPA 8270C (Figure 5.2).

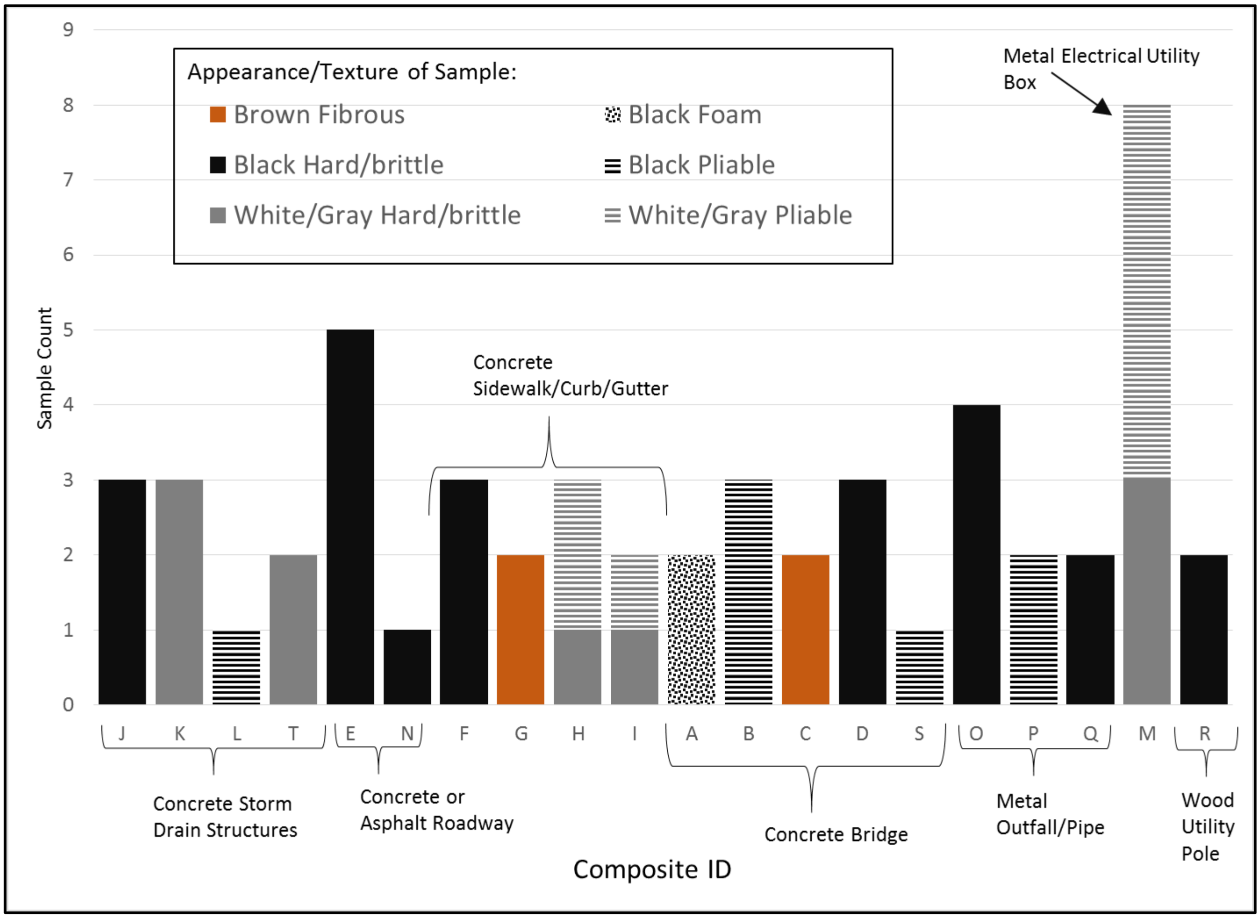

Figure 5.2. Structure types and sample appearance for the caulk and sealant samples included in each composite.

Total PCBs concentrations across the 20 composite samples ranged from non-detect (ND) to > 4,000 mg/Kg. The majority of the composites had PCBs concentrations that were below 0.2 mg/Kg. PCBs were not detected in ten of the composite samples, representing nearly 60% of the individual samples collected during the program. PCBs in twenty-five percent (5 of 20) of the composites were above 1 mg/Kg. Of these, two composites had very high PCBs concentrations (> 1,000 mg/Kg) that indicate PCBs were likely part of the original caulk or sealant formulations. Both of these composites were comprised of black, pliable joint filler materials that were collected from concrete bridges/overpasses. These results demonstrate that PCBs-containing caulks and sealants were used to some degree in Bay Area roadway and storm drain infrastructure in the past, but the full extent and magnitude of this use is unknown. The conclusions from this sampling program are limited by the small number of structures that were sampled (n=54), compared with the vast number of roadway and storm drain structures throughout the Bay Area that were originally constructed during the peak period of PCBs production and use (1950 – 1980).

Given the limitations of the project, much more information would be needed to estimate the total mass of PCBs in infrastructure caulk and sealant materials, to better understand the fate and transport of PCBs in these materials, and to calculate stormwater loading estimates. Nevertheless, this screening-level sampling program was the first step towards understanding if infrastructure caulk and sealants are a potential source of PCBs to urban stormwater. Although limited by the small sample number, the results of this sampling program indicate: (1) the majority of roadway and storm drain structure types that were sampled in this project did not have PCBs-containing caulks or sealants at concentrations of concern, and (2) only black, pliable joint fillers found on concrete bridges/overpasses sampled had PCBs concentrations of potential concern. If further investigation is conducted, focus on this type of application may be a reasonable place to continue such efforts.

The final project report was included with the Program's Fiscal Year 2017/18 Annual Report, submitted to the Regional Water Board on September 30, 2018 (BASMAA 2018).

5.2.2 Best Management Practices (BMP) Effectiveness Study

The BASMAA Best Management Practices (BMP) Effectiveness Study was developed to satisfy provision C.8.f requirements to collect at least eight PCBs and mercury samples (per participating county) that address Management Question #3 (Management Action Effectiveness). A major consideration of the study was collection of data in support of conducting the Reasonable Assurance Analysis (RAA) that is required by provision C.12.c.iii.(3). The RAA must be submitted with the 2020 Annual Report (September 30, 2020). The study design, developed in September 2017, describes monitoring and sample collection activities designed to evaluate, at a pilot scale, the effectiveness of two treatment options that were identified in the CW4CB study as having the potential to reduce PCBs discharges: biochar- enhanced bioretention filters and hydrodynamic separator (HDS) units. In WY 2018, the BASMAA project team implemented the BMP Effectiveness Study by collecting a total of 34 samples. Results of the study are summarized in two reports addressing the two targeted treatment options. These reports are submitted with this WY 2018 Urban Creeks Monitoring Report as **Appendices D and E**.

Biochar-Amended Bioretention Soil Media Column Study

This regional study evaluated the effectiveness of biochar-amended bioretention soil media (BSM) to remove PCBs and mercury from stormwater runoff collected within the region covered by the MRP. A prior BASMAA study, the CW4CB project, found that BSM amended with biochar substantially improved PCBs removal compared to the standard BSM specified in MRP Provision C.3 (BASMAA 2017a). Only one biochar source was tested in the CW4CB study, so it was unknown whether there would be substantial performance differences among differing biochar sources.

The goal of this study was to identify readily available biochar media amendments that improve PCBs and mercury load removal by bioretention BMPs. Stormwater runoff was collected in March and April of 2018, and the bench scale BSM testing was conducted in April and May of 2018. Twenty-six samples consisting of influent/effluent pairs from column tests of biochar-enhanced BSM were analyzed. Stormwater runoff was run through six columns with five different biochar-enhanced BSM mixes and one standard BSM as a control to evaluate which mix was most effective at removing PCBs and mercury. Dilutions were run on two columns to assess removal efficiencies with decreasing influent pollutant concentrations. Samples were analyzed for the RMP 40 PCB congeners (method EPA 1668C), total mercury (method EPA 1631E), SSC (method ASTM D3977-97), and total organic carbon (method EPA 9060).

All five biochar-BSM blends showed evidence of overall improved PCBs and mercury performance compared to the standard BSM; however, the increased benefit relative to increased cost was not analyzed. Hydraulics were found to be a critical factor in achieving good pollutant removal in the columns suggesting that outlet controls could be used to enhance the performance of BMPs. Furthermore, this study suggested that an irreducible minimum concentration of PCBs may be 1,000 pg/L.

The final project report is included as **Appendix D**.

HDS Unit Study

The goal of the BASMAA Evaluation of Mercury and PCBs Removal Effectiveness of Full Trash Capture HDS Units study was to evaluate the mercury and PCBs removal effectiveness of HDS units due to removal of solids captured within HDS sumps. The information provided by this monitoring effort will be used by MRP Permittees and the Regional Water Board to better quantify the pollutant load reductions achieved by existing and future HDS units installed in urban watersheds of the Bay Area to remove trash.

The study combined sampling and modeling efforts to evaluate the mercury and PCBs removal performance of HDS units as follows:

- First samples of the solids captured and removed from eight HDS unit sumps during cleanouts were collected and analyzed for the RMP 40 PCB congeners (method EPA 1668), total mercury (method EPA 1631E), total solids[14] (method EPA 160.3), total organic carbon (method EPA 415.1), and bulk density (method ASTM E1109-86). If the sample was comprised of sediments only, it was also analyzed for grain size (method ASTM D422M/PSEP). If the sample contained organic/leaf debris, it was also analyzed for total organic matter (method EPA 160.4) in order to calculate the inorganic fraction (i.e., the mineral fraction assumed to be associated with POCs).

- Second, maintenance records and construction plans for the HDS units were reviewed to develop estimates of the average volume of solids removed per cleanout. This information was combined with the monitoring data to calculate the mass of POCs removed during cleanouts.

- Third, the annual mercury and PCBs loads discharged from each HDS unit catchment were estimated under two different loading scenarios. For the first loading scenario (Land Use x Yield), the POC loads discharged from each catchment were calculated from land-use based POC yields. For the second loading scenario (Flow x EMC), the POC loads discharged from each catchment were calculated from modeled stormwater volumes and POC event mean concentrations (EMCs) for a given land-use type.

- Finally, HDS unit performance was evaluated under each loading scenario by calculating the average annual percent removal of POCs due to cleanout of solids from the HDS unit sumps.

Across all eight units, the median percent PCBs removal for calculated catchment loads ranged from 5% to 32%. These results will be considered in the update to the Interim Accounting Methodology that is being conducted as part of a separate BASMAA regional study in support

[14] Samples were analyzed for total solids so that dry weight calculations could be made.

of Reasonable Assurance Analysis development.

The final project report is included as **Appendix E**.

5.3 Small Tributaries Loading Strategy

The RMP Small Tributaries Loading Strategy was developed in 2009 by the STLS Team, which includes representatives from BASMAA, Regional Water Board staff, RMP staff, and technical advisors and is overseen by the Sources, Pathways, and Loadings Workgroup (SPLWG). The objective of the STLS is to develop a comprehensive planning framework to coordinate POC monitoring/modeling between the RMP and RMC participants. In 2018, the following management policies were identified:

- Refining pollutant loading estimates for future TMDL updates;
- Informing provisions of the current and future versions of the MRP;
- Identifying small tributaries to prioritize for management actions; and
- Informing decisions on the BMPs for reducing pollutant concentrations and loads.

Work conducted by the STLS is framed by the same five priority POC management information needs identified in the MRP (see beginning of Section 5.0).

The sections below describe the tasks implemented by the RMP STLS in 2018 to address the relevant management policies.

5.3.1 Wet Weather Characterization

With a goal of identifying watershed sources of PCBs and mercury, STLS field monitoring in WYs 2015 - 2018 focused on collection of stormwater runoff composite samples in the downstream reaches of catchments located throughout the Bay Area. In WY 2018, 10 catchments were sampled during storm events. The 10 catchments ranged in size from 0.02 km^2 to 36.67 km^2 and represented engineered MS4 drainage areas, flood control channels, and creeks. Half of the WY 2018 samples were collected at previously sampled stations in order to compare to concentrations previously measured. Stormwater runoff composite samples were analyzed for concentrations of PCBs (i.e., RMP 40 congeners), total mercury, and suspended sediment concentration. In addition, a pilot study was continued at a subset of locations (two stations) to collect fine sediments using specialized settling chambers. A full description of the methods and results from WY 2015 through WY 2018 monitoring is included in **Appendix F** (Pollutants of Concern Reconnaissance Monitoring Final Progress Report, Water Years 2015 - 2018).

In WY 2018, two catchments, both in the City of South San Francisco and previously sampled in WY 2016, were targeted based on recommendations by SMCWPPP staff evaluating prior monitoring results and land uses in San Mateo County. PCBs concentrations in the WY 2016 samples were relatively low, and concentrations (total PCBs and particle ratio) were roughly an order of magnitude higher in WY 2018, except that the PCBs particle ratio for one sample was similar for both events (for more details see Section 5.1.1 and Appendix C). SMCWPPP is applying these data to the WMA prioritization process (see Section 5.1.1 and Appendix C), which will inform future POC monitoring in San Mateo County and PCBs control measure planning.

Wet weather characterization monitoring by the RMP STLS is planned to continue in WY 2019.

Findings

The RMP STLS has a growing database of nearly 83 stations that have been sampled at least once during wet weather events for PCBs, mercury, and SSC since 2003. Some stations have also been sampled for a larger suite of constituents. Prior to WY 2015, most of the stations were located in natural creeks, whereas 49 of the 60 stations sampled in WY 2015 through WY 2018 were located in small catchments draining primarily old industrial land uses. At 15 of the stations, a second sample was collected with either a Hamlin or Walling tube (or both) remote sediment sampler.

Acknowledging that dynamic climatic conditions and individual storm characteristics may affect data interpretation, the following conclusions have been identified:

- PCBs concentrations positively correlate with impervious cover, old industrial land use, and mercury. They inversely correlate with watershed area.
- The positive relationship between PCBs and mercury concentration is relatively weak, probably due to the larger role of atmospheric recirculation in the mercury cycle and the differences in use history of each POC.
- Neither PCBs nor mercury have strong correlations with other trace metals (As, Cu, Cd, Pb, and Zn). Therefore, there is no support for the use of trace metals as surrogate investigative tools for either PCBs or mercury sources.
- Remote samplers generally characterized sites similarly to the composite stormwater sampling methods and in the future could potentially be used exclusively for preliminary screening of new stations to identify watershed sources of PCBs and mercury.
- Continued focus on resampling of some stations (i.e., those that return lower than expected concentrations) is recommended to test for false negatives.

5.3.2 STLS Trends Strategy

In 2018, the STLS Trends Strategy team continued to meet. The STLS Trends Strategy was initiated in 2015 per a recommendation from the SPLWG. The SPLWG advised the STLS to define where and how trends may be most effectively measured in relation to management effort so that data collection methods deployed over the next several years will support this management information need. The STLS Trends Strategy team is comprised of SFEI staff, RMC participants, and Regional Water Board staff. Invitations to key meetings are extended to additional interested parties (e.g., EPA) and technical advisors (e.g., USGS), whose staff are consulted to review specific technical work products.

The Trends Strategy document (and Technical Appendix), initially drafted in WY 2016, serves as a foundation for this team. The main document summarizes the background, management questions, and guiding principles of the Trends Strategy. It also describes coordination between the RMP and BASMAA within the context of the MRP, proposed tasks to answer the management questions, anticipated deliverables, and the overall timeline. The current priority POCs are PCBs and mercury and trend indicators under consideration (i.e., PCB concentrations and particle ratios) were identified within the context of existing datasets (e.g., POC loading station data) and TMDL timelines. However, the Strategy recognizes that priorities can change in the future. A “Technical Appendix to the Small Tributaries Trend Design” (Melwani et al. 2016) presents an evaluation of variability and statistical power for detecting trends based on

POC loading station PCBs data. It presents sample size and revisits frequency scenarios needed to detect declining trends in PCBs in 25 years with > 80% statistical power. Due to high variability in baseline PCB concentrations, the modeled sampling scenarios would likely be cost-prohibitive to implement. Therefore, the Technical Appendix recommends additional analyses and monitoring that should be considered prior to developing a trends monitoring design.

In 2018, the STLS Trends Strategy team followed up on some of the recommendations from the Technical Appendix. A statistical model for trends in PCB loads in the Guadalupe River (as a case study) was finalized. The model incorporates the significant turbidity-PCBs relationships that exist and evaluates climatic, seasonal, and inter-annual factors as potential drivers of PCB loads. More intensive review of the Guadalupe River dataset resulted in two main findings: 1) No trends in PCB loads were apparent for the period of 2003 through 2014: 2) A monitoring design that includes sampling at least two storms in 13 out of 20 years (with 4 to 6 grab samples per storm) would detect inter-annual trends of 25% or more over 20 years with > 80% power[15] (Melwani et al. 2018). Results of the statistical analyses were presented at key stages in the analysis to USGS technical advisors with expertise in trends analysis of water data. It is uncertain how the Guadalupe River model and analysis could be applied to other watersheds with different characteristics.

In 2018, the Trends Strategy team updated the Trends Strategy document to include an evaluation of how various tasks to date have and could be used to address the five POC information needs from the MRP (see list at the beginning of Section 5.0). This review included empirical data collection (i.e., POC loads monitoring via loading stations and wet weather characterization, BASMAA source identification and BMP effectiveness monitoring, and SPoT monitoring) and modeling approaches (i.e., RWSM, the Guadalupe River statistical analysis, and Reasonable Assurance Analysis). The updated document describes the pros and cons of various methods available to identify and predict trends. Due to concerns about the limitations of extrapolating monitoring results from a relatively small number of watersheds to the entire region, regional modeling was proposed as the most efficient tool to estimate POC loading over time and space for trends evaluation at the desired spatial scales. The 2018 Trends Strategy document reviews and compares currently available models and modeling platforms relative to their ability to answer key management questions, including countywide stormwater program RAA modeling efforts, the Bay Area Hydrological Model (BAHM), the RWSM, and HSPF and SWMM platforms. Based on the goals of the STLS Trends Strategy team, the BAHM (which is based on the HSPF platform) is recommended as the most suitable starting point to develop a regional POC trends model.

A preliminary multi-year workplan for regional POC trends assessment, with estimates of annual budget allocations, was developed in 2018. The workplan recommends development of a Model Implementation Plan in 2019, model development beginning in 2020, and “no-regrets” monitoring based on the Model Implementation Plan beginning in 2020.

5.3.3 Advanced Data Analysis

In 2018, the STLS began a new task to provide a deeper analysis of the growing set of PCBs data collected by BASMAA and the RMP. The Advanced Data Analysis task includes two

[15] Power is defined as the probability of detecting a trend of a certain magnitude during a specified monitoring period (years), where a Type I error rate is set at 5%.

parallel lines of investigation: site inter-comparison methodologies and PCBs congener profile comparisons.

Site Inter-Comparison Methodologies

Most of the wet weather characterization data used by the Countywide Program and other BASMAA RMC partners to identify and prioritize Watershed Management Areas where PCBs source investigations will be conducted are based on composite samples collected during a single storm event. See Section 5.1.1 for more information on the wet weather sampling programs implemented by the Countywide Program and the WMA characterization process. Since only one storm has been sampled at most sites, differing storm characteristics (intensity, duration, antecedent rainfall conditions) may confound comparisons of PCBs source intensity among watersheds. For example, if the targeted storm was relatively small, it is possible that measured PCBs concentrations (and/or PCB particle ratios) will be lower than they would be in a sample collected at the same station during a larger storm, when more sediments and associated pollutants may be mobilized. The main goal of this investigation was to develop a method to account for the differences in targeted storm characteristics at the various sampled stations.

In 2018, the STLS began development of a method to generate comparable yield estimates for small industrial watersheds where only a single storm has been sampled. The draft method entails five steps:

1. Estimate stormwater runoff volume in the sampled watershed.
2. Compute estimates of stormwater runoff PCBs load for the sampled storm.
3. Adjust estimates of storm load to a standard sized storm.
4. Normalize standardized storm loads to the land uses and source areas of interest to generate storm yields.
5. Compare these yields between watersheds taking into account all the uncertainties associated with the field conditions and the methods used to interpret the data.

This stepwise method was developed using Santa Clara County as a case study and pilot tested with a focus on nested sites within the Guadalupe River watershed. Further development, review, and testing in a greater number of areas, with a wider range of conditions, is recommended for 2019. A report describing the loads-based site inter-comparison method is anticipated in 2019.

PCBs Congener Profile Comparisons

PCBs samples collected by BASMAA and the STLS are routinely analyzed for 40 individual PCBs congeners (i.e., the “RMP 40”). Although most data analyses are conducted using the sum of those congeners, BASMAA and the STLS recognize the value of generating the more robust RMP 40-based dataset and the potential for future data exploration possibilities. For example, PCBs congener profiles can be used to help identify source areas that contribute most to the PCB mass exported from the watershed via stormwater, and to illustrate variability in PCBs mobilization from source areas over time. It is important to note that weathering of PCBs in the environment over time and other factors may introduce uncertainties into these types of analyses.

In 2018, the STLS began development of a method to estimate the contributions of different Aroclor[16] mixtures to the congener profiles of samples of stormwater and sediment. The method is based on the use of indicator congeners that are representative of each of the four most commonly used Aroclors. Data from the Pulgas Creek Pump Station watershed in San Carlos were used to pilot test the method. At this station, stormwater and sediment had high concentrations with a relatively unique pattern, dominated by congeners indicative of a combination of Aroclors 1242 and 1260. The concentrations and congener profiles in sediment suggest that there are at least two distinct source areas in the watershed that combine to create the mix of 1242 and 1260 that is dominant in stormwater runoff at the Pump Station (Figure 5.3). The data suggest that if PCBs flux from one of these areas could be eliminated, loads from the watershed would be reduced by 50% or more.

For the Coyote Creek watershed in San Jose, the similarity in congener profiles between the highest concentration sediment samples and the stormwater runoff samples suggest that the important source areas in the watershed have been identified, and that reduction of loading from an area at the south end of the Charcot Avenue Storm Drain watershed would yield the greatest reduction in export at the Coyote Creek station. The concentrations and congener profiles in stormwater runoff and sediment from the Guadalupe River watershed indicate the presence of one source area that is likely a significant contributor to PCBs export from the watershed, but suggest that all of the significant sources areas may not yet have been identified.

A report describing the PCB congener profile comparison method is anticipated in 2019.

[16] PCBs were manufactured and used as complex mixtures of individual PCBs compounds (referred to as PCBs congeners). In North America, the only producer was the Monsanto Company, which marketed PCBs under the trade name Aroclor from 1930 to 1977. A series of different Aroclor mixtures was produced, with varying degrees of overall chlorine content, and these different mixtures were used for different purposes. As a consequence of the use of Aroclor mixtures, PCBs are also present in the environment as complex mixtures of congeners.

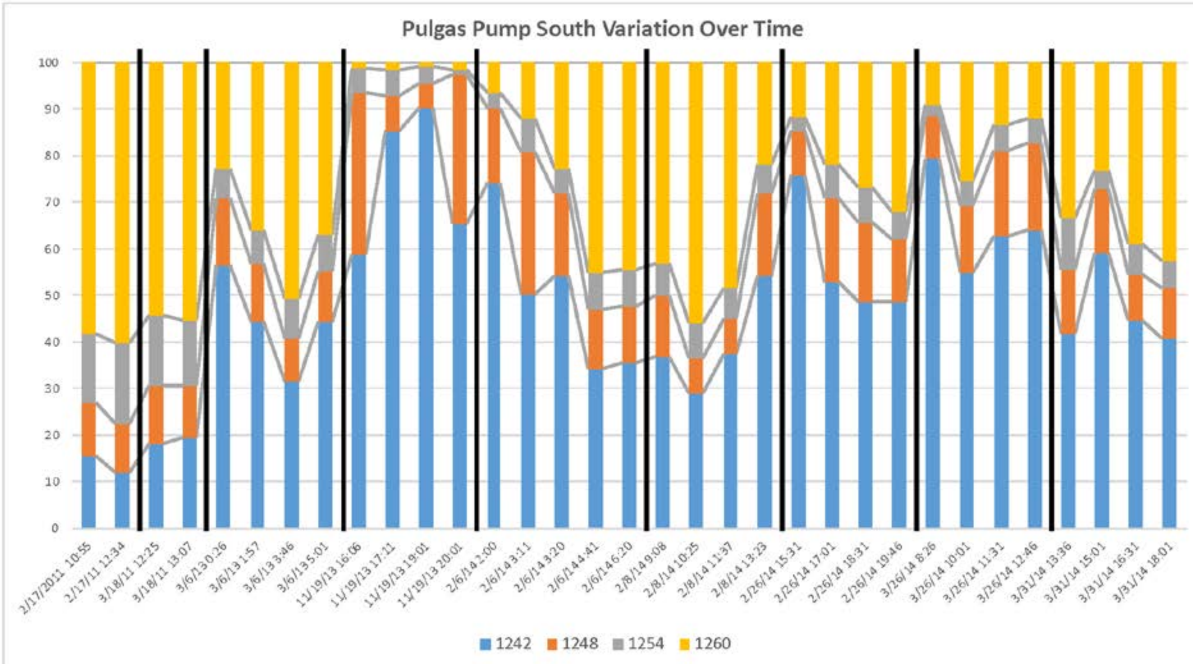

Figure 5.3. Aroclor indices in stormwater at the outlet of Pulgas Creek Pump Station South over time (figure produced by SFEI, 2018).

5.3.4 Alternative Flame Retardant Conceptual Model

Alternative flame retardants (AFRs) came into use following state bans and nationwide phase-outs of polybrominated diphenyl ether (PBDE) flame retardants in the early 2000's. They include many categories of compounds, including organophosphate esters. In 2018 the RMP STLS and the Emerging Contaminant Workgroup (ECWG) worked together to conduct a special study to inform ECWG's planning activities related to AFRs. The special study compiled and reviewed available data and previously developed conceptual models for PBDE to support a stormwater-related AFR conceptual model being developed by the ECWG. Organophosphate esters were prioritized for further investigation due to their increasing use, persistent character, and ubiquitous detections at concentrations exceeding PBDE concentrations in the Bay. Limited stormwater runoff data from two watersheds in Richmond and Sunnyvale suggest that urban runoff may be an important source of these compounds. Additional monitoring and modeling were recommended. Results of the AFR special study were published in a technical report in 2018 (Lin and Sutton 2018).

5.3.5 Regional Watershed Spreadsheet Model

The Regional Watershed Spreadsheet Model (RWSM) is a land use based planning tool for regional scale estimation of annual POC loads from small tributaries to San Francisco Bay. Development of the RWSM began in 2010 and, in 2018, the STLS Team continued to provide support of the RWSM tool-kit that was published in 2017.

The RWSM is based on the idea that to accurately assess total contaminant loads entering San Francisco Bay, it is necessary to estimate loads from local watersheds. "Spreadsheet models" of stormwater quality provide a useful and relatively inexpensive means of estimating regional scale watershed loads. Spreadsheet models have advantages over mechanistic models because the data for many of the input parameters required by mechanistic models may not currently exist; mechanistic models also require large calibration datasets which require a significant investment of time and resources to collect.

The RWSM is based on the assumption that an estimate of mean annual runoff **volume** for each land use type within a watershed can be combined with an estimate of mean annual pollutant **concentration** for that same land use type to derive a pollutant **load** which can be aggregated for a watershed or many watersheds within a region of interest. It may be used to provide hypotheses about which sub-regions or watersheds export relatively higher or lower loads to the Bay relative to area. It can also serve as a baseline for analyzing changes in loadings due to large scale changes in land use (e.g., associated with redevelopment and new development) and runoff (e.g., associated with climate change and changes in impoundment). However, the RWSM is less reliable for predicting loadings from individual watersheds and for estimating load changes in relation to implementation of treatment BMPs.

The RWSM beta tool-kit, published in June 2017 includes:

- Hydrology Model coded using ArcPy and drawing on a user interface accessible through ArcGIS;
- Pollutant Model Spreadsheet for taking the outputs from the Hydrology Model and inputting land use coefficients to estimate pollutant loads;
- Two optional calibration tools – a spreadsheet for manual calibration, and an R script for an optimized automated calibration; and
- User Manual.

Testing of the RWSM beta tool-kit by some of the BASMAA RMC partners began in WY 2017 and continued into WY 2018. The STLS will continue to support the RWSM in WY 2019. If warranted, and in consultation with the STLS and the SPLWG, a more sophisticated dynamic simulation model (i.e., SWMM, HSPF) may be developed in future years. As the modeling team at SFEI becomes more proficient with alternative water-based platforms (i.e., SWMM, HEC-RAS) through development of the Green Plan-IT tool, a more sophisticated basis may be adopted in future years. Decisions on model improvements will be made in consultation with the STLS and the SPLWG.

6.0 Next Steps

Water quality monitoring required by Provision C.8 of the MRP is intended to assess the condition of water quality in Bay Area receiving waters (creeks and the Bay); identify and prioritize stormwater associated impacts, stressors, sources, and loads; identify appropriate management actions; and detect trends in water quality over time and the effects of stormwater control measure implementation. On behalf of San Mateo County Permittees, SMCWPPP conducts creek water quality monitoring and other monitoring projects in San Mateo County in collaboration with the BASMAA Regional Monitoring Coalition, and actively participates in the Regional Monitoring Program for Water Quality in San Francisco Bay, which focuses on assessing Bay water quality and associated impacts.

In WY 2019, SMCWPPP will continue to comply with water quality monitoring requirements of the MRP. Specifically, in WY 2019 SMCWPPP will continue to:

- Collaborate with the RMC (MRP Provision C.8.a);
- Where applicable, collect and report monitoring data that are compatible with SWAMP (MRP Provision C.8.b);
- Provide financial contributions towards the RMP and will assist San Mateo County Permittees and BASMAA to actively participate in the RMP committees and work groups described in Sections 2.0 and 5.0 (MRP Provision C.8.c);
- Conduct probabilistic and targeted creek status monitoring consistent with the specific requirements of MRP Provision C.8.d;
- Conduct pesticides and toxicity monitoring consistent with MRP Provision C.8.g;
- Review water quality monitoring results and maintain a list of all results exceeding trigger thresholds (MRP Provision C.8.e.i). SMCWPPP will coordinate with the RMC to initiate eight new SSID projects by the end of the permit term (MRP Provision C.8.e.iii). This will include implementation of the Pillar Point Harbor Bacteria SSID Project and participation in the regional SSID project addressing releases of PCBs from electrical utility equipment.
- Participate in the STLS and SPLWG which address MRP Provision C.8.f POC management information needs and monitoring requirements through wet weather characterization monitoring, refinement of the RWSM, and development and implementation of the STLS Trends Strategy.
- Implement a POC monitoring framework to comply with Provision C.8.f of the MRP. The monitoring framework addresses the annual and total minimum number of samples required for each POC (i.e., PCBs, mercury, copper, emerging contaminants, nutrients) and each management information need (i.e., Source Identification, Contributions to Bay Impairment, Management Action Effectiveness, Loads and Status, Trends). WY 2019 monitoring will include collection of 25 dry weather grab sediment samples from the public right-of-way to attempt to identify sources of PCBs to urban runoff. The sampling plan will be informed by SMCWPPP's process to prioritize Watershed Management Areas (WMAs). WY 2018 monitoring will also include sampling for nutrients and copper.
- WY 2019 POC monitoring accomplishments and allocation of sampling efforts for POC monitoring in WY 2020 will be submitted in the Pollutants of Concern Monitoring Report that is due to the Water Board by October 15, 2019 (MRP Provision C.8.h.iv).

Results of WY 2019 monitoring will be described in the Programs Integrated Monitoring Report (IMR) that is due to the Water Board by March 31, 2020 in lieu of the annual Urban Creeks Monitoring Report (MRP Provision C.8.h.v). This report will be part of the Report of Waste Discharge for the reissuance of the MRP. The IMR will contain a comprehensive analysis of all data collected pursuant to provision C.8 since the previous IMR which was submitted on March 31, 2014 and included WY 2012 and WY 2013 monitoring data. A major component of the IMR will be evaluation of eight years (WY 2012 – WY 2019) of probabilistic bioassessment monitoring data. Overall stream condition in San Mateo County will be evaluated using the BMI-based CSCI and other available IBIs. Stressors associated with poor condition will be evaluated using the statistical tools implemented by BASMAA in the RMC 5-Year Report.

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Appendix A

SMCWPPP Creek Status Monitoring Report, Water Year 2018

Appendix B

Regional Stressor/Source Identification (SSID) Report

Appendix C

SMCWPPP Pollutants of Concern Data Report, Water Year 2018

Appendix D

BASMAA Pollutant Removal from Stormwater with Biochar Amended BSM

Appendix E

Evaluation of Mercury and PCBs Removal Effectiveness of Full Trash Capture HDS Units

Appendix F

RMP STLS POC Reconnaissance Monitoring Progress Report, Water Years 2015 - 2018

Appendix G

PCBs from Electrical Utilities in San Francisco Bay Area Watersheds. Stressor/Source Identification (SSID) Project Work Plan