**FAIRFIELD-SUISUN SEWER DISTRICT**
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GREGORY G. BAATRUP, GENERAL MANAGER

March 15, 2014

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Mr. Bruce Wolfe, Executive Officer
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612

Attn: Ms. Selina Louie, Water Resources Control Engineer

RE: Fairfield-Suisun Urban Runoff Management Program
Integrated Monitoring Report

Dear Mr. Wolfe:

The attached Integrated Monitoring Report represents the Fairfield-Suisun Urban Runoff Management Program's submittal in compliance with the Municipal Regional Permit (MRP) Reporting Provision C.8.g.v of NPDES Permit No. CA S612008 as adopted on October 14, 2009 via Order No. R2-2009-0074.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,

Kevin A. Cullen

Kevin A. Cullen, P.E.
Senior Environmental Engineer

cc: George Hicks, City of Fairfield
Dan Kasperson, City of Suisun City

Attachment

VALLEJO SANITATION &
FLOOD CONTROL DISTRICT
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March 15, 2014

Mr. Bruce Wolfe, Executive Officer
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612

Attn: Ms. Selina Louie, Water Resources Control Engineer

RE: Vallejo Sanitation and Flood Control District and the City of Vallejo's Integrated Monitoring Report

Dear Mr. Wolfe:

The attached Integrated Monitoring Report represents Vallejo Sanitation and Flood Control District and the City of Vallejo's submittal in compliance with the Municipal Regional Permit (MRP) Reporting Provision C.8.g.v of NPDES Permit No. CA S612008 as adopted on October 14, 2009 via Order No. R2-2009-0074.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,

Daniel Tafolla
Director of Environmental Services

*Attachment*

# Integrated Monitoring Report Part A
# Water Years 2012 - 2013

**March 15, 2014**

**Submitted by:**

**Fairfield-Suisun Urban Runoff Management Program**
**Vallejo Sanitation and Flood Control District**
**City of Vallejo**

## LIST OF ACRONYMS

| | |
|---|---|
| BASMAA | Bay Area Stormwater Management Agencies Association |
| BMP | Best Management Practice |
| BOD | Board of Directors |
| CEC | Contaminants of Emerging Concern |
| CFWG | Contaminant Fate Workgroup |
| CRAM | California Rapid Assessment Method |
| ECWG | Emerging Contaminant Workgroup |
| EEWG | Exposure and Effects Workgroup |
| EMC | Event Mean Concentrations |
| GIS | Geographic Information System |
| IMR | Integrated Monitoring Report |
| IMS | Information Management System |
| MRP | Municipal Regional Permit |
| MPC | Pollutants of Concern Committee |
| MYP | Multi-Year Monitoring Plan |
| NP | Nonylphenol |
| NPE | Nonylphenol Esters |
| NPDES | National Pollutant Discharge Elimination System |
| PFAS | Perfluoroalkyl sulfonates |
| PFOS | Perfluorooctane Sulfonates |
| POC | Pollutants of Concern |
| POTW | Publicly Owned Treatment Works |
| P/S | Pilot and Special Studies |
| QA | Quality Assurance |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| RMC | Regional Monitoring Coalition |
| RMP | Regional Monitoring Program |
| RWSM | Regional Watershed Spreadsheet Model |
| S&T | Status and Trends (Monitoring Program) |
| SC | Steering Committee |
| SCCWRP | Southern California Coastal Water Research Project |
| SFEI | San Francisco Estuary Institute |
| SPLWG | Sources, Pathways and Loading Workgroup |
| SPoT | Statewide Stream Pollutant Trend Monitoring Program |
| STLS | Small Tributary Loading Strategy |
| STLS-MYP | Small Tributary Loading Strategy Multi-Year Plan |
| SWAMP | Surface Water Ambient Monitoring Program |
| SWRCB | State Water Resources Control Board |
| TMDL | Total Maximum Daily Loads |
| TRC | Technical Review Committee |
| USGS | United States Geological Survey |
| WLA | Wasteload Allocations |
| WY | Water Year |

## TABLE OF CONTENTS PAGE

Section A.1 - Introduction 5
Regional collaborative monitoring (BASMAA RMC) 6
Section A.2 - San Francisco Estuary receiving WATER Monitoring (C.8.b) 7
Section A.3 - Creek Status Monitoring (C.8.c) 9
Regional and Local Monitoring Designs 9
Section A.4 - Monitoring Projects (C.8.d) 10
Section A.5 - Poc and Long-term Trends Monitoring (C.8.e) 10
A. POC Loads Monitoring 10
B. Long-Term Trends Monitoring (C.8.e) 13
Section A.6 – Sediment Delivery EstimATE / Budget (C.8.e.vi) 14
Section A.7 – Emerging Pollutants Work plan (C.8.e.v) 15
Section A.8 - Citizen Monitoring and Participation (C.8.f) 18
Section A.9 – Summary of results by watershed **Error! Bookmark not defined.**
References 22

## LIST OF TABLES

Table A-1. Stormwater Program annual contributions to the Regional Monitoring Program for Water Quality in the San Francisco Bay Estuary in 2011/2012 by MRP-related Programs

Table A-2. Location of monitoring result analyses for each parameters in MRP Table 8.1.

Table A-3. San Francisco Bay Regional Monitoring Program's CEC Pilot Monitoring Work Plan Approach - Receiving Waters, Sediment, and Tissue (Relative to SWRCB Panel Guidance).

Table A-4. San Francisco Bay Regional Monitoring Program's CEC Pilot Monitoring Work Plan Approach – Wastewater Treatment Plant Effluent (Relative to SWRCB Panel Guidance).

Table A-5. San Francisco Bay Regional Monitoring Program's CEC Pilot Monitoring Work Plan Approach – Urban Creeks (Stormwater) (Relative to SWRCB Panel Guidance).

## LIST OF APPENDICES

**A.1 C8c Creek Status – Regional/Probabilistic Parameters**

**A.2 C8c Creek Status – Targeted Parameters**

## SECTION A.1 - INTRODUCTION

This Integrated Monitoring Report, Part A, is submitted by the Fairfield-Suisun Urban Runoff Management Program, Vallejo Sanitation and Flood Control District and City of Vallejo (Solano County permittees) subject to the Municipal Regional Stormwater NPDES Permit (MRP, Order R2009-0074) issued by the San Francisco Regional Water Quality Control Board (Water Board) on October 14, 2009. This report (including all appendices and attachments) fulfills the requirements of MRP Provision C.8.g for interpreting and reporting monitoring data collected during Water Years 2012 (October 1, 2011 - September 30, 2012) and 2013 (October 1, 2012 – September 30, 2013). Monitoring data presented in this report were submitted electronically to the Water Board by RMC participants and may be obtained via the San Francisco Bay Area Regional Data Center (http://water100.waterboards.ca.gov/ceden/sfei.shtml).

This report is organized into two main parts – the main body and appendices. The main body provides brief summaries of accomplishments made in Water Years (WY) 2012 and 2013 in compliance with Municipal Regional Permit (MRP) provision C.8. Summaries are organized by sub-provisions of the MRP and grouped into the following sections:

A.1 Introduction / Preface
A.2 San Francisco Estuary Receiving Water Monitoring
A.3 Creek Status Monitoring
A.4 Monitoring Projects
A.5 Pollutants of Concern and Long-Term Trends Monitoring
A.6 Sediment Delivery Estimate / Budget
A.7 Emerging Pollutants Work Plan
A.8 Citizen Monitoring and Participation
A.9 Summary of Results by Watershed
A.10 Monitoring Budget Summary and Recommendations
A.11 Reporting, Monitoring Protocols, and Data Quality

Appendices include data analyses for interpretive reports focused on specific types of water quality monitoring required by the MRP. Appendices are also grouped together by sub-provision and referenced within the applicable sections of the main body.

The main body of this report and associated appendices address the following reporting requirements for the annual Urban Creeks Monitoring Report (Provision C.8.g.iii) including as appropriate for each type of monitoring in Provision C.8:

- Descriptions of monitoring purpose and study design rationale
- QA/QC summaries for sample collection and analytical methods, including a discussion of any limitations of the data;
- Descriptions of sampling protocols and analytical methods;
- Tables and Figures describing: Sample location descriptions (including waterbody names, and lat/longs); sample ID, collection date (and time where relevant), media (e.g., water, filtered water, bed sediment, tissue); concentrations detected, measurement units, and detection limits;
- Data assessment, analysis, and interpretation for Provision C.8.c.;
- Pollutant load and concentration at each mass emissions station;
- A listing of volunteer and other non-Permittee entities whose data are included in the report;
- Assessment of compliance with applicable water quality standards; and,
- A signed certification statement.

For the Integrated Monitoring Report (IMR) Part A also addresses the following additional reporting requirements in Provision C.8.g.v:

- A comprehensive analysis of all data collected pursuant to Provision C.8 during the permit term;
- A budget summary for each monitoring requirement;
- Recommendations for future monitoring;
- Methods, data, calculations, load estimates, and source estimates for each Pollutant of Concern Monitoring parameter.

**REGIONAL COLLABORATIVE MONITORING (BASMAA RMC)**

Provision C.8.a (Compliance Options) of the MRP allows Permittees to address monitoring requirements through a "regional collaborative effort," their Stormwater Program, and/or individually. In June 2010, Permittees notified the 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 Agencies Association (BASMAA) Regional Monitoring Coalition (RMC). With notification of participation in the RMC, Permittees were required to commence water quality data collection by October 2011. In a November 2, 2010 letter to the Permittees, the Water Board's Assistant Executive Officer (Thomas Mumley) acknowledged that all MRP Permittees have opted to conduct monitoring required by the MRP through a regional monitoring collaborative, i.e. tha BASMAA RMC.

In February 2011, the RMC developed a Multi-Year Work Plan (RMC Work Plan) to provide a framework for implementing regional monitoring and assessment activities required under MRP provision C.8. The RMC Work Plan summarizes RMC projects planned for implementation between Fiscal Years 2009-10 and 2014-15. 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 (BOD). A total of 27 regional projects are identified in the RMC Work Plan, based on the requirements described in provision C.8 of the MRP.

Regionally-implemented activities in the RMC Work Plan are conducted under the auspices of BASMAA, a 501(c)(3) non-profit organization comprised of 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,* approved by the BASMAA BOD. MRP Permittees, 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 shared by either all BASMAA members or among those Phase I municipal stormwater programs that are subject to the MRP.

## SECTION A.2 - SAN FRANCISCO ESTUARY RECEIVING WATER MONITORING (C.8.b)

As described in MRP provision C.8.b, Permittees are required to provide financial contributions toward 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 MRP, Permittees have complied with this provision by making financial contributions to the RMP directly or through stormwater programs (Table 1). Additionally, Permittees actively participated in RMP committees and work groups through Permittee and/or stormwater program staff as described in the following sections, which also provide a brief description of the RMP and associated monitoring activities conducted during this reporting period.

The RMP is a long-term monitoring program that is discharger funded and shares direction and participation by regulatory agencies and the regulated community with the goal of assessing water quality in the San Francisco Bay.[1] The regulated community includes Permittees, publicly owned treatment works (POTWs), dredgers and industrial dischargers. 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?

**Table A-1.** Stormwater Program annual contributions to the Regional Monitoring Program for Water Quality in the San Francisco Bay Estuary in 2013 by MRP-related Programs

| RMC Participant | 2013 Contribution |
|---|---|
| Santa Clara Valley Urban Runoff Pollution Prevention Program | $177,950 |
| Alameda Countywide Clean Water Program | $170,491 |
| Contra Costa Clean Water Program | $139,457 |
| San Mateo Countywide Water Pollution Prevention Program | $84,303 |
| Vallejo Sanitation and Flood Control District | $12,826 |
| Fairfield-Suisun Urban Runoff Management Program | $15,041 |
| **Total** | **$600,068** |

The RMP budget is generally broken into two major program elements: Status and Trends, and Pilot/Special Studies. The following paragraphs provide a brief overview of these programs.

[1] RMP Annual Work Plans can be found at www.sfei.org/rmp/what.

**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 and redesigned in 2007 based on a more rigorous statistical design that enables the detection of trends. In Water Year 2013 the S&T Program was comprised of the following program elements that collect data to address RMP management questions described above:

- Water/Sediment/Biota Chemistry and Toxicity Monitoring
- Sediment Benthos Monitoring
- Small and Large Tributary Loading Studies
- Small Fish and Sport Fish Contamination Studies
- Studies to Determine the Causes of Sediment Toxicity
- Suspended Sediment, Hydrography and Phytoplankton Monitoring
- Bird Egg Monitoring

In fall 2011 the RMP Steering Committee, as part of a 5-year Master Planning process reviewed the S&T Program and agreed to reduce the frequency of some of data collection activities or elements in future years so that more funding will be available for pilot and special studies. Additional information on the S&T Program and associated monitoring data are available for downloading via the RMP website using the Status and Trends Monitoring Data Access Tool at www.sfei.org/rmp/data.htm.

**RMP Pilot and Special Studies**

The RMP also conducts Pilot and Special Studies (P/S Studies) on an annual basis. Studies usually are 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 and standing workgroups identify as priority for further study. These studies are developed through an open selection process at the workgroup level and selected for funding through RMP committees. Results and summaries of the most pertinent P/S Studies can be found on the RMP website (www.sfei.org/rmp/).

In Water Years 2012 and 2013, a considerable amount of RMP and Stormwater Program staff time was spent in overseeing and implementing special studies associated with the RMP's Small Tributary Loading Strategy (STLS) and the STLS Multi-Year Monitoring Plan (MYP). 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 tributaries to the San Francisco Bay. Additional information is provided on STLS-related studies under section C.8.e (POC and Long-Term Trends Monitoring) of this Report.

**Participation in Committees, Workgroups and Strategy Teams**

In Water Years 2012 and 2013, Permittees actively participated in the following RMP Committees and work groups:

- Steering Committee (SC)
- Technical Review Committee (TRC)
- Sources, Pathways and Loadings Workgroup (SPLWG)
- Contaminant Fate Workgroup (CFWG)
- Exposure and Effects Workgroup (EEWG)
- Emerging Contaminant Workgroup (ECWG)

- Sport Fish Monitoring Workgroup
- Toxicity Workgroup
- Strategy Teams (e.g., PCBs, Mercury, Dioxins, Small Tributaries, Nutrients)

Committee and workgroup representation was provided by Permittee, stormwater program staff and/or individuals designated by RMC participants and the BASMAA BOD. Representation included participating in meetings, reviewing technical reports and work products, co-authoring or reviewing articles included in the RMP's Pulse of the Estuary, 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 representatives (on behalf of Permittees) during MPC and/or BOD meetings to ensure Permittees' interests were adequately represented.

## SECTION A.3 - CREEK STATUS MONITORING (C.8.c)

Provision C.8.c 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, river 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 stormwater program are described in Table 8.1 of the MRP. Based on the implementation schedule described in MRP Provision C.8.a.ii, creek status monitoring coordinated through the RMC began in October 2011.

### Regional and Local Monitoring Designs

The RMC's regional monitoring strategy for complying with MRP provision C.8.c - creek status monitoring is described in *Creek Status and Long-Term Trends Monitoring Plan* (BASMAA 2011). The strategy includes a regional ambient/probabilistic monitoring component and a component based on local "targeted" monitoring. The combination of these monitoring designs allows each individual RMC participating program to assess the status of beneficial uses in local creeks within its Program (jurisdictional) area, while also contributing data to answer management questions at the regional scale (e.g., differences between aquatic life condition in urban and non-urban creeks)[2].

Solano County permittees submitted their Creek status monitoring data for Water Year 2013 to the Water Board by January 15, 2014. The analyses of results from creek status monitoring conducted by RMC participants in Water Years 2012 and 2013 are presented in Appendices A.1-A.2. Table A-2 provides a list of which parameters are included in program-specific and jointly produced appendices.

[2] MRP provision C.8.a.i states in reference to all subsections of C.8 that "provided these data types, quantities, and quality are obtained, a regional monitoring collaborative may develop its own sampling design".

**Table A-2.** Location of monitoring result analyses for each parameters in MRP Table 8.1.

| Biological Response and Stressor Indicators | Detailed data Appendix to IMR | |
|---|---|---|
| | Appendix A.1 | Appendix A.2 |
| Bioassessment (Benthic Macroinvertebrates and Algae) & Physical Habitat Assessments | X | |
| Chlorine | X | |
| Nutrients | X | |
| Water Toxicity | X | |
| Sediment Toxicity | X | |
| Sediment Chemistry | X | |
| General Water Quality (Continuous) | | X |
| Temperature (Continuous) | | X |
| Pathogen Indicators | | X |
| Stream Survey (USA or CRAM) | | X |

# SECTION A.4 - MONITORING PROJECTS (C.8.D)

Three types of monitoring projects are required by provision C.8.d of the MRP:

1) Stressor/Source Identification Projects (C.8.d.i);
2) BMP Effectiveness Investigations (C.8.d.ii); and,
3) Geomorphic Projects (C.8.d.iii).

The overall scopes of these projects are generally described in the MRP and the RMC Work Plan. Solano County permittees only began monitoring in Water Year 2013 and thus have not initiated any of the monitoring projects listed above. Results from these data will inform monitoring projects to begin in Water Year 2014 and beyond.

## SECTION A.5 - POC AND LONG-TERM TRENDS MONITORING (C.8.e)

### A. POC Loads Monitoring

Pollutants of Concern (POC) loads monitoring is required by provision C.8.e.i of the MRP. Loads monitoring is intended to assess inputs of POCs to the Bay from local tributaries and urban runoff, assess progress toward achieving wasteload allocations (WLAs) for TMDLs, and help resolve uncertainties associated with loading estimates for these pollutants. In particular, there are four priority management questions that need to be addressed though POC loads monitoring:

1. Which Bay tributaries (including stormwater conveyances) contribute most to Bay impairment from POCs?
2. What are the annual loads or concentrations of POCs from tributaries to the Bay?
3. What are the decadal-scale loading or concentration trends of POCs from small tributaries to the Bay? and,

4. What are the projected impacts of management actions (including control measures) on tributaries and where should these management actions be implemented to have the greatest beneficial impact?

To assist participants in effectively and efficiently conducting POC loads monitoring required by the MRP and answer POC loads management questions listed above, an RMP Small Tributaries Loading Strategy (STLS) was developed in 2009 by the STLS Team, which included representatives from BASMAA, Water Board staff, RMP/SFEI and technical advisors. The objective of the STLS is to develop a comprehensive planning framework to coordinate POC loads monitoring/modeling between the RMP and RMC participants. This framework and a summary of activities and products to date are provided in the STLS Multi-Year Plan (STLS-MYP). With concurrence of participating Water Board Staff, the STLS-MYP presents an alternative approach to the POC loads monitoring requirements described in MRP Provision C.8.e.i, as allowed by Provision C.8.e. The most recent version of the STLS Multi-Year Plan was appended to the BASMAA RMC's Urban Creeks Monitoring Report in 2013, with various appendices provided along with previous semi-annual Monitoring Status Reports. The main body of Version 2013 describes the major STLS elements, including recent activities summarized below.

RMC participant activities associated with POC loads monitoring during Water Years 2012 and 2013 focused on bottom-of-watershed monitoring and the continued development of a watershed pollutant load estimation model, both of which were coordinated through the STLS Team and the associated RMP Sources Pathways Loadings Work Group (SPLWG).

## STLS Multi-Year Plan Activities

Based on the consensus of the STLS Team, RMC representatives in coordination with SFEI staff created the STLS Multi-Year Plan to assist Permittees in complying with provision C.8.e (POC Monitoring). The Multi-Year Plan is an alternative POC monitoring program to the one described in the MRP that equally addresses the management information needs described in the MRP. The alternative approach addresses the four core POC loads monitoring management questions, while integrating activities funded by BASMAA via the RMC with those funded by the RMP. The Multi-Year Plan provides a more comprehensive description and work plan for STLS activities over the next 5 to10 years, including a detailed rationale for the methods and locations of proposed activities (e.g., POC loads monitoring in small tributaries).

The MYP includes four main elements that collectively address the four priority management questions for POC monitoring:

1. Watershed modeling (Regional Watershed Spreadsheet Model);
2. Bay Margins Modeling;
3. Source Area Runoff Monitoring; and,
4. Small Tributaries Monitoring

Previous MYP updates regarding STLS activities were provided in the Monitoring Status Report submitted to the Water Board in September 2012, and additional activities after July 2013 were summarized in the Urban Creeks Monitoring Report. The following paragraphs provide brief summaries of each of these elements and activities conducted during the period from October 2012 through September 2013:

- **Watershed Modeling** –The STLS and RMP Sources, Pathways and Loading Work Group (SPLWG) continued to provide oversight in Water Years 2012 and 2013 to the construction and initial testing of the Regional Watershed Spreadsheet Model, which is the primary tool for estimation of overall POC loads to San Francisco Bay. Initial modeling efforts focused on developing load estimates for sediment, mercury and PCBs. For each POC a submodel architecture will be developed specific to its runoff characteristics and source areas in the Bay Area landscape. An initial test model was constructed for copper for which the submodel is similar to the basic hydrologic version and inputs from other efforts that were readily available. In the second half of 2012, a graphic user interface was also developed that allows for customization and running of submodels by users who are not GIS software experts.

- **Bay Margins Modeling** – in 2012 the RMP released a second draft Bay Margins Conceptual Model report incorporating extensive review comments by the RMP Contaminant Fate Work Group, which includes representatives from BASMAA. The RMP Steering Committee also authorized the development of a multi-year plan to develop a modeling framework with multiple objectives regarding nutrients and other contaminants of interest, which may be used to answer management questions regarding contaminant processes in the Bay Margins. The goals of the modeling strategy pertinent to the STLS include identification of high-leverage watersheds whose POC loadings contribute disproportionately to Bay impacts. Further development of the Bay Modeling Strategy planned in 2013 will include convening technical experts, stakeholders and RMP work groups to produce an initial draft work plan for Bay modeling-related activities.

- **Source Area Runoff Monitoring** – This element of the STLS is intended as a placeholder for studies to develop Event Mean Concentrations (EMCs) of POCs to parameterize the Regional Watershed Model. On the advice of the SPLWG, initial RMP studies used alternative approaches to "back-calculate" EMCs from available data, as a cost-effective way to support the first iteration of the watershed model. The STLS Work Group received progress updates on initial modeling results in 2013 and will determine priorities for possible source area runoff field-data collection in Water Year 2015.

- **Small Tributaries Watershed Monitoring** – For this STLS element, the approach outlined in the Multi-Year Plan consists of intensively monitoring a total of six "bottom-of-watershed" stations over several years to accumulate samples needed to calibrate the watershed model and assist in developing loading estimates from small tributaries for priority POCs. Monitoring is also intended to provide a more limited characterization of additional lower priority analytes. Water Year 2013 was the second year of monitoring activities at four stations that were set up and mobilized beginning in October 2011. Two additional stations, North Richmond Pump Station and Pulgas Pump Station, were established in October 2012 to begin monitoring and complete the phasing in of watershed stations:

  1. Lower Marsh Creek(Contra Costa County)
  2. Guadalupe River (Santa Clara County)
  3. Lower San Leandro Creek (Alameda County)
  4. Sunnyvale East Channel (Santa Clara County)
  5. North Richmond Pump Station (Contra Costa County)
  6. Pulgas Pump Station (San Mateo County)

The stations in Lower Marsh Creek, Guadalupe River and Pulgas Pump Station are operated by the Contra Costa Clean Water Program, the Santa Clara Valley Urban Runoff Pollution Prevention Program and the San Mateo Countywide Water Pollution Prevention Program, respectively, on behalf of RMC participants. The stations in the Sunnyvale East Channel and North Richmond Pump Station are operated by SFEI on behalf of the RMP, as was the Lower San Leandro Creek Station in its first year before operation was transferred to the Alameda Countywide Clean Water Program in summer 2012 for operation starting in WY2013.

Monitoring methods and laboratory analyses according to the descriptions in the STLS Multi-Year Plan are documented in a Field Manual and Quality Assurance Project Plan, currently under development as a BASMAA regional project. These documents are expected to be completed in Water Year 2013.

For Water Year 2012, BASMAA contracted with SFEI to coordinate laboratory analyses, data management and data quality assurance. The goal was to ensure data consistency among all watershed monitoring stations. BASMAA again recently approved a contract with SFEI to continue to support these activities in Water Year 2013.

**Water Year 2012-13 Results**

Preliminary results of Water Year 2012 and 2013 POC Monitoring conducted by the STLS team are presented in program-specific reports submitted by the agencies conducting the monitoring for this reporting period.

## B. Long-Term Trends Monitoring (C.8.e)

In addition to POC loads monitoring, Provision C.8.e requires Permittees to conduct long-term trends monitoring to evaluate if stormwater discharges are causing or contributing to toxic impacts on aquatic life. Required long-term monitoring parameters, methods, intervals and occurrences are included as Category 3 parameters in Table 8.4 of the MRP, and prescribed long-term monitoring locations are included in Table 8.3. Similar to creek status and POC loads monitoring, long-term trends monitoring was scheduled to begin in October 2011 for RMC participants.

As described in the *RMC Creek Status and Trends Monitoring Plan* (BASMAA 2011), the State of California's Surface Water Ambient Monitoring Program (SWAMP) through its Statewide Stream Pollutant Trend Monitoring (SPoT) Program currently monitors the seven long-term monitoring sites required by Provision C.8.e.ii. Sampling via the SPoT program is currently conducted at the sampling interval and for parameters as described in Provision C.8.e.iii in the MRP. The SPoT program is generally conducted to answer the management question:

- What are the long-term trends in water quality in creeks?

Based on discussions with Region 2 SWAMP staff, RMC participants intend to comply with MRP provision C.8.e that are associated with long-term trends via monitoring conducted by the SPoT program. This manner of compliance is consistent with the MRP language in provision C.8.e.ii. A SPoT program technical report on 2009-2010 data was released to the public in 2013 (Anderson et al., 2013). RMC representatives will continue to coordinate with the SPoT program on long-term monitoring to ensure MRP monitoring and reporting requirements are

addressed[3]. Additional information on the SPoT program can be found at http://www.waterboards.ca.gov/water_issues/programs/swamp.

## SECTION A.6 – SEDIMENT DELIVERY ESTIMATE / BUDGET (C.8.e.vi)

Provision C.8.e.vi of the MRP requires Permittees to develop a design for a robust sediment delivery estimate/sediment budget in local tributaries and urban drainages, and implement the study by July 1, 2012. The purpose of the sediment delivery estimate is to improve the Permittees' ability to estimate urban runoff contributions to loads of POCs, most of which are closely associated with sediment. To determine a strategy for a robust sediment estimate/budget, BASMAA representatives reviewed recent sediment delivery estimates developed by the RMP, and determined that these objectives would be met effectively through sediment-specific submodeling with the Regional Watershed Spreadsheet Model (RWSM), under the ongoing oversight of the RMP Sources Pathways Loadings Work Group and the Small Tributaries Loading Strategy (STLS) Work Group.

The implementation of the sediment delivery/budget study was designed to occur in coordination with the STLS Multi-Year Plan, with funding from both the RMP and BASMAA regional projects. Sediment-specific model developments included:

- Literature-based refinement of land-use based Event Mean Concentrations;
- Development of a sub-model incorporating bedrock type, hillslope and convergence processes, and level /age of urbanization;
- Incorporation and calibration of specific watershed sediment loads calculated from available USGS gauge data or previous monitoring stations; and
- Coordination of sediment submodeling with RWSM model development for PCBs and mercury
- Mapping of areas upstream of reservoirs and application of estimated delivery ratios to adjust modeled loads for storage of sediment within watersheds

BASMAA-funded activities included:

- Sensitivity analyses and evaluation of weaknesses in the initial set of sediment runoff coefficients for the RWSM;
- Implementation of high-priority improvements and convening a panel of local experts to provide input on the geological bases for model coefficients;
- Analysis of results of calibration on modeled sediment estimates and model loads; and
- Development of a RWSM geoprocessing tool to incorporate the sediment model structure and its parameterization from locally derived land use/geological sediment erosion coefficients and equations.

SFEI produced annual progress reports on overall RWSM development and provided a June 2013 internal update to BASMAA on the sediment model. In December 2013 distributed for STLS review a draft report section with preliminary results of the RWSM models for PCBs and mercury, which apply coefficients based on particle concentrations to the estimates of suspended sediment loadings from the modeled watersheds. SFEI noted that the sediment

[3] MRP Provision C.8.a.iv "Third Party Monitoring" states that where an existing third-party organization has initiated plans to conduct monitoring that would fulfill one or more requirements of Provision C.8 but the monitoring would not meet MRP due date(s) by a year or less, the Permittees may request that the Executive Officer adjust the due date(s) to synchronize with such efforts.

model remains unverified and the parameterization calibration runs would potentially be improved by the addition of a climatic parameter as recommended by the expert panel.

## SECTION A.7 – EMERGING POLLUTANTS WORK PLAN (C.8.e.v)

Provision C.8.e.vii of the MRP requires Permittees to develop a work plan and schedule for initial loading estimates and source analyses for contaminants of emerging concern (CECs). Contaminants that are mentioned in the MRP include: endocrine-disrupting compounds, PFOS/PFAS (Perfluorooctane Sulfonates (PFOS), Perfluoroalkyl sulfonates (PFAS), and NP/NPEs (nonylphenols/nonylphenol esters -estrogen-like compounds). The work plan developed by Permittees is to be implemented in the next Permit term.

Consistent with these requirements, Permittees (via Countywide Stormwater Programs) have and will continue to coordinate the investigation and significance of CECs with the San Francisco Bay Regional Monitoring Program for Water Quality (RMP). As such, Permittees have participated in the development and funding of a CEC strategy entitled "Contaminants of Emerging Concern in San Francisco Bay: A Strategy for Future Investigations" (Sutton et.al. 2013). Consistent with the CEC strategy Permittees have also participated in the development and implementation of the following work plans, which are consistent with provision C.8.e.vii:

- *Monitoring Alternative Flame Retardants in SF Bay Water, Sediment and Biota* (Sutton and Sedlak 2013);
- *Monitoring Alternative Flame Retardants in SF Bay Water, Sediment, and Biota: Pathway Characterization – Wastewater and Stormwater* (Sutton and Sedlak 2013); and
- Special two-year study of Bioanalytical tools entitled *Linkage of in Vitro Assay Results with in Vivo End Points* (Denslow et.al, 2012).

In addition, Permittees have and continue to participate in the broader Statewide CEC investigation and monitoring efforts through RMP coordination with the State Water Board's contractor, the Southern California Coastal Water Research Project (SCCWRP). Summary tables that illustrate the relationship between CECs of high priority to the broader statewide effort and the RMP strategy are included as Tables A3-5. During the next Permit term, Permittees intend to continue to work with the RMP staff and update the current CEC strategy as needed based on the significance of the results of the various ongoing investigations. In addition, the need for the development of preliminary loading estimates as well as source analyses will be considered as part of the CEC strategy updates and investigatory results.

**Table A-3**. San Francisco Bay Regional Monitoring Program's CEC Pilot Monitoring Work Plan Approach - Receiving Waters, Sediment, and Tissue (Relative to SWRCB Panel Guidance).

| Compound[1] | San Francisco Bay Risk level[2] | SWRCB Panel Guidance Embayment Water / Sediment/Tissue[3] | RMP Approach |
|---|---|---|---|
| Bis(2-ethylhexyl) phthalate (PPCP) | I | NA/NA/NA | Widely detected at low level in surface water, tissue, and sediment. Below available effects thresholds for sediment. Uncertainty regarding the applicability of thresholds to Bay data. |
| Bisphenol A (PPCP) | I | M/NA/NA | ND samples; DL high. Consider re-sampling using lower DLs. BPA is included in RMP Bioanalytical study[4]. |
| Bifenthrin (pesticide) | II | M/M/NA | Hydrophobic; based on Bay sediment concentrations, expect ND in water |
| Butylbenzyl phthalate (PPCP) | I | NA/NA/NA | Exceed low apparent effects threshold values in sediment but high uncertainty regarding the application of these thresholds to the Bay. ND in mussel tissue. |
| Permethrin (pesticide) | II | M/M/NA | Hydrophobic; based on Bay sediment concentrations, expect ND in water |
| Estrone (hormone) | | NA/NA/NA | No Bay data. Included in RMP Bioanalytical study[4] |
| Ibuprofen (PPCP) | II | NA/NA/NA | Mostly ND in pilot study. Low priority. |
| 17-beta estradiol (hormone) | | M/NA/NA | No Bay data. Include in bioanalytical tools. |
| Galaxolide –HHCB (PPCP) | II | M/NA/NA | Detected in Bay samples from 1999-2000 and in later Bay POCIS passive sampling study. Included in RMP Bioanalytical study[4]. Special study of PPCPs under consideration. |
| Diclofenac (PPCP) | | NA/NA/NA | No data. RMP reviewing as part of PPCP paper. |
| p-Nonylphenol (PPCP) | III | NA/NA/NA | Detected in water, sediment and tissue. Included in RMP Bioanalytical study[4]. |
| PBDE-47 and 99 (flame retardants) | III | NA/M/M | Analyzed extensively in water, sediment and tissue. Concentrations declining in multiple species. Prepared summary report on 10 years of RMP data[5]. |
| Fipronil | III | M/M/NA | Monitored in sediment and water (pilot study). |
| PFOS (PFAS) | III | NA/M/M | Detected in elevated concentrations in seals and bird eggs. Continue monitoring in tissue (bird/seal). Consider evaluating effluent and sediments |
| Triclosan (PPCP) | II | NA/NA/NA | Low to ND in sediment. ND in water and mussels. |
| Non-PBDE Flame Retardants[6] | I | RMP | RMP special study; see note 6 below (RMP special study plan and addendum dated June 2013 ) |

1 – Chlorpyrifos not included in monitoring – see SWRCB Panel September 2013 meeting notes and rationale
2 – Risk Levels (for San Francisco Bay Receiving Waters): Tier IV (High Concern), Tier III (Moderate Concern), Tier II (Low Concern), and Tier I (Possible Concern); see RMP report "Contaminants of Emerging Concern in San Francisco Bay: A Strategy for Future Investigations," Contribution 700, 2013.
3 - NA = Not Applicable, M = Monitoring suggested
4 – See RMP Detailed Workplan 2014, December 2013
5- PBDE Synthesis Report. Draft 2013.
6 – Additional SF Bay CEC special study; see discussion and rationale in "Contaminants of Emerging Concern in San Francisco Bay: A Strategy for Future Investigations," Contribution 700, 2013; RMP Study Plan "Monitoring Alternative Flame Retardants in SF bay Water, Sediment and Biota" Sutton and Sedlak, June 2013; and RMP addendum "Monitoring Alternative Flame Retardants in SF Bay Water, Sediment, and Biota: Pathway Characterization – Wastewater and Stormwater," Sutton and Sedlak, June 2013.

**Table A-4.** San Francisco Bay Regional Monitoring Program's CEC Pilot Monitoring Work Plan Approach – Wastewater Treatment Plant Effluent (Relative to SWRCB Panel Guidance).

| Compound[1] | San Francisco Bay Risk level[2] | SWRCB Panel Guidance Embayment Water / Sediment/Tissue[3] | RMP Approach |
|---|---|---|---|
| Bis(2-ethylhexyl) phthalate (PPCP) | I | NA | Consider monitoring in concert with butylbenxyl phthalate? |
| Bisphenol A (PPCP) | I | M | Included in RMP Bioanalytical study[4] |
| Bifenthrin (pesticide) | II | M | Effluent from 32 facilities have been monitored for pyrethroids. Report pending (Jan 2014). |
| Butylbenzyl phthalate (PPCP) | I | NA | Under consideration to analyze? |
| Permethrin (pesticide) | II | M | Effluent from 32 facilities have been monitored for pyrethroids. Report pending (Jan 2014). |
| Estrone (hormone) | I | M | Included in RMP Bioanalytical study[4] |
| Ibuprofen (PPCP) | II | NA | Mostly ND in pilot study in Bay. |
| 17-beta estradiol (hormone) | | NA | No data. Address using bioanalytical tools |
| Galaxolide –HHCB (PPCP) | II | M | Included in RMP Bioanalytical study[4] |
| Diclofenac (PPCP) | | NA | No data. Conducting review of PPCPs. |
| p-Nonylphenol (PPCP) | III | NA | Included in RMP Bioanalytical study[4] |
| PBDE -47 and 99 (flame retardants) | III | M | Declining concentrations; Not a high priority to monitor in effluent due to use restrictions[5] |
| Fipronil | III | NA | Depending on water results, consider effluent? |
| PFOS (PFAS) | III | M | Consider monitoring PFOS and precursors in effluent? |
| Triclosan (PPCP) | II | NA | Not a high priority because low levels observed in Bay sediments. |
| Non-PBDE Flame Retardants[6] | I | RMP | RMP special study; see note 6 below (RMP special study plan and addendum dated June 2013 ) |

1 – Chlorpyrifos not included in monitoring – see SWRCB Panel September 2013 meeting notes and rationale
2 – Risk Levels (for San Francisco bay Receiving Waters): Tier IV (High Concern), Tier III (Moderate Concern), Tier II (Low Concern), and Tier I (Possible Concern); see RMP report "Contaminants of Emerging Concern in San Francisco Bay: A Strategy for Future Investigations," Contribution 700, 2013.
3 - NA = Not Applicable, M = monitoring suggested
4 – See RMP Detailed Workplan 2014, December 2013
5- PBDE Synthesis Report. Draft 2013.
6 – Additional SF Bay CEC special study; see discussion and rationale in "Contaminants of Emerging Concern in San Francisco Bay: A Strategy for Future Investigations," Contribution 700, 2013; RMP Study Plan "Monitoring Alternative Flame Retardants in SF bay Water, Sediment and Biota" Sutton and Sedlak, June 2013; and RMP addendum "Monitoring Alternative Flame Retardants in SF Bay Water, Sediment, and Biota: Pathway Characterization – Wastewater and Stormwater," Sutton and Sedlak, June 2013

**Table A-5.** San Francisco Bay Regional Monitoring Program's CEC Pilot Monitoring Work Plan Approach – Urban Creeks (Stormwater) (Relative to SWRCB Panel Guidance).

| Compound[1] | San Francisco Bay Risk level[2] | SWRCB Panel Guidance Embayment Water / Sediment/Tissue[3] | RMP Approach |
|---|---|---|---|
| Bis(2-ethylhexyl) phthalate (PPCP) | II | NA | NA |
| Bisphenol A (PPCP) | II | M | NA |
| Bifenthrin (pesticide) | IV (UC) | M | Monitoring in urban creeks (UC) |
| Butylbenzyl phthalate (PPCP) | I | NA | NA |
| Permethrin (pesticide) | IV (UC) | M | Monitoring in urban creeks (UC) |
| Estrone (hormone) | I | M | NA |
| Ibuprofen (PPCP) | II | M | NA |
| 17-beta estradiol (hormone) | I | M | NA |
| Galaxolide –HHCB (PPCP) | II | M | NA |
| Diclofenac (PPCP) | | M | NA |
| p-Nonylphenol (PPCP) | III | NA | NA |
| PBDE -47 and 99 (flame retardants) | III | M | Monitoring in urban creeks (UC) |
| Fipronil | III | M | Monitoring in urban creeks (UC) |
| PFOS (PFAS) | III | M | Have monitored in the past (see Houtz and Sedlak 2012) |
| Triclosan (PPCP) | II | M | NA |
| Non-PBDE Flame Retardants[4] | I | RMP | RMP special study; see note 4 below (RMP special study plan and addendum dated June 2013 ) |

1 – Chlorpyrifos not included in monitoring – see SWRCB Panel September 2013 meeting notes and rationale
2 – Risk Levels (FOR San Francisco Bay Receiving Waters): Tier IV (High Concern), Tier III (Moderate Concern), Tier II (Low Concern), and Tier I (Possible Concern); see RMP report "Contaminants of Emerging Concern in San Francisco Bay: A Strategy for Future Investigations," Contribution 700, 2013.
3 - NA = Not Applicable, M = monitoring suggested
4 – See RMP Detailed Workplan 2014, December 2013
5- PBDE Synthesis Report. Draft 2013.
6 – Additional SF Bay CEC special study; see discussion and rationale in "Contaminants of Emerging Concern in San Francisco Bay: A Strategy for Future Investigations," Contribution 700, 2013; RMP Study Plan "Monitoring Alternative Flame Retardants in SF bay Water, Sediment and Biota" Sutton and Sedlak, June 2013; and RMP addendum "Monitoring Alternative Flame Retardants in SF Bay Water, Sediment, and Biota: Pathway Characterization – Wastewater and Stormwater," Sutton and Sedlak, June 2013

## SECTION A.8 - CITIZEN MONITORING AND PARTICIPATION (C.8.f)

In compliance with Provision C.8.f, Permittees are required to make reasonable efforts to seek out citizen and stakeholder input regarding waterbody function and quality, and to demonstrate within annual reports of their outreach efforts to these groups. Solano County permittees put resources toward watershed stewardship outreach and citizen monitoring efforts via the following programs:

*Watershed Explorers:* Fairfield-Suisun Urban Runoff Management Program, Vallejo Sanitation and Flood Control District and the City of Vallejo, in addition to other County partners, contract Solano Resource Conservation District to manage and implement the third grade

Watershed Explorers Program. This program utilizes science and place-based learning to build awareness and understanding of local creeks and watersheds including their unique ecosystems, and good stewardship practices to care for them. In-field discussions and activities teach children about the fragile habitats of birds and other wildlife. Students learn the importance of water quality in their watershed and discover the impacts of urban runoff and its components: trash, oil, and animal waste. The program offers local children, many of whom have little or no experience being in open space settings, a concrete, experiential introduction to their watershed and the creatures that inhabit it, using a curriculum based on concepts directly linked to California's state educational standards.

Watershed Explorers is an introductory program and covers basic ecology concepts and stewardship responsibilities. The primary program goal is to help students develop an awareness of the outdoor, natural world. Participants leave the program:

- understanding the impact of storm water on their watershed, particularly the impacts of oil and human debris in that storm water;
- knowing individual stewardship practices in their watershed, i.e., how they can mitigate or eliminate the impacts of their own and their family's behaviors around storm water protection and water quality;
- understanding the difference between native and invasive plants;

*Suisun Marsh Watershed & Wetland Education Program:* Also a program of Solano Resource Conservation District, 6th grade student participants in this program receive three in-class lessons prior to the field trip and one lesson after the field trip. The first lesson addresses the characteristics of a watershed and demonstrates how storm water pollution affects our creeks, marsh, and ocean. In the second lesson, students look at the geography of Solano County as it relates to the Suisun Marsh Watershed through various types of maps. The third lesson provides background on native and non-native plants and animals. Students also participate in a poster session where they research an endangered species, threatened species, or species of concern and present their findings to the class.

Participating teachers have the option of taking their students on a tour of North Bay Regional Water Treatment Plant, to further strengthen student understanding of the connection between source water and their household water taps.

The Suisun Marsh Watershed Program takes a macro view of a discreet, special watershed, and builds on the ecology and stewardship lessons from our Watershed Explorers Program, but also stands alone. Participants leave the program:

- understanding the concept of storm water on their watershed, particularly the impacts of oil, chemicals and human debris in that storm water;
- understanding the concept of a watershed;
- having the ability to name where their drinking water comes from;
- having the ability to articulate the threats to Suisun Marsh and demonstrate how they can improve it.

*Biomonitoring Program*: Vallejo Sanitation & Flood Control District and Solano County Office of Education contract Solano Resource Conservation District to manage and implement their Biomonitoring Program, an urban-runoff education program. Each participating class receives seven classroom presentations with topical activities. Lessons focus on stream ecology, storm water and watersheds, topographic mapping, macroinvertebrate identification and chemical water testing. Students participate in two field trips: a restoration-focused trip where students remove invasive plants and plant native vegetation, and an all-day citizen science field trip to monitor the health of a local creek.

During the biomonitoring field trip, students utilize the California Streamside Biosurvey, which employs a catch and release method and assesses invertebrate populations on site at the survey creek. This technique promotes the use of a non-lethal method for evaluating water quality. The Biosurvey's three components are all assessed creekside during the field trip:

1. Biological survey collection and analysis of benthic macroinvertebrates
2. Habitat assessment of the physical characteristics of the stream's substrate, flow, banks, and riparian zones.
3. Chemical analysis of water quality for dissolved oxygen, pH, temperature, turbidity, phosphates, and nitrates.

The Biomonitoring Program focuses on a micro-perspective, looking at a single reach of a single creek, evaluating watershed health through physical, chemical and biological parameters. This program builds on our Watershed Explorers Program and Suisun Marsh Watershed and Wetland Education Program, but also stands alone.

Goals of the program include:

- To raise knowledge and awareness of efforts to improve surface water quality
- To develop students' problem solving and critical thinking skills
- To promote stewardship of local water resources
- To teach students about stream ecology and water quality
- To implement student conducted bio-assessments and provide students with the opportunity to analyze real data that is submitted to CA data network

## SECTION A.9 – REPORTING, DATA QUALITY AND DATA MANAGEMENT (C.8.g&h)

Provision C.8.g requires Permittees to report annually on water quality data collected in compliance with the MRP. Annual reporting requirements include: 1) water quality standard exceedances; 2) creek status monitoring electronic reporting; and 3) urban creeks monitoring reporting. For RMC participants, creek status monitoring electronic data submittals to the Water Board were completed by January 15, 2013 for Water Year 2012 data and January 15, 2014 for Water Year 2013 data. Preliminary evaluations of data compared to water quality objectives were included in these submittals. Additional evaluations of data collected pursuant to provision C.8 are included in this Report and associated appendices.

Provision C.8.h requires that water quality data collected by Permittees in compliance with the MRP should be of a quality that is consistent with the State of California's Surface Water Ambient Monitoring Program (SWAMP) standards, set forth in the SWAMP Quality Assurance Project Plan (QAPP). To assist Permittees in meeting SWAMP data quality standards and developing data management systems that allow for easy access of water quality monitoring data by Permittees, the RMC coordinated guidance for SWAMP comparable data collection through several regional projects:

<u>Standard Operating and Quality Assurance Procedures</u>

For Creek Status Monitoring the RMC adapted existing creek status monitoring SOPs and QAPP developed by SWAMP to document the field procedures necessary to maintain comparable, high quality data among RMC participants. Version 1 of these documents (BASMAA 2012a, 2012b) were completed in Water Year 2012 prior to field work. All interpretative issues or concerns raised during the initial two years of monitoring were resolved through the RMC Work Group and were documented in Version 2 (BASMAA 2014a, 2014b) along with minor revisions addressing lessons learned.

For POC Loads Monitoring, a draft Field Manual and QAPP were developed through the STLS Team and described in the Multi-Year Plan. BASMAA implemented a master contract with SFEI to contract for laboratory analyses for all sites operated by RMC programs as well as those operated by SFEI for the RMP.

Information Management

For Creek Status Monitoring, the RMC participants developed an Information Management Systems (IMS) to provide SWAMP-compatible storage and import/export of data for all RMC programs. A data management subgroup of the RMC Work Group met periodically for training and review of data management issues, and suggested enhancements for data checking and to increase efficiency, which were implemented in 2013,

For POC Loads Monitoring BASMAA contracted with SFEI to design and maintain an IMS for management of data from stations operated by the RMC programs. SFEI also provided ongoing updates to the IMS and performed QA review of the data collected by RMC programs, consistent with the QA for data collected through the RMP.

The IMSs provide standardized data storage formats, thus providing a mechanism for sharing data among RMC participants and efficient submittal of data electronically to the Water Board per provision C.8.g.

# REFERENCES

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BASMAA. 2012a. Creek Status Monitoring Program Quality Assurance Project Plan, Final Draft Version 1.0. Prepared for BASMAA by EOA, Inc. on behalf of the Santa Clara Urban Runoff Pollution Prevention Program and the San Mateo Countywide Water Pollution Prevention Program, Applied Marine Sciences on behalf of the Alameda Countywide Clean Water Program, and Armand Ruby Consulting on behalf of the Contra Costa Clean Water Program. 80 pp plus appendices.

BASMAA. 2012b. Creek Status Monitoring Program Standard Operating Procedures. Prepared for BASMAA by EOA, Inc. on behalf of the Santa Clara Urban Runoff Pollution Prevention Program and the San Mateo Countywide Water Pollution Prevention Program, Applied Marine Sciences on behalf of the Alameda Countywide Clean Water Program, and Armand Ruby Consulting on behalf of the Contra Costa Clean Water Program. 196 pp.

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BASMAA. 2014b. Creek Status Monitoring Program Standard Operating Procedures, Final Version 2. Prepared for BASMAA by EOA, Inc. on behalf of the Santa Clara Urban Runoff Pollution Prevention Program and the San Mateo Countywide Water Pollution Prevention Program, Applied Marine Sciences on behalf of the Alameda Countywide Clean Water Program, and Armand Ruby Consulting on behalf of the Contra Costa Clean Water Program. 203 pp.

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# CREEK STATUS MONITORING REPORT – REGIONAL/PROBABILISTIC PARAMETERS

# Integrated Monitoring Report, Part A – Appendix A.1

## *Water Years 2012 and 2013 (October 1, 2011 – September 30, 2013)*

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**March 15, 2014**

## Acknowledgments

This report is in large part derived from the Regional Monitoring Coalition Urban Creeks Monitoring Report (UCMR) for Water Year 2012, Appendix A, Regional Urban Creeks Status Monitoring Report, prepared by EOA, Inc. and Armand Ruby Consulting. Analyses contained herein derive in large part from the methods, results and formats presented within the Regional UCMR.

Applied Marine Sciences contributed to this report under contract to the Alameda Countywide Clean Water Program, as part of a BASMAA Task of Regional Benefit (TRB). Participating programs in this BASMAA TRB are the Alameda Countywide Clean Water Program (ACCWP), Contra Costa Clean Water Program (CCCWP), Fairfield-Suisun Urban Runoff Management Program (FSURMP) and City of Vallejo / Vallejo Sanitation and Flood Control District (VSFCD). ACCWP staff acted as BASMAA Project Manager in overseeing the conduct of the TRB.

## Preface

The Bay Area Stormwater Management Agencies Association (BASMAA) Regional Monitoring Coalition (RMC) developed an outline for preparation of the Integrated Monitoring Report (IMR) to be submitted in compliance with the Municipal Regional Permit (MRP) Reporting Provision C.8.g.v for all monitoring conducted during the MRP term.

The following participants make up the RMC:

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

This report is a joint product funded by ACCWP, CCCWP, FSURMP, and Vallejo to fulfill reporting requirements for a portion of the Creek Status monitoring data collected in Water Years 2012 (October 1, 2011, through September 30, 2012) and 2013 (October 1, 2012, through September 30, 2013) through the RMC's probabilistic design for certain parameters monitored according to Provision C.8.c. This report is an Appendix to the full IMR submitted by each of the contributing programs on behalf of their respective Permittees.

As described in the *Regional Monitoring Coalition Final Creek Status and Long-Term Trends Monitoring Plan*, RMC participants collected data by implementing standard operating procedures in accordance with the Quality Assurance Program Plan (QAPP). Analytical laboratory analyses were also conducted under the direction of RMC participants. The quality of all data presented in this report, therefore, is assured by the RMC participants involved in their collection and management, and not the authors.

In addition to the RMC participants, San Francisco Bay Regional Water Quality Control Board staff, Kevin Lunde and Jan O'Hara, participated in RMC workgroup meetings that contributed to the design and implementation of the RMC Monitoring Plan. These staff also provided input on the outline of the initial *Regional Urban Creeks Status Monitoring Report* and threshold trigger analyses conducted herein.

## List of Acronyms

| | |
|---|---|
| ACCWP | Alameda Countywide Clean Water Program |
| AFDM | ash-free dry mass |
| A-IBI | Algal Index of Biological Integrity |
| BASMAA | Bay Area Stormwater Management Agencies Association |
| B-IBI | Benthic Index of Biological Integrity |
| BMI | Benthic Macroinvertebrate |
| BMP | Best management practice |
| CCC | Criterion Continuous Concentration (CCC) |
| CCCWP | Contra Costa Clean Water Program |
| CDFW | California Department of Fish and Wildlife |
| CMC | Criteria Maximum Concentration |
| CTR | California Toxics Rule |
| DO | Dissolved Oxygen |
| DQO | Data Quality Objective |
| DW | Dry Weight |
| EDD | Electronic Data Deliverable |
| FSURMP | Fairfield Suisun Urban Runoff Management Program |
| GIS | Geographic Information System |
| GRTS | Generalized Random Tessellated Stratified |
| IBI | Index of Biological Integrity |
| IMR | Integrated Monitoring Report |
| LC50 | Lethal Concentration to 50% of test organisms |
| LIMS | Laboratory Information Management System |
| MCL | Maximum Contaminant Level |
| MDL | Method Detection Limit |
| MPC | BASMAA Monitoring and Pollutants of Concern Committee |
| MQO | Measurement Quality Objective |
| MRP | Municipal Regional Permit |
| MS | Matrix Spike |
| MSD | Matrix Spike Duplicate |
| ND | Non-Detect Data |
| NorCal B-IBI | Northern California Benthic Index of Biological Integrity |
| NPDES | National Pollutant Discharge Elimination System |
| NT | Non-Target |
| PAH | Polycyclic aromatic hydrocarbon |
| PEC | Probable Effect Concentration |
| PHab | Physical Habitat Assessment |
| POC | Pollutant of Concern |
| PRM | Pathogen-Related Mortality |
| PSA | Perennial Streams Assessment |
| QA | Quality Assurance |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| RL | Reporting Limit |

| | |
|---|---|
| RMC | Regional Monitoring Coalition |
| RMP | Regional Monitoring Program |
| RPD | Relative Percent Difference |
| RWB | Reach-Wide Benthos |
| SCCWRP | Southern California Coastal Water Research Project |
| SCVURPPP | Santa Clara Valley Urban Runoff Pollution Prevention Program |
| SF Bay Water Board | San Francisco Bay Regional Water Quality Control Board |
| SMC | Southern California Stormwater Monitoring Coalition |
| SMCWPPP | San Mateo Countywide Water Pollution Prevention Program |
| SoCal | Southern California |
| SoCal B-IBI | Southern California Benthic Index of Biological Integrity |
| SOP | Standard Operating Procedure |
| SSID | Stressor/Source Identification |
| STLS | Small Tributaries Loading Strategy |
| SWAMP | Surface Water Ambient Monitoring Program |
| TEC | Threshold Effect Concentration |
| TKN | Total Kjeldahl Nitrogen |
| TNS | Target Not Sampled Samplable (or change on pg 14) |
| TOC | Total Organic Carbon |
| TS | Target Sampled Samplable (or change on pg 14) |
| TU | Toxicity Unit |
| U | Unknown |
| USEPA | U.S. Environmental Protection Agency |
| WQ | Water Quality |
| WY | Water Year |

# Table of Contents

1.0 Introduction ..... 1
2.0 Study Area & Monitoring Design ..... 5
2.1 RMC Area ..... 5
2.2 Regional Monitoring Design ..... 5
2.2.1 Site Selection ..... 5
2.2.2 Management Questions ..... 12
2.3 Monitoring Design Implementation ..... 13
3.0 Monitoring Methods ..... 14
3.1 Site Evaluation ..... 14
3.2 Field Data Collection Methods ..... 16
3.2.1 Bioassessments ..... 17
3.2.2 Physico-chemical Measurements ..... 18
3.2.3 Chlorine ..... 18
3.2.4 Nutrients and Conventional Analytes ..... 19
3.2.5 Water Toxicity ..... 19
3.2.6 Sediment Chemistry & Sediment Toxicity ..... 19
3.3 Laboratory Analysis Methods ..... 19
3.4 Data Analysis ..... 20
3.4.1 Biological Condition ..... 20
3.4.2 Physical Habitat Condition ..... 24
3.4.3 Water and Sediment Chemistry and Toxicity ..... 24
3.5 Quality Assurance & Control ..... 24
4.0 Results & Discussion ..... 26
4.1 Statement of Data Quality ..... 26
4.1.1 Bioassessment ..... 26
4.1.2 Sediment Chemistry ..... 26
4.1.3 Water Chemistry ..... 27
4.1.4 Sediment Toxicity ..... 27
4.1.5 Water Toxicity ..... 27
4.2 Condition Assessment ..... 27
4.3 Stressor Assessment ..... 37
4.3.1 Stressor Indicators ..... 37
4.3.2 Stressor Analysis ..... 49
5.0 Conclusions and Next Steps ..... 68
5.1 Summary of Stressor Analyses ..... 68
5.2 Next Steps ..... 69
6.0 References ..... 70

## List of Tables

Table 1-1. Regional Monitoring Collaboration participants ..... 2
Table 1-2. Municipal Regional Permit Provisions addressed by the Integrated Monitoring Report..... 3
Table 1-3. Creek Status Monitoring parameters sampled in compliance with MRP Provision C.8.c. and the associated reporting format. A subset of regional parameters is reported jointly for Water Years 2012 and 2013 in this report ..... 3
Table 1-4. Index to Standard Report Content per MRP Provision C.8.g.vi ..... 4
Table 2-1. Parameters sampled at sites from the RMC Probabilistic Monitoring Design in Water Year 2012 by sampling agency. Water toxicity sampled on 3/17/12 and 7/25/12; sediment toxicity and chemistry sampled on 7/25/12. FSURMP and Vallejo did not initiate RMC monitoring activities until WY 2013 ..... 9
Table 2-2. Parameters sampled at sites from the RMC Probabilistic Monitoring Design in Water Year 2013 by sampling agency. Wet season water toxicity was sampled on 3/5/13 and 3/6/13 (ACCWP), 3/6/13 and 4/4/13 (CCCWP), and 3/20/13 (FSURMP and Vallejo). Dry-season water toxicity was sampled on 7/9/13 (ACCWP and CCCWP), 7/11/13 (FSURMP and Vallejo). Sediment toxicity and chemistry and dry-season chlorine were sampled 7/9/13 (ACCWP and CCCWP), 7/11/13 (FSURMP), and 7/18/13 (Vallejo) ..... 10
Table 2-3. Cumulative numbers of planned bioassessment samples per monitoring year according to RMC design ..... 12
Table 2-4. Number of Bioassessment sites sampled by contributing Programs in Water Years 2012 and 2013 by land use and county ..... 13
Table 3-1. RMC Standard Operating Procedures (SOPs) pertaining to regional creek status monitoring . 16
Table 3-2. Condition categories for Southern California B-IBI scores for BMI taxonomy data……21
Table 3-3. Condition categories for Central Coast A-IBI scores for algae taxonomy data……23
Table 3-4. Metrics used in evaluating algae taxonomy data.....22
Table 4-1. RMC creeks and associated designated beneficial uses listed in the San Francisco Bay Region Basin Plan (SF RWQCB 2013). ..... 28
Table 4-2. Benthic macroinvertebrate metrics and B-IBI scores for Solano County bioassessment samples collected in Water Year 2013 (all urban). ..... 34
Table 4-3. A-IBI scores and associated metrics for Solano County bioassessment sites sampled in Water Year 2013 ..... 35
Table 4-4. Additional algae metrics for Solano County bioassessment sites sampled in Water Year 2013……36
Table 4-5. Physical habitat scores for Solano County bioassessment sites sampled in Water Year 2013……37
Table 1-6. Descriptive statistics for water chemistry results collected at RMC sites during Water Years 2012 and 2013. Results include two years of monitoring for ACCWP and CCCWP and one year (2013) for FSURMP and Vallejo……38
Table 4-7. Calculation of mean concentration of water chemistry parameters using MDL- vs. MRL-based substitutions for non-detects……39
Table 4-8. Summary of WY 2012 and WY 2013 wet-season water toxicity results for four-species tests. Shaded cells indicate monitoring conducted in WY 2012 ..... 41
Table 4-9. Comparison between laboratory control and receiving water sample toxicity results (*H. azteca* and *C. dubia*) for RMC samples collected in WY 2012 and WY 2013 wet season, in the context of MRP trigger criteria ..... 42

Table 4-10. Summary of WY 2013 wet-season water toxicity testing conducted as retests of 2012 results ..... 42
Table 4-11. Comparison between laboratory control and receiving water sample toxicity results (*H. azteca)* for RMC samples retested in WY 2013 wet season, in the context of MRP trigger criteria ..... 42
Table 4-12. Comparison between laboratory control and receiving water sample toxicity results for *P. promelas* for RMC samples collected in the WY 2012 and WY 2013 wet seasons, in the context of MRP trigger criteria. Shaded cells indicate monitoring conducted in WY 2012 ..... 43
Table 4-13. Summary of WY 2012 and WY 2013 dry-season aquatic toxicity results ..... 44
Table 4-14. Comparison between laboratory control and receiving water sample toxicity results (*C. dubia* and *H. azteca)* for RMC samples collected in WY 2012 and WY 2013 dry seasons and reported as toxic, in the context of MRP trigger criteria ..... 44
Table 4-15. Comparison between laboratory control and receiving water sample toxicity results for *P. promelas* for RMC samples identified as toxic collected in the WY 2012 and WY 2013 dry seasons, in the context of MRP trigger criteria ..... 45
Table 4-16. Summary of WY 2012 and WY 2013 dry-season sediment toxicity results. Shaded cells indicate monitoring conducted in WY 2012 ..... 46
Table 4-17. Detailed sediment toxicity results for dry-season samples exhibiting significant toxicity to *H. azteca.* Shaded cells indicate sampling conducted in WY 2012 ..... 46
Table 4-18. Descriptive statistics for WY 2012 and WY 2013 sediment chemistry results[1] ..... 48
Table 4-19. Water quality thresholds available for comparison to Water Year 2012 and 2013 water chemistry constituents ..... 50
Table 4-20. Comparison of water quality (nutrient) data to associated water quality thresholds for WY 2012 and WY 2013 water chemistry results. (NDs estimated as ½ MDL). Shaded cells indicates monitoring conducted in WY 2012 ..... 51
Table 4-21. Summary of chlorine testing results for samples collected in WY 2012 and WY 2013 in comparison to Municipal Regional Permit trigger criteria. Shaded cells represent data collected in WY 2012 ..... 55
Table 4-22. Overall summary of 2012 aquatic and sediment toxicity samples with toxic response in comparison to Municipal Regional Permit trigger criteria ..... 57
Table 4-23. Overall summary of WY 2013 aquatic toxicity retests triggered by WY 2012 MRP toxicity trigger criteria ..... 57
Table 4-24. Overall summary of 2013 toxicity results in comparison to Municipal Regional Permit trigger criteria. ..... 58
Table 4-25. Threshold Effect Concentration (TEC) quotients for 2012 and 2013 sediment chemistry constituents ..... 60
Table 4-26. Probable Effect Concentration (PEC) quotients for WY 2012 and WY 2013 sediment chemistry constituents. Yellow highlighted cells indicate sites where mean PEC quotient $\geq$ 0.5 (trigger threshold per MRP Table H-1); bolded values indicate individual PEC quotients > 1.0 ..... 60
Table 4-27. Calculated pyrethroid toxic unit equivalents, 2012 and 2013 sediment chemistry data. Yellow highlighted cells indicate sites where the sum of the pyrethroid TU equivalents is $\geq$ 1.0; bolded values indicate individual pyrethroid TUs > 1.0. ..... 64
Table 4-28. Summary of sediment quality triad evaluation results, WY 2012 (shaded cells) and WY 2013 data. Yellow highlighted cells indicate results above MRP trigger threshold.....67

## List of Figures

Figure 2-1. BASMAA RMC area, creeks included in the RMC probabilistic monitoring design, and the sites sampled in Water Years 2012 and 2013 by the Programs contributing to this report. ..... 7
Figure 2-2. Solano County sites sampled from the RMC probabilistic monitoring design by FSURMP and Vallejo in WY 2013. ..... 8
Figure 3-1. Results of RMC Site Evaluations for Water Year 2012. ..... 15
Figure 3-2. Results of RMC Site Evaluations for Water Year 2013..... 15
Figure 4-1. Benthic macroinvertebrate metric values derived from RMC sites sampled in Water Year 2012. Statistics include minimum (lower whisker), maximum (upper whisker), 25th percentile (lower box), median (box midline) and 75th percentile (upper box)..... 32
Figure 4-2. Benthic macroinvertebrate metric values derived from Solano County sites sampled in Water Year 2013. Statistics include minimum (lower whisker), maximum (upper whisker), 25th percentile (lower box), median (box midline) and 75th percentile (upper box). ..... 33
Figure 4-3. Dominant diatom taxa sampled at RMC sites in Water Year 2012. Green-hued sections indicate sensitive species intolerant to pollutants; orange-hued sections indicate species more tolerant of pollutants, including fine sediment (Blinn and Herbst, 2003; Herbst and Blinn, 2008). ..... 35
Figure 4-4. Plot of unionized ammonia (calculated from total ammonia, pH, temperature, and electrical conductivity) with threshold indicated, WY 2012 and WY 2013 data ..... 53
Figure 4-5. Plot of chloride with Aquatic Life and MUN thresholds indicated, WY 2012 and WY 2013 data ..... 53
Figure 4-6. Plot of nitrate and nitrite as N, WY 2012 and WY 2013 data (threshold not shown = 10 mg/L for MUN only) ..... 54
Figure 4-7. Plot of mean PEC quotient per site, WY 2012 and WY 2013 data.....65
Figure 4-8. Plot of the sum of pyrethroid toxic unit equivalents per site, WY 2012 and WY 2013 data…65

## Executive Summary

The Integrated Monitoring Report (IMR) Part A reports monitoring data collected through implementation of the Regional Monitoring Coalition (RMC) during Water Years (WYs) 2012 (October 1, 2011, through September 30, 2012) and 2013 (October 1, 2012, through September 30, 2013). This Appendix A.1 presents the results for portions of creek status monitoring conducted by a subset of the RMC programs for data collected using a probabilistic monitoring design used by all RMC participants. The RMC was formed by members of the Bay Area Stormwater Management Agencies Association (BASMAA) to assist member agencies in fulfilling requirements of Provision C.8 of the Municipal Regional Stormwater National Pollutant Discharge Elimination System Permit. Certain creek status monitoring parameters were addressed on a regional basis using the probabilistic design and are included in this report for the four Programs contributing to its development (ACCWP, CCCWP, FSURMP, and Vallejo).

Other parameters were addressed using a targeted design, with regional coordination and common methodologies. These parameters are reported in separate appendices or portions of the IMR Part A prepared individually by each RMC participating program.

During Water Year 2012, 60 sites were monitored by all RMC member agencies under the probabilistic design for bioassessment, physical habitat, and related water chemistry parameters, including 30 by two programs contributing to this joint report (ACCWP and CCCWP). Ten of the 60 sites were also monitored for water and sediment toxicity and sediment chemistry. During Water Year 2013, an additional 70 sites were monitored by all RMC member agencies, including 40 by the four contributing programs. Of these 40 sites, 10 were monitored for water and sediment toxicity and sediment chemistry, with an additional two sites monitored for water and sediment toxicity and/or sediment chemistry, but not bioassessment.

The water and sediment chemistry and toxicity data were used to evaluate potential stressors that may affect aquatic habitat quality and beneficial uses. Each program also used bioassessment and related data to develop a preliminary condition assessment for the monitored sites, to be used in conjunction with the stressor assessment based on sediment chemistry and toxicity. The probabilistic design requires at least three years to produce sufficient data to develop a statistically-robust characterization of regional creek conditions, so the analysis and interpretation that can be completed with the first two years of data are necessarily limited.

The following MRP reporting requirements (per Provision C.8.g.iv) are addressed in this report or other portions of the IMR, as applicable:

- Descriptions of monitoring purpose and study design rationale.
- QA/QC summaries for sample collection and analytical methods, including a discussion of any limitations of the data.
- Descriptions of sampling protocols and analytical methods.
- Tables and figures describing Sample location descriptions (including water body names and latitudes and longitudes); sample ID, collection date (and time where relevant), and media (e.g., water, filtered water, bed sediment, tissue); concentrations detected; measurement units; and detection limits.
- Data assessment, analysis, and interpretation for Provision C.8.c.

- Pollutant load and concentration at each mass emissions station.
- A listing of volunteer and other non-Permittee entities whose data are included in the report.
- Assessment of compliance with applicable water quality standards.
- A signed certification statement.

The stressor analysis revealed the following potential stressors, based on an analysis of the first two years of RMC data for ACCWP and CCCWP, and the initial year of monitoring data for FSURMP and Vallejo.

- **Nutrients (and Conventional Constituents):** The MRP Table 8.1 trigger criterion for "Nutrients" (20% of results in one water body exceed one or more water quality standards or applicable thresholds) was considered to be exceeded at only three of the 68 monitoring sites.
- **Water Toxicity:** Of the 10 wet and dry season samples collected in 2012, not including retests, three water samples exhibited results "<50% of Control" and therefore were resampled and retested in Water Year 2013, per MRP Table 8.1. Following the retesting, two of the sites again exhibited significant toxicity at levels meeting MRP Table 8.1 trigger criteria.

  In 2013, 2 of 14 samples collected in wet and dry season exhibited results meeting MRP Table 8.1 trigger criteria.
- **Sediment Toxicity:** Of the 12 samples collected cumulatively in Water Years 2012 and 2013, sediment toxicity results were more than 20% less than the control[1] in 5 samples, meeting the MRP Table 8.1 trigger criterion.
- **Sediment Chemistry:** Sediment chemistry results produced evidence of potential stressors in three ways, based on the criteria from MRP Table H-1:
  - At 10 of 12 sites, three or more constituents had TEC quotients greater than or equal to 1.0.
  - At 1 of 12 sites, the mean PEC quotient was greater than 0.5.
  - At 8 of 12 sites, the sum of TU equivalents for all measured pyrethroids was greater than 1.0.

The results of the above analyses are used in conjunction with related bioassessment data and condition assessments to address the management questions underlying the RMC design. The trigger analysis identified a number of sites that may deserve further investigation to provide better understanding of the sources/stressors likely contributing to reduced ecological condition in Bay Area creeks.

[1] See body of report for RMC interpretation of MRP trigger criteria.

# 1.0 Introduction

This report fulfills a portion of the reporting requirements of Provision C.8.g.v of the Bay Area Municipal Regional Stormwater National Pollutant Discharge Elimination System Permit (MRP; SF RWQCB, 2009) for creek status monitoring data produced pursuant to MRP Provision C.8.c during Water Years 2012 and 2013 (October 1, 2011 - September 30, 2013) under a regional probabilistic design. The regional probabilistic design was developed and implemented by the Regional Monitoring Coalition (RMC) of the Bay Area Stormwater Management Agencies Association (BASMAA). Provision C.8.c monitoring data collected by CCCWP at targeted sites (not included in the probabilistic design) are reported in Appendix A.2.

The RMC was formed in early 2010 as a collaborative among several BASMAA members and all MRP Permittees (Table 1-1) to focus on development and implementation of a regionally-coordinated water quality monitoring program. The intent of the regional monitoring effort is to improve stormwater management in the region and address water quality monitoring required by the MRP[2]. Through its implementation, the RMC allows Permittees and the San Francisco Bay Regional Water Quality Control Board (SF Bay Water Board) to effectively modify their previous creek monitoring programs and improve their collective ability to answer core management questions in a cost-effective and scientifically rigorous way. Participation in the RMC is coordinated by county stormwater programs and/or Permittee representatives (or equivalent), and facilitated through the BASMAA Monitoring and Pollutants of Concern Committee (MPC). The RMC Work Group is a subgroup of the MPC that meets and communicates regularly to coordinate planning and implementation of monitoring-related activities. This workgroup includes staff from the SF Bay Water Board at two levels – those generally engaged with the MRP as well as those working regionally with the State of California's Surface Water Ambient Monitoring Program (SWAMP).

[2] The San Francisco Bay Regional Water Quality Control Board (SF Bay Water Board) issued the five-year MRP to 76 cities, counties, and flood control districts (i.e., Permittees) in the Bay Area on October 14, 2009 (SF Bay Water Board, 2009). The BASMAA programs supporting MRP Regional Projects include all MRP Permittees as well as the cities of Antioch, Brentwood, and Oakley, which are not named as Permittees under the MRP but have voluntarily elected to participate in MRP-related regional activities. Note that the RMC regional monitoring design was expanded to include the portion of eastern Contra Costa County that drains to the San Francisco Bay in order to assist the CCCWP in fulfilling parallel provisions in their NPDES permit from the Region 5 SF Bay Water Board.

**Table 1-1. Regional Monitoring Collaboration 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 Water Agency |
| 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 and towns of Belmont, Brisbane, Burlingame, Daly City, East Palo Alto, Foster City, Half Moon Bay, Menlo Park, Millbrae, Pacifica, Redwood City, San Bruno, San Carlos, San Mateo, South San Francisco, Atherton, Colma, Hillsborough, Portola Valley, and Woodside; San Mateo County Flood Control District; and San Mateo County |
| Fairfield-Suisun Urban Runoff Management Program (FSURMP) | Cities of Fairfield and Suisun City |
| Vallejo Permittees | City of Vallejo and Vallejo Sanitation and Flood Control District |

The goals of the RMC are to:

1. Assist Permittees[3] in complying with requirements in MRP Provision C.8 (Water Quality Monitoring).
2. Develop and implement regionally consistent creek monitoring approaches and designs in the San Francisco Bay Area, through improved coordination among RMC participants, SF Bay Water Board[4] and other agencies with common goals.
3. Stabilize the costs of creek monitoring by reducing duplication of effort and streamlining monitoring-related activities.

The RMC addresses the scope of subprovisions specified in MRP Provision C.8 (Table 1-2). This report is a joint product developed by four of the RMC programs (ACCWP, CCCWP, FSURMP, and Vallejo) to present and discuss some of the results of Creek Status Monitoring that were conducted using a regional ambient (probabilistic) monitoring design to comply with Provision C.8.c (Table 1-3). The list of parameters in Table 1-3 derive from the MRP Table 8-1 (SF Bay Water Board, 2009; BASMAA, 2014a, 2014b).

[3] For the CCCWP this includes addressing the eastern portion of Contra Costa County that drains to the San Francisco Bay that is within the jurisdiction of the Region 5 Regional Water Quality Control Board.

[4] The intent is to coordinate with SF Bay Water Board staff working regionally with the State of California's Surface Water Ambient Monitoring Program (SWAMP).

**Table 1-2. Municipal Regional Permit Provisions addressed by the Integrated Monitoring Report**

| Subprovision | Subprovision Title | Reporting Document |
|---|---|---|
| C.8.a | Compliance Options | • Regional Monitoring Coalition Creek Status & Long-Term Trends Monitoring Plan (BASMAA, 2011) |
| C.8.b | San Francisco Bay Estuary Monitoring | • Regional Monitoring Program Annual Monitoring Results (www.sfei/rmp.org) |
| **C.8.c** | **Creek Status Monitoring** | • Integrated Monitoring Report, Part A (main body)<br>• IMR Part A, Appendices (see index of Appendices in main body) |
| C.8.d | Monitoring Projects | See index of Appendices in main body of IMR Part A, if applicable |
| | • Stressor/Source Identification (SSID) | • SSID Reports (if applicable) |
| | • BMP Effectiveness Investigation | • BMP Effectiveness Reports (if applicable) |
| | • Geomorphic Project | • Geomorphic Project Report (if applicable) |
| C.8.e | Pollutants of Concern (Loads) and Long-Term Trends Monitoring | • Pollutants of concern (POC) loads monitoring data progress report, Water Years 2012 and 2013 (see index of Appendices in main body) |
| C.8.f | Citizen Monitoring and Participation | • Integrated Monitoring Report, Part A (main body) |
| C.8.g | Data Analysis and Reporting | • Integrated Monitoring Report, Part A (main body)<br>• IMR Part A, Appendices (see index of Appendices in main body) |

**Table 1-3. Creek Status Monitoring parameters sampled in compliance with MRP Provision C.8.c. and the associated reporting format. A subset of regional parameters is reported jointly for Water Years 2012 and 2013 in this report.**

| Biological Response and Stressor Indicators | Monitoring Design | | Reporting | |
|---|---|---|---|---|
| | Regional Ambient (Probabilistic) | Local (Targeted) | Regional WY 2012 (Joint WY 2013) | Local |
| Bioassessment & Physical Habitat Assessment | X | | X | (WY 2013) |
| Chlorine | X | | X (X) | |
| Nutrients | X | | X (X) | |
| Water Toxicity | X | | X (X) | |
| Sediment Toxicity | X | | X (X) | |
| Sediment Chemistry | X | | X (X) | |
| General Water Quality | | X | | X |
| Temperature | | X | | X |
| Bacteria | | X | | X |
| Stream Survey | | X | | X |

Data presented in this report were collected between October 1, 2011, and September 30, 2013, referred to hereafter as Water Years 2012 and 2013.

Prior to formation of the RMC, San Francisco Bay Area stormwater programs implemented monitoring designs that targeted creek reaches of interest to address site-specific management questions. Because the representativeness of such targeted data was unknown, the overall condition of all creek reaches in the Bay Area was also unknown. The RMC addressed this issue by augmenting targeted monitoring designs with an ambient (probabilistic) creek status design that integrates many elements of the individualized monitoring programs that currently exist in the region.

The probabilistic monitoring design described in subsequent sections of this report complies with MRP Provision C.8.c[5] by addressing the core monitoring questions listed below, which are further elaborated upon later in this report and in the main IMR. This monitoring design allow each individual RMC participating program to assess stream ecosystem conditions within its program area (e.g., county boundary) while contributing data to answer regional management questions about water quality and beneficial use condition in San Francisco Bay Area creeks.

1. What is the condition of aquatic life in creeks in the San Francisco Bay Area; are water quality objectives met and are beneficial uses supported?
2. What are the major stressors[6] to aquatic life?
3. What are the long-term trends in water quality in creeks over time?

The remainder of this report addresses Study Area and Monitoring Design (Section 2.0), data collection and analysis methods (Section 3.0), results and data interpretation (Section 4.0), and conclusions and next steps (Section 5.0). More specifically, this report includes the standard report content as required by MRP Provision C.8.g.v in the respective sections referenced in Table 1-4. Additional details or discussion may also be found in other Appendices or in the main IMR Part A.

**Table 1-4. Index to Standard Report Content per MRP Provision C.8.g.vi**

| Report Section | Standard Report Content |
|---|---|
| 2.0 | Monitoring purpose and study design rationale |
| 3.0 | Sampling protocols and analytical methods |
| 3.5 | QA/QC summaries for sample collection and analytical methods |
| 2.1 | Sample location descriptions, sample dates, IDs |
| 4.0 | Sample concentrations detected, measurement units, detection limits |
| 4.0 | Data assessment, analysis and interpretation |
| See Main IMR Part A[7] | List of volunteer and other non-Permittee entities whose data are included in the report |
| 5.0 | Assessment of compliance with applicable water quality standards |

[5] The MRP states that Provision C.8.c status monitoring is intended to answer the following questions: “Are water quality objectives, both numeric and narrative, being met in local receiving waters, including creeks, rivers and tributaries?” “Are conditions in local receiving waters supportive of or likely to be supportive of beneficial uses?” The management questions described in this plan are intended to answer the questions posed in the MRP.

[6] Stressors are interpreted per MRP Table 8-1 (SF Bay Water Board, 2009) as results that “trigger” action based upon comparison with an identified threshold.

[7] Data collected by the SF Bay Water Board are not included in this report.

# 2.0 Study Area & Monitoring Design

## 2.1 RMC Area

Status and trends monitoring was conducted in non-tidally influenced, flowing water bodies (i.e., creeks, streams and rivers) interspersed among 3,407 square miles of land in the RMC area. The water bodies monitored were drawn from a master list that included all perennial and non-perennial creeks and rivers that run through urban and non-urban areas within the portions of the five participating counties that fall within the SF Bay Water Board boundary, and the eastern portion of Contra Costa County that drains to the Central Valley Regional Board (Figure 2-1). A total of 60 sites were sampled in 2012 by RMC participants, with another 70 sites sampled in 2013. Of these, data from 30 sites monitored in 2012 (Table 2-1) and 40 sites in 2013 (Table 2-2) by the four contributing programs are included within the analysis for this report.

## 2.2 Regional Monitoring Design

In 2011, the RMC developed a regional probabilistic monitoring design to identify ambient conditions of creeks in the five main counties subject to the requirements of the MRP (SF Bay Water Board, 2009). The regional design was developed using the Generalized Random Tessellation Stratified (GRTS) approach developed by the U.S. Environmental Protection Agency (USEPA) and Oregon State University (Stevens and Olson, 2004). GRTS offers multiple benefits for coordinating amongst monitoring entities including the ability to develop a spatially balanced design that produces statistically representative data with known confidence intervals. The GRTS approach has been implemented recently in California by several agencies including the statewide Perennial Streams Assessment (PSA) conducted by SWAMP (Ode et al., 2011) and the Southern California Stormwater Monitoring Coalition's (SMC's) regional monitoring program conducted by municipal stormwater programs in Southern California (SMC, 2007). For the purpose of developing the RMC's probabilistic design, the RMC area is considered to represent the "sample universe."

### 2.2.1 Site Selection

Sample sites were selected and attributed using the GRTS approach from a sample frame consisting of a creek network geographic information system (GIS) data set within the RMC boundary[8] (BASMAA, 2011). This approach was agreed to by SF Bay Water Board staff during RMC meetings although it differs from that specified in MRP Provision C.8.c.iv., e.g., sampling on the basis of individual watersheds in rotation and selecting sites to characterize segments of a water body (or water bodies). The sample frame includes non-tidally influenced perennial and non-perennial creeks within five management units representing areas managed by the storm water programs associated with the RMC. The sample frame was stratified by management unit to ensure that MRP Provision C.8.c sample size requirements (SF Bay Water Board, 2009) would be achieved.

The National Hydrography Dataset Plus (1:100,000) was selected as the creek network data layer to provide consistency with both the Statewide PSA and the SMC, and the opportunity for future data coordination with these programs. The RMC sample frame was classified by county and land use (i.e., urban and non-urban) to allow for comparisons between these strata. Urban areas were delineated by

[8] Based on discussion during RMC meetings, with SF Bay Water Board staff present, the sample frame was extended to include the portion of Eastern Contra Costa County that drains to the San Francisco Bay in order to address parallel provisions in CCCWP's Region 5 Permit for Eastern Contra Costa County. Reporting on data collected for that permit, other than those collected via the RMC, however, is outside the scope of this report.

combining urban area boundaries and city boundaries defined by the U.S. Census (2000). Non-urban areas were defined as the remainder of the areas within the sample universe (i.e., RMC area). Based on discussion during RMC meetings, with SF Bay Water Board staff present, RMC participants weighted their sampling efforts so that annual sampling efforts are approximately 80% in urban areas and 20% in non-urban areas for the purpose of comparison (Figure 2-1). RMC participants coordinated with the SF Bay Water Board by identifying additional non-urban sites from their respective counties for SWAMP sampling.

Solano County participants (FSURMP and Vallejo permitees) were each required to sample four bioassessment sites and one toxicity/chemistry site (water and sediment) in WY 2013 (Figure 2-2). Unfortunately the toxicity/chemistry sites did not overlap with the bioassessment sites, making a triad analysis of stressors impossible. This happened for several reasons:

- FSURMP – Site 207R00236, first on the RMC sample draw, was sampled for wet season water toxicity and was planned to be a bioassessment site. The creek was dry in May, however, and thus bioassessment could not be done. By mid-summer it was running again due to urban irrigation runoff, and was sampled for dry season water toxicity and sediment chemistry and toxicity. Thus this site was monitored for all toxicity and sediment parameters, but not bioassessment.
- Vallejo – Site 207R00064 was sampled for wet and dry season toxicity as well as bioassessment, but upon submission to the analytical laboratory, lab personnel determined that there was insufficient sediment for both toxicity and chemistry tests. Thus sediment was re-sampled at a more suitable site (207R05524) the following week and tested for sediment chemistry and toxicity.

FSURMP and Vallejo began monitoring in WY 2013 and thus only have one year of data to report. All chemistry and toxicity stressor analyses presented here were done in conjunction with the other programs contributing to this report. Bioassessment data are reported for Solano County programs only.

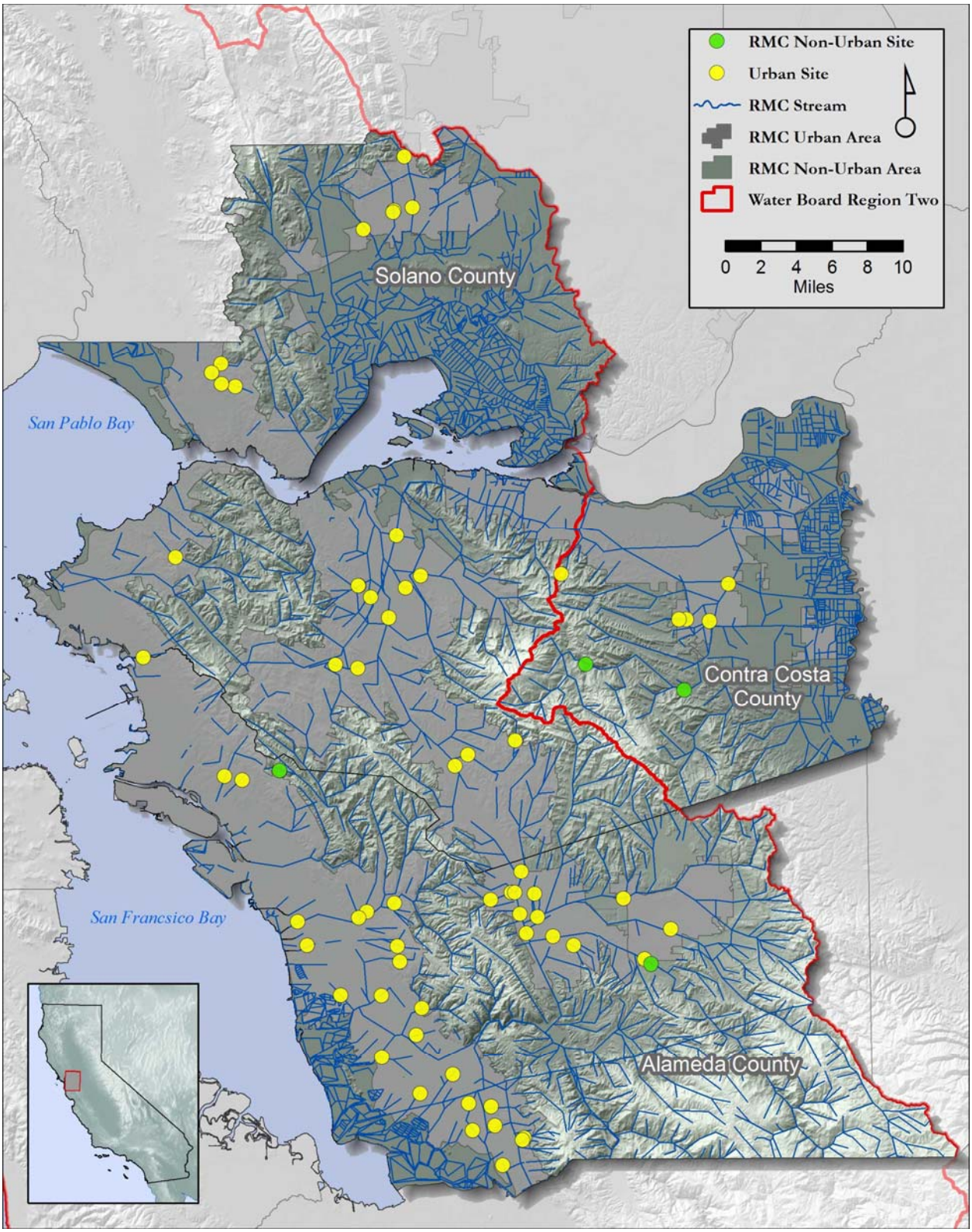


**Figure 2-1. BASMAA RMC area, creeks included in the RMC probabilistic monitoring design, and the sites sampled in Water Years 2012 and 2013 by the programs contributing to this report.**

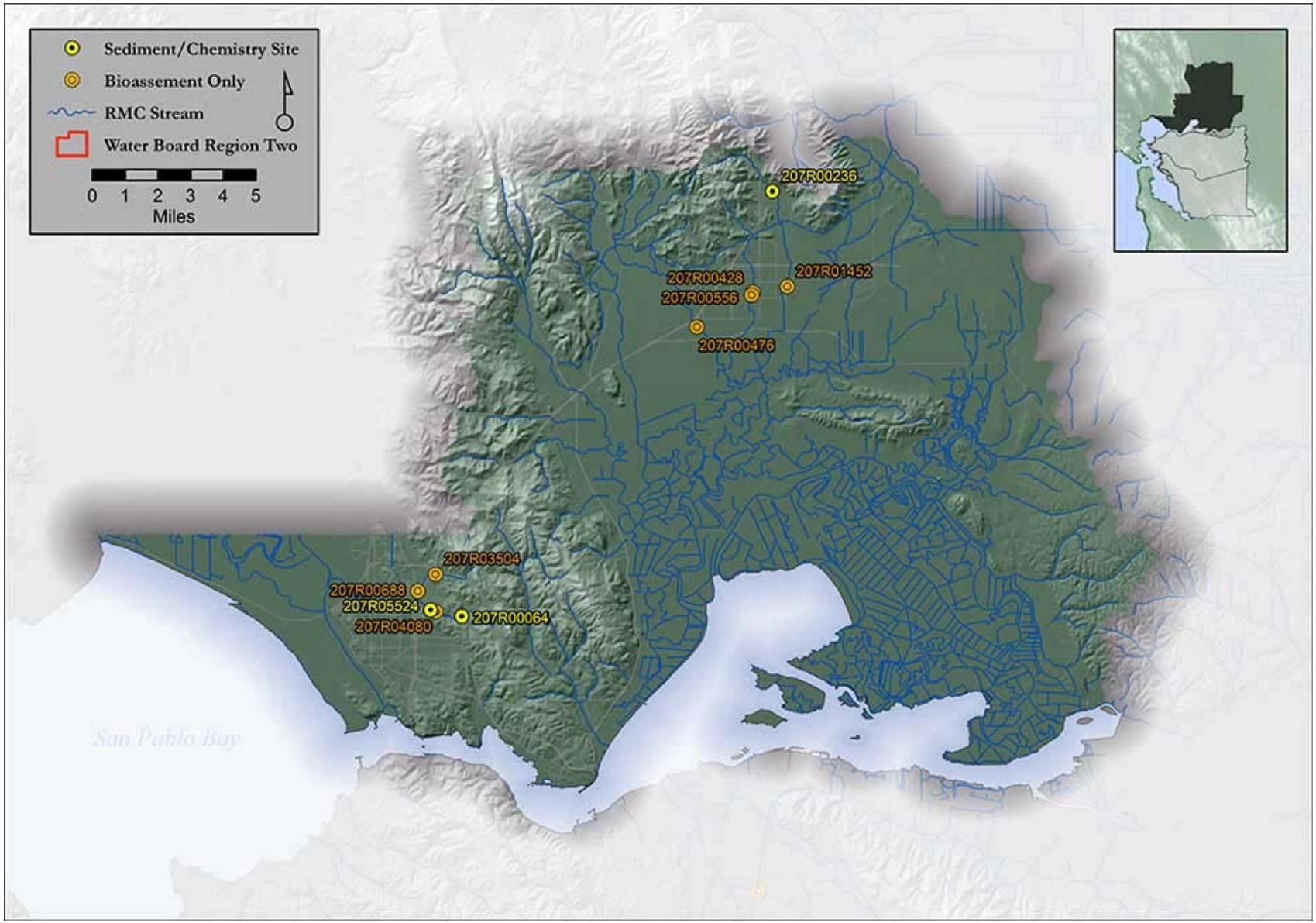


**Figure 2-2. Solano County sites sampled from the RMC probabilistic monitoring design by FSURMP and Vallejo in WY 2013.**

**Table 2-1. Parameters sampled at sites from the RMC Probabilistic Monitoring Design in Water Year 2012 by sampling agency. Water toxicity sampled on 3/17/12 and 7/25/12; sediment toxicity and chemistry sampled on 7/25/12. FSURMP and Vallejo did not initiate RMC monitoring activities until WY 2013.**

| Site ID | Creek Name | Land Use | Latitude | Longitude | Bioassessment, PHab, Chlorine, Nutrients | Water & Sediment Toxicity, Sediment Chemistry | Initial Sampling Date | Sampling Agency |
|---|---|---|---|---|---|---|---|---|
| 204R00047 | Castro Valley Creek | Urban | 37.68826 | -122.07257 | x | x | 6/6/2012 | ACCWP |
| 204R00068 | Collier Channel, Line 7-M | Urban | 37.69908 | -121.80891 | x | | 5/31/2012 | ACCWP |
| 204R00084 | Dublin Creek | Urban | 37.70104 | -121.92542 | x | x | 5/24/2012 | ACCWP |
| 204R00100 | Arroyo Mocho | Urban | 37.68280 | -121.89625 | x | x | 5/30/2012 | ACCWP |
| 204R00191 | Arroyo del Valle | Urban | 37.66584 | -121.87840 | x | | 5/29/2012 | ACCWP |
| 204R00303 | Chabot Creek | Urban | 37.68421 | -122.08200 | x | | 6/14/2012 | ACCWP |
| 204R00319 | Sausal Creek | Urban | 37.79923 | -122.21818 | x | | 6/7/2012 | ACCWP |
| 204R00340 | Big Canyon Creek, Line 7-J-1 | Urban | 37.70218 | -121.92074 | x | | 6/11/2012 | ACCWP |
| 204R00356 | Arroyo de la Laguna | Urban | 37.66873 | -121.90920 | x | | 6/4/2012 | ACCWP |
| 204R00367 | Ward Creek | Urban | 37.65957 | -122.04172 | x | | 6/12/2012 | ACCWP |
| 204R00383 | Sulphur Creek | Urban | 37.65909 | -122.13676 | x | | 6/11/2012 | ACCWP |
| 204R00391 | Line5-M | Urban | 37.58682 | -122.02358 | x | | 6/6/2012 | ACCWP |
| 204R00455 | Zeile Creek | Urban | 37.64676 | -122.03931 | x | | 6/13/2012 | ACCWP |
| 204R00583 | Line 3A-D | Urban | 37.61906 | -122.05928 | x | | 6/13/2012 | ACCWP |
| 204R00596 | Line 7-G-2 | Urban | 37.70094 | -121.90154 | x | | 5/31/2012 | ACCWP |
| 204R00639 | San Lorenzo Creek | Urban | 37.68151 | -122.14437 | x | | 6/19/2012 | ACCWP |
| 204R00647 | Dry Creek | Urban | 37.60965 | -122.01750 | x | | 6/18/2012 | ACCWP |
| 205R00110 | Agua Caliente | Urban | 37.50273 | -121.91225 | x | | 6/18/2012 | ACCWP |
| 205R00430 | Line 6-D | Urban | 37.48229 | -121.93782 | x | | 6/5/2012 | ACCWP |
| 205R00535 | Line 5-F-1 | Urban | 37.53942 | -122.01980 | x | | 6/19/2012 | ACCWP |
| 203R00039 | Cerrito Creek | Urban | 37.89802 | -122.30027 | x | | 5/14/2012 | CCCWP |
| 206R00155 | San Pablo Creek | Urban | 37.92408 | -121.74088 | x | | 5/16/2012 | CCCWP |
| 206R00215 | San Pablo Creek | Urban | 37.95477 | -122.07821 | x | | 5/23/2012 | CCCWP |
| 207R00011 | Grayson Creek | Urban | 37.95485 | -122.07829 | x | x | 5/22/2012 | CCCWP |
| 207R00139 | Las Trampas Creek | Urban | 37.88742 | -122.07995 | x | | 5/17/2012 | CCCWP |
| 207R00247 | Walnut Creek | Urban | 37.92833 | -122.04745 | x | | 5/22/2012 | CCCWP |
| 543R00137 | Deer Creek | Urban | 37.92408 | -121.74807 | x | | 5/15/2012 | CCCWP |
| 543R00219 | Marsh Creek | Nonurban | 37.88654 | -121.84347 | x | | 5/21/2012 | CCCWP |
| 543R00245 | Marsh Creek | Nonurban | 37.86732 | -121.74947 | x | | 5/21/2012 | CCCWP |
| 544R00025 | Dry Creek | Urban | 37.92611 | -121.71722 | x | x | 5/15/2012 | CCCWP |

**Table 2-2. Parameters sampled at sites from the RMC Probabilistic Monitoring Design in Water Year 2013 by sampling agency. Wet season water toxicity was sampled on 3/5/13 and 3/6/13 (ACCWP), 3/6/13 and 4/4/13 (CCCWP), and 3/20/13 (FSURMP and Vallejo). Dry-season water toxicity was sampled on 7/9/13 (ACCWP and CCCWP), 7/11/13 (FSURMP and Vallejo). Sediment toxicity and chemistry and dry-season chlorine were sampled 7/9/13 (ACCWP and CCCWP), 7/11/13 (FSURMP), and 7/18/13 (Vallejo).**

| Site ID | Creek Name | Land Use | Latitude | Longitude | Bioassessment, PHab, Chlorine, Nutrients | Water & Sediment Toxicity, Sediment Chemistry | Initial Sampling Date | Sampling Agency |
|---|---|---|---|---|---|---|---|---|
| 204R00447 | Kottinger Creek | Urban | 37.65844 | -121.86108 | x | x | 4/22/13 | ACCWP |
| 205R00174 | Line 6-K | Urban | 37.52816 | -121.94772 | x | | 4/23/13 | ACCWP |
| 205R00686 | Canada Del Aliso | Urban | 37.51243 | -121.94393 | x | x | 4/24/13 | ACCWP |
| 205R00878 | Zone 5 Line B | Urban | 37.5544 | -121.98651 | x | | 4/24/13 | ACCWP |
| 204R00967 | Crandall Creek | Urban | 37.56895 | -122.05885 | x | | 4/25/13 | ACCWP |
| 204R00852 | Alamo Creek | Urban | 37.71961 | -121.91376 | x | | 5/6/13 | ACCWP |
| 204R00327 | Line 3A-A-3 | Urban | 37.62009 | -122.10072 | x | x | 5/7/13 | ACCWP |
| 204R00334 | Arroyo Valle | Urban | 37.64659 | -121.78812 | x | | 5/8/13 | ACCWP |
| 204R00590 | Arroyo Valle | Nonurban | 37.64266 | -121.78169 | x | | 5/8/13 | ACCWP |
| 204R00473 | Arroyo Mocho | Urban | 37.67085 | -121.76115 | x | | 5/9/13 | ACCWP |
| 205R01134 | Agua Caliente | Urban | 37.50063 | -121.91567 | x | | 5/20/13 | ACCWP |
| 205R01198 | Zone 6 Line G | Urban | 37.50878 | -121.9666 | x | | 5/20/13 | ACCWP |
| 204R00724 | Dublin Creek | Urban | 37.69649 | -121.94548 | x | | 5/21/13 | ACCWP |
| 204R01316 | Arroyo de la Laguna | Urban | 37.68452 | -121.91557 | x | | 5/22/13 | ACCWP |
| 205R01390 | Zone 6 Line G | Urban | 37.53087 | -121.97042 | x | | 5/23/13 | ACCWP |
| 204R00623 | San Lorenzo Creek | Urban | 37.69461 | -122.04478 | x | | 6/3/13 | ACCWP |
| 204R00063 | Peralta Creek | Urban | 37.79651 | -122.19966 | x | | 6/4/13 | ACCWP |
| 204R00751 | Redwood Canyon Creek | Nonurban | 37.80408 | -122.16134 | x | | 6/5/13 | ACCWP |
| 203R00983 | Strawberry Creek | Nonurban | 37.80404 | -122.16136 | x | | 6/6/13 | ACCWP |
| 204R01471 | Arroyo Mocho | Urban | 37.96222 | -121.86892 | x | | 5/22/13 | ACCWP |
| 206R00727 | Pinole Creek | Urban | 37.97913 | -122.26646 | x | | 5/13/13 | CCCWP |
| 207R00271 | Sycamore Creek | Urban | 37.82651 | -121.91876 | x | X | 4/29/13 | CCCWP |
| 207R00375 | Galindo Creek | Urban | 37.96209 | -122.01407 | x | | 5/1/13 | CCCWP |
| 207R00395 | Las Trampas Creek | Urban | 37.89066 | -122.10258 | x | | 5/14/13 | CCCWP |
| 207R00503 | Pine Creek | Urban | 37.95234 | -122.02984 | x | | 5/2/13 | CCCWP |
| 207R00532 | Tributary, Sycamore Creek | Urban | 37.81527 | -121.96726 | x | | 4/29/13 | CCCWP |
| 207R00567 | Walnut Creek | Urban | 37.99528 | -122.03836 | x | | 4/30/13 | CCCWP |
| 207R00631 | Grayson Creek | Urban | 37.94515 | -122.06595 | x | | 5/16/13 | CCCWP |
| 207R00788 | San Ramon Creek | Urban | 37.80643 | -121.98093 | x | | 5/15/13 | CCCWP |
| 544R00281 | Marsh Creek | Urban | 37.95238 | -121.69678 | x | x | 5/15/13 | CCCWP |
| 207R00236 | Laurel Creek | Urban | 38.30557 | -122.02620 | | x | 3/20/2013 | FSURMP |
| 207R00428 | Union Ave. Creek | Urban | 38.26096 | -122.03772 | x | | 5/21/2013 | FSURMP |

| Site ID | Creek Name | Land Use | Latitude | Longitude | Bioassessment, PHab, Chlorine, Nutrients | Water & Sediment Toxicity, Sediment Chemistry | Initial Sampling Date | Sampling Agency |
|---|---|---|---|---|---|---|---|---|
| 207R00476 | Ledgewood Creek | Urban | 38.24580 | -122.06958 | x | | 5/23/2013 | FSURMP |
| 207R00556 | Union Ave. Creek | Urban | 38.25963 | -122.03854 | x | | 5/15/2013 | FSURMP |
| 207R01452 | Laurel Creek | Urban | 38.26325 | -122.01848 | x | | 5/28/2013 | FSURMP |
| 207R00064 | Blue Rock Springs Creek | Urban | 38.11852 | -122.20327 | x | X* | 5/28/2013 | Vallejo |
| 207R03504 | Rindler Creek | Urban | 38.13726 | -122.21778 | x | | 5/29/2013 | Vallejo |
| 207R00688 | Blue Rock Springs Creek | Urban | 38.12988 | -122.22782 | x | | 5/29/2013 | Vallejo |
| 207R04080 | Blue Rock Springs Creek | Urban | 38.12072 | -122.21785 | x | | 5/30/2013 | Vallejo |
| 207R05524 | Blue Rock Springs Creek | Urban | 38.12146 | -122.22083 | | X* | 7/18/2013 | Vallejo |

*After sediment quantity from 207R00064 was found insufficient by the laboratory to conduct sediment chemistry and toxicity testing, a back-up sample was collected at 207R05524.

### 2.2.2 Management Questions

The RMC regional monitoring design was developed to address the management questions listed below. Those appearing in bolded font are addressed in this report in a preliminary manner. Those in normal font could not be addressed at this time due to the limited sample size available from the initial two years of monitoring, but can be answered in future years once sample sizes increase. Table 2-3 illustrates the length of time that would be required to establish statistically representative sample sizes for each of the classified strata in the regional monitoring design, estimated for continuation of the present rate of annual bioassessment sampling.

1. **What is the condition of aquatic life in creeks in the RMC area; are water quality objectives met and are beneficial uses supported?**
    a. What is the condition of aquatic life in the urbanized portion of the RMC area; are water quality objectives met and are beneficial uses supported?
    b. What is the condition of aquatic life in RMC participant counties; are water quality objectives met and are beneficial uses supported?
    c. To what extent does the condition of aquatic life in urban and non-urban creeks differ in the RMC area?
    d. To what extent does the condition of aquatic life in urban and non-urban creeks differ in each of the RMC participating counties?
2. **What are major stressors to aquatic life in the RMC area?**
    a. What are major stressors to aquatic life in the urbanized portion of the RMC area?
3. **What are the long-term trends in water quality in creeks over time?**

**Table 2-3. Cumulative numbers of bioassessment samples per monitoring year according to RMC design; shaded cells indicate when a minimum sample size may be available to develop a statistically representative data set to address management questions related to condition of aquatic life.**

| **Monitoring Year** | **RMC Area** (Region-wide) | | **Santa Clara County** | | **Alameda County** | | **Contra Costa County** | | **San Mateo County** | | **Solano County** [b] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Land Use* | *Urban* | *Non-Urban* | *Urban* | *Non-Urban* | *Urban* | *Non-Urban* | *Urban* | *Non-Urban* | *Urban* | *Non-Urban* | *Urban* | *Non-Urban* |
| Year 1 (WY 2012) | **48** | 22 | 16 | 6 | 16 | 6 | 8 | 4 | 8 | 4 | 0 | 2 |
| Year 2 (WY 2013) | **100** | **44** | **32** | 12 | **32** | 12 | 16 | 8 | 16 | 8 | 8 | 0 |
| Year 3[c] (WY 2014) | **156** | **66** | **48** | 18 | **48** | 18 | 24 | 12 | 24 | 12 | 12 | 6 |
| Year 4 (WY 2015) | **204** | **88** | **64** | 24 | **64** | 24 | **32** | 16 | **32** | 16 | 12 | 8 |
| Year 5 (WY 2016) | **256** | **110** | **80** | **30** | **80** | **30** | **40** | 20 | **40** | 20 | 16 | 10 |

[a] Assumes SF Bay Water Board will continue WY 2012-13 monitoring effort of two non-urban sites annually in each RMC county.
[b] Assumes: FSURMP and Vallejo only monitor urban sites; FSURMP monitors four sites in Years 2, 3 and 5; and Vallejo monitors four sites in Year 2.
[c] Final year of monitoring under the MRP 5-Year Permit.

## 2.3 Monitoring Design Implementation

Sampling was conducted in accordance with the RMC Multi-year Monitoring Plan (BASMAA 2011). The sampling plan (Table 2-3) illustrates the total number of sites that each RMC Permittee[9] plans to sample within the MRP term (SFBRWQCB 2009). It also illustrates the number of sampling years required to establish statistically representative samples for each strata (e.g., management unit and urban or non-urban land use) included in the regional monitoring design. A target of at least 80% of the sites sampled annually by RMC participants are in urban[10] areas with up to 20% in non-urban areas. Due to unforeseen field circumstances, however, this percentage may vary by year. For example, some sites may not be sampleable due to seasonal drying and/or access issues, thereby altering the relative proportion of urban-to-nonurban sites sampled in a given year (Table 2-4). Such outcomes can be addressed in subsequent sampling years by adjusting the relative proportion of urban and non-urban sites, or while conducting regional statistical analyses by adjusting the number of sites considered from each stratum to the desired proportions.

**Table 2-4. Number of bioassessment sites sampled by contributing Programs in Water Years 2012 and 2013 by land use and county**

| Monitoring Year | Alameda County | | Contra Costa County | | FSURMP | | Vallejo | |
|---|---|---|---|---|---|---|---|---|
| *Land Use* | *Urban* | *Non-Urban* | *Urban* | *Non-Urban* | *Urban* | *Non-Urban* | *Urban* | *Non-Urban* |
| WY 2012 | 20 | 0 | 8 | 2 | 0 | 0 | 0 | 0 |
| WY 2013 | 17 | 3 | 10 | 0 | 4 | 0 | 4 | 0 |
| **Total** | **37** | **3** | **18** | **2** | **4** | **0** | **4** | **0** |

[9]The scenario assumes continued SF Bay RWQCB sample effort averaging 2 sites per county as part of the total number of nonurban sites listed.

[10]Some sites classified as urban, using the aforementioned data in a geographic information system, may be considered for reclassification as non-urban based on actual land uses of the drainage area despite location inside municipal jurisdictional boundaries.

# 3.0 Monitoring Methods

This section describes the methods used to evaluate monitoring sites identified in the regional sample draw, consistent with the Southern California Coastal Water Research Project (SCCWRP) Bioassessment Program (SCCWRP, 2012), and to sample field data, consistent with the RMC workplan (BASMAA, 2011), Field parameters sampled included bioassessments (benthic macroinvertebrates [BMIs], algae, and physical habitat), physicochemical measurements (dissolved oxygen, temperature, conductivity, and pH), chlorine, nutrients, water samples for testing water toxicity, and sediment samples for testing sediment toxicity and chemistry.

## 3.1 Site Evaluation

Sites identified in the regional sample draw were evaluated by each RMC participant in chronological order using a two-step process, consistent with that described by SCCWRP[11] (2012). Each site was evaluated to determine if it met the following RMC sampling location criteria:

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

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

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

During WY2012, 126 RMC sites were evaluated for sampling by ACCWP and CCCWP, with FSURMP and Vallejo initiating monitoring activities in WY2013. In WY2013, 271 sites were evaluated for sampling by the four Programs. The outcome of these site evaluations is summarized below for the two years and illustrated by Water Year in Figure 3-1 and Figure 3-2.

[11] Communication with managers for the SMC and the PSA are ongoing to ensure the consistency of site evaluation protocols.
[12] If landowners did not respond to at least two attempts to contact them either by written letter, e-mail, or phone call, permission to access the respective site was effectively considered to be denied.

- **TS** –WY2012: 24% of sites (N=30); WY2013: 15% of sites (N=40) met all the site evaluation criteria for monitoring
- **TNS** – WY2012: 8% of sites (N= 10); WY2013: 18% of sites (N=50) met the sampleable "target" criteria but could not be sampled.
- **NT** – WY2012: 28% of sites (N = 35) ; WY2013: 26% of sites (N=71) did not meet the sampleable "target" criteria and could not be sampled.
- **U** – WY2012: 40% of sites (N = 51) ; WY2013: 41% of sites (N=110) had outstanding unknown characteristics and their sampling target status was unknown

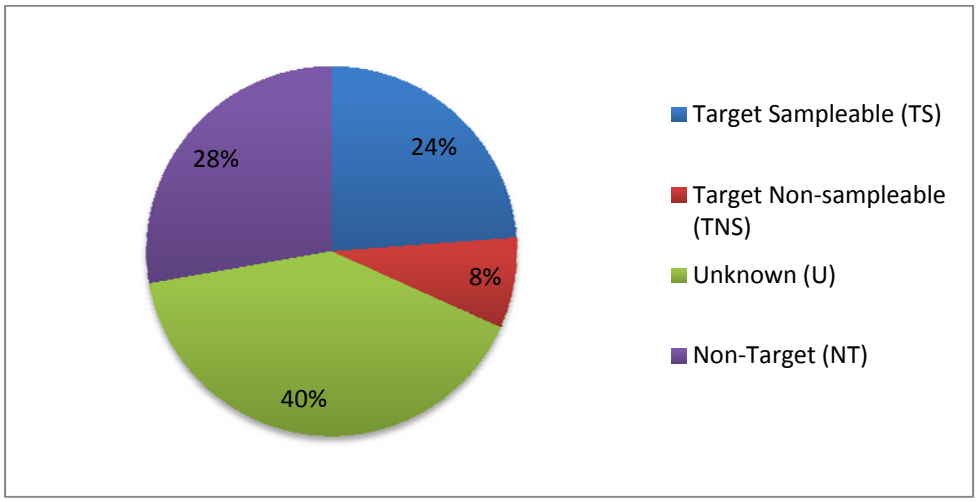


**Figure 3-1. . Results of RMC Site Evaluations for Water Year 2012 for Four Collaborating Programs**

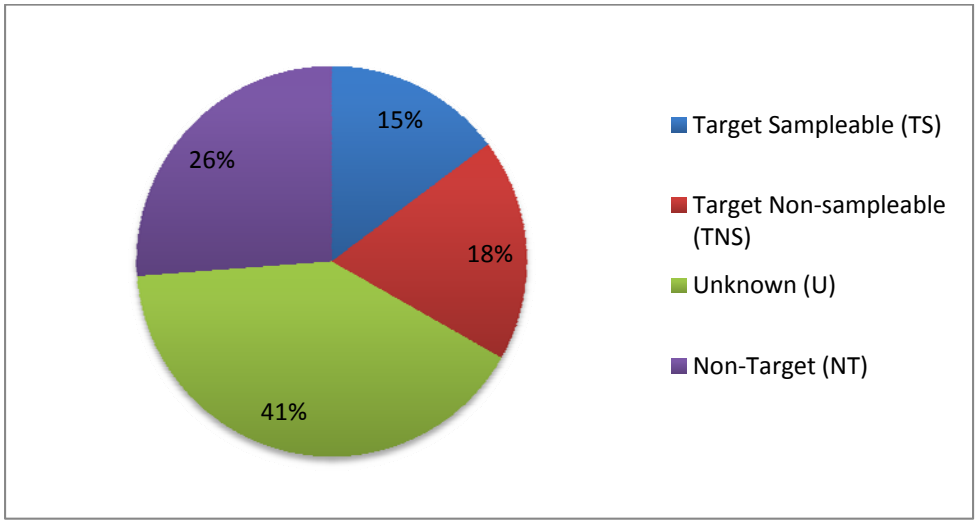


**Figure 3-2. Results of RMC Site Evaluations for Water Year 2013 for Four Collaborating Programs**

During the site evaluation field visits flow status was recorded as one of five categories:

- Wet flowing (continuously wet or nearly so, flowing water);
- Wet Trickle (continuously wet or nearly so, very low flow (trickle, less than 0.1 L/second);
- Majority Wet (discontinuously wet, greater than 25% by length of stream bed covered with water (isolated pools);
- Minority Wet (discontinuously wet, less than 25% of stream bed by length covered with water (isolated pools); or
- No Water (no surface water present).

Observations of flow status occurring during fall site reconnaissance events prior to occurrence of significant precipitation, and spring sampling occurring post- wet weather season were combined to classify sites as perennial or non-perennial as follows:

- **Perennial:** fall flow status either Wet Flowing or Wet Trickle and spring flow sufficient to sample.
- **Non-Perennial:** fall flow status either Majority Wet, Minority Wet, or No Water, and spring flow sufficient to sample.

## 3.2 Field Data Collection Methods

Field data were collected in accordance with existing SWAMP-comparable methods and procedures, as described in the RMC Quality Assurance Project Plan (QAPP) (BASMAA, 2014a) and the associated Standard Operating Procedures (SOPs) (BASMAA, 2014b). As of the writing of this report, initial versions of these documents are in the process of being updated to maintain their currency and optimal applicability.[13] The SOPs were developed using a standard format that describes health and safety cautions and considerations, relevant training, site selection, and sampling methods/procedures, including pre-fieldwork mobilization activities to prepare equipment, sample collection, and de-mobilization activities to preserve and transport samples. The SOPs relevant to the monitoring discussed in this report are listed in Table 3-1.

**Table 3-1. RMC Standard Operating Procedures (SOPs) pertaining to regional creek status monitoring**

| SOP # | SOP |
|---|---|
| FS-1 | BMI and algae bioassessments and physical habitat assessments |
| FS-2 | Water quality sampling for chemical analysis, pathogen indicators, and toxicity testing |
| FS-3 | Field measurements, manual |
| FS-6 | Collection of bedded sediment samples |
| FS-7 | Field equipment cleaning procedures |
| FS-8 | Field equipment decontamination procedures |
| FS-9 | Sample container, handling, and chain-of-custody procedures |
| FS-10 | Completion and processing of field data sheets |
| FS-11 | Site and sample naming convention |
| FS-12 | Ambient Creek Status Monitoring Site Evaluation |
| FS-13 | QA/QC Data Review |

[13] Approval anticipated February 2014.

### 3.2.1 Bioassessments

In accordance with the RMC QAPP (BASMAA, 2014a), bioassessments were conducted during the spring index period (approximately April 15 to July 15) and at a minimum of 30 days after any significant storm (roughly defined as at least 0.5 inch[14] of rainfall within a 24-hour period). During Water Year 2012, the last significant storm occurred April 12–13, 2012. As a result, bioassessments began during the week of May 14, 2012.

In comparison, for Water Year 2013 monitoring there was no region-wide, late season significant precipitation event that required delay of sampling, and bioassessment monitoring was performed during the normal index period. The last significant storm event of the season occurred on April 1 and, for the four programs participating in this report, precipitation exceeded the RMC criterion as defined above for only the northwestern section of Alameda County (i.e., Oakland and north). Monitoring stations were therefore prioritized so that non-affected portions of the four collaborating programs were monitored first, and the affected area of Alameda County was monitored after May 1.

Each bioassessment monitoring site consisted of an approximately 150 m stream reach that was divided into 11 equidistant transects placed perpendicular to the direction of flow. The sampling position within each transect alternated between 25%, 50%, and 75% distance of the wetted width of the stream (see SOP FS-1, BASMAA, 2014b).

**Benthic Macroinvertebrates**

BMIs were collected via kick-net sampling using the Reach-Wide Benthos (RWB) method described in RMC SOP FS-1 (BASMAA, 2014b). Samples were collected from a 1-square-foot area approximately 1 m downstream of each transect. The benthos were disturbed by manually rubbing areas of coarse substrate, followed by disturbing the upper layers of finer substrate to a depth of 4–6 inches to dislodge any remaining invertebrates into the net. Slack water habitat procedures were used at transects with deep and/or slow-moving water (Ode, 2007). Material collected from the 11 subsamples was composited in the field by transferring the entire sample into one to two 1,000 mL wide-mouth jar(s), and the samples were preserved with 95% ethanol. The laboratory then performed taxonomic identification nominally on a minimum of 600 BMI individuals for each sample according to standard taxonomic effort Level 1 as established by the Southwest Association of Freshwater Invertebrate Taxonomists. Three of the eight Solano County sites sampled contained fewer than 600 BMI individuals. One site was particularly low in BMI abundance in addition to being very difficult to analyze due to copious amounts of fine filamentous algae. For this site (207R00476), the sub-sampling procedure was modified to include a sub-sample despite the lack of abundance.

**Algae**

Filamentous algae and diatoms also were collected using the Reach-Wide Benthos (RWB) method described in SOP FS-1 (BASMAA, 2014b). Algae samples were collected synoptically with BMI samples. The sampling position within each transect was the same as used for BMI sampling, except that algae samples were collected six inches upstream of the BMI sampling position and following BMI collection from that location. The algae were collected using a range of methods and equipment, depending on the particular substrate occurring at the site (i.e., erosional, depositional, large and/or immobile, etc) per RMC SOP FS-1. Erosional substrates included any material (substrate or organics) that was small

[14] This number was erroneously reported as 0.25 inch over a 24-hour period in UCMR (BASMAA, 2013).

enough to be removed from the stream bed, but large enough in size to isolate an area equal in size to a rubber delimiter (12.6 $cm^2$ in area). When a sample location along a transect was too deep to sample, a more suitable location was selected, either on the same transect or from one further upstream. Algae samples were collected at each transect prior to moving on to the next transect. Sample material (substrate and water) from all 11 transects was combined in a sample bucket, agitated, and a suspended algae sample was then poured into a 500 mL cylinder, creating a composite sample for the site. A 45 mL subsample was taken from the algae composite sample and combined with 5 mL glutaraldehyde into a 50 mL sample tube for taxonomic identification of soft algae. Similarly, a 40 mL subsample was extracted from the algae composite sample and combined with 10 mL of 10% formalin into a 50 mL sample tube for taxonomic identification of diatoms. Laboratory processing included identification and enumeration of 300 natural units of soft algae and 600 diatom valves to the lowest practical taxonomic level.

The algae composite sample also was used for collection of chlorophyll-a and ash-free dry mass (AFDM) samples following methods described in Fetscher et al. (2009). For the chlorophyll-a sample, 25 mL of the algae composite volume was removed and run through a glass fiber filter (47 mm, 0.7 µm pore size) using a filtering tower apparatus in the field. The AFDM sample was collected using a similar process using pre-combusted filters. Both filter samples were placed in Whirl-Paks, covered in aluminum foil, and immediately placed on ice for transport to the analytical laboratory.

**Physical Habitat**

Physical habitat assessments (PHab) were conducted at each BMI bioassessment sampling event using the PHab protocols described in Ode (2007) (see SOP FS-1, BASMAA, 2014b). Physical habitat data were collected at each of the 11 transects and at 10 additional inter-transects (located between each main transect) by implementing the “Basic” level of effort, with the following additional measurements/assessments as defined in the “Full” level of effort (as prescribed in the MRP): water depth and pebble counts, cobble embeddedness, flow habitat delineation, and instream habitat complexity. At algae sampling locations, additional assessment of presence of micro- and macroalgae was conducted during the pebble counts. In addition, water velocities were measured at a single location in the sample reach (when possible) using protocols described in Ode (2007).

### 3.2.2 Physicochemical Measurements

Dissolved oxygen, temperature, conductivity, and pH were measured during bioassessment sampling using a multi-parameter probe (see SOP FS-3, BASMAA, 2014b). Dissolved oxygen, specific conductivity, water temperature, and pH measurements were made either by direct submersion of the instrument probe into the sample stream. Water quality measurements were taken approximately 0.1 m below the water surface at locations of the stream that appeared to be completely mixed, ideally at the centroid of the stream. Measurements occurred prior to any bed disturbance in the stream.

### 3.2.3 Chlorine

Water samples were collected and analyzed for free and total chlorine using CHEMetrics test kits (K-2511 for low range and K-2504 for high range). Chlorine measurements in water were conducted during bioassessments and during dry season monitoring for sediment chemistry, sediment toxicity, and water toxicity.

### 3.2.4 Nutrients and Conventional Analytes

Water samples were collected for nutrient analyses using the standard grab sample collection method as described in SOP FS-2 (BASMAA, 2014b), associated with bioassessment monitoring conducted. Sample containers were rinsed, as appropriate, using ambient water and completely filled and recapped below water surface whenever possible. An intermediate container was used to collect water for all sample containers with preservative already added in advance by laboratory. Sample container size and type, preservative type and associated holding times for each analyte are described in Table 1 of FS-9 (BASMAA, 2014b). Syringe filtration method was used to collect samples for analyses of dissolved orthophosphate and dissolved organic carbon. All sample containers were labeled and stored on ice for transport to the analytical laboratory, with the exception of analysis of AFDM and chlorophyll-a samples, which were field-frozen on dry ice by some sampling teams where appropriate.

### 3.2.5 Water Toxicity

Samples were collected using the Standard Grab Sample Collection Method described above, filling the required number of 2.25-L labeled amber glass bottles with ambient water, putting them on ice to cool to 4°C ± 2°C, and delivering to the laboratory within the required hold time. Bottle labels include station ID, sample code, matrix type, analysis type, project ID, and date and time of collection. The laboratory was notified of the impending sample delivery to meet the 24-hour sample delivery time requirement. Procedures used for sampling and transporting samples are described in SOP FS-2 (BASMAA, 2014b).

### 3.2.6 Sediment Chemistry and Sediment Toxicity

In the case where sediment samples and water samples / measurements were collected at the same event, sediment samples were collected after any water samples were collected. Before conducting sampling, field personnel surveyed the proposed sampling area to identify appropriate fine-sediment depositional areas, to avoid disturbing possible sediment collection sub-sites. Personnel carefully entered the stream and started sampling at the closest appropriate reach, continuing upstream. Sediment samples were collected from the top 2 cm of sediment in a compositing container, thoroughly homogenized, and then aliquotted into separate jars for chemical and toxicological analysis using standard clean sampling techniques (see SOP FS-6, BASMAA, 2014b). Sample jars were submitted to respective laboratories per SOP FS-9 (BASMAA, 2014b).

## 3.3 Laboratory Analysis Methods

RMC participants agreed to use the same laboratory for individual parameters, developed standards for contracting with the labs, and coordinated quality assurance issues. All samples collected by RMC participants that were sent to laboratories for analysis were analyzed and reported per SWAMP-comparable methods as described in the RMC QAPP (BASMAA, 2014a). Analytical laboratory methods, reporting limits and holding times for chemical water quality parameters are also reported in BASMAA (2012a). The following analytical laboratory contractors were used for chemical and toxicological analysis:[15]

- BioAssessment Services, Inc. – BMI identification
- EcoAnalysts, Inc. – algae identification

[15] BioVir Laboratories, Incorporated was similarly contracted for Pathogen Indicators. These data are reported in each stormwater program's IMR Part A and Program-specific Appendices.

- CalTest, Inc. – sediment chemistry, nutrients, chlorophyll-a, AFDM
- Pacific EcoRisk, Inc. – water and sediment toxicity

## 3.4 Data Analysis

This section describes methods used to analyze the data collected during bioassessment monitoring, as well as water and sediment toxicity, and sediment chemistry data. The bioassessment data are then used to evaluate stream conditions, and the associated physical, chemical and toxicity testing data are then analyzed to identify potential stressors that may be impacting water quality and biological conditions. As the cumulative RMC sample sizes increase through monitoring conducted in future years (per Table 2-3), it will be possible to develop a statistically representative data set to address management questions related to condition of aquatic life and report on these per MRP Provision C.8.g.iii.

This report includes analysis of regional/probabilistic data generated per MRP Provision C.8.c during Water Years 2012 and 2013 in the following presentation format:

- Solano County permittees only:
  - Biological data (BMI and algae taxonomy)
  - PHab data
- ACCWP, CCCWP, Fairfield-Suisun, and Vallejo jointly:
  - Water chemistry data associated with bioassessment
  - Water toxicity
  - Sediment chemistry and toxicity

Analysis of Provision C.8.c monitoring data generated by Solano County programs at local/targeted sites (not included in the probabilistic design) is reported in Appendix A.2.

### 3.4.1 Biological Condition

Assemblages of freshwater organisms are commonly used to assess the biological integrity of water bodies because they provide direct measures of ecological condition (Karr and Chu, 1999). Benthic macroinvertebrates (BMIs) are an essential link in the aquatic food web, providing food for fish and consuming algae and aquatic vegetation (Karr and Chu 1999). The presence and distribution of BMIs can vary across geographic locations based on elevation, creek gradient, and substrate (Barbour et al. 1999). These organisms are sensitive to disturbances in water and sediment chemistry as well as physical habitat, both in the stream channel and along the riparian zone. Because of their relatively long life cycles (approximately one year) and limited migration, BMIs are particularly susceptible to site-specific stressors (Barbour et al. 1999). Algae also are increasingly being used as indicators of water quality, as they form the autotrophic base of aquatic food webs and exhibit relatively short life cycles that respond quickly to chemical and physical changes. Diatoms have been found to be particularly useful for interpreting some causes of environmental degradation (Hill et al. 2000).

In this report the biological condition of each probabilistic site monitored by FSURMP and Vallejo in Water Year 2013 was evaluated principally through analysis of BMI and algal taxonomic metrics, and calculation of associated benthic index of biological integrity (B-IBI) and algal index of biological integrity (A-IBI) scores. An IBI is an analytical tool involving calculation of a site condition score based on a compendium of biological metrics.

### Benthic Macroinvertebrate Data Analysis

Biological metrics associated with BMI assemblages are typically characterized by the following five categories (Ode et al. 2005):

- Richness measures (numbers of distinct taxa within the assemblage or taxonomic groups).
- Composition measures (distribution of individuals among taxonomic groups; includes measures of diversity).
- Tolerance/Intolerance measures (relative sensitivity of the observed taxonomic groups to disturbance).
- Functional feeding groups (relative preponderance of types of feeding strategies in the aquatic assemblage).
- Abundance (estimates of the total number of organisms in a sample based on a 9-square-foot sampling area).

An array of BMI metrics were computed for the Solano County data for Water Year 2013. For consistency with the 2012 UCMR and other RMC programs, the SoCal B-IBI score is the primary tool used for condition assessment in this report. The scores calculated using the SoCal B-IBI were classified according to condition categories established for the SoCal B-IBI (Table 3-2).

**Table 3-2. Condition categories for Southern California B-IBI scores for BMI taxonomy data.**

| Condition Category | Southern California B-IBI |
|---|---|
| Very Good | 80–100 |
| Good | 60–79 |
| Fair | 40–59 |
| Poor | 20–39 |
| Very Poor | 0–19 |

### Algae Data Analysis

Algal taxonomy has more recently been actively investigated for use as a biological indicator, and IBI development in California is less well-established for algae than for BMIs. Recently algal IBIs (A-IBIs) have been developed for Southern California (Fetscher et al. 2013) and the California Central Coast (Rollins et al., undated), but these have not been tested for Bay Area waters. However, because the Central Coast A-IBI has not been fully peer reviewed, and because there is a version of the SoCal A-IBI that relies only on diatoms and is thought to be more transferable to other areas of the state, it was determined that the SoCal A-IBI "D18" (per Fetscher et al. 2014) could be used provisionally for assessment of stream conditions for this report.

As with BMI data, an array of biological metrics can be derived for algal taxonomic data. The following characteristics were considered in the recent development of the algae IBI for Central Coast rivers and streams (Rollins et al., undated), according to the methods described in Stoddard et al. (2008):

- Autecological Preferences, such as species-level preferences in pH, salinity, nitrogen uptake metabolism, oxygen requirements, saprobity, trophic state, and moisture.

- Community Structure, including metrics pertaining to presence, relative individual abundance, relative species abundance, dominance, evenness, and measures of diversity.
- Ecological Guilds, including metrics derived from motility and morphological classifications.
- Tolerance and Intolerance, including metrics derived from the pollution tolerance index developed by Bahls (1993), as well as metrics developed from central coast data specific to taxa whose abundance most effectively discriminated between sites with the least human disturbance and sites with the greatest human disturbance.
- Production, including metrics derived from measures of biomass such as chlorophyll, ash-free dry mass (AFDM), microalgal growth, and macroalgal growth.

Speaking to the last category above, a variety of primary producer abundance measures can be used to assess the relative levels of algal growth in streams (Fetscher et al. 2013), such as:

- Algal biomass measures:
  - Benthic chlorophyll-a
  - Benthic AFDM
- Algae/macrophytes cover measures:
  - Percent presence of attached macroalgae (defined as algal mats or filaments easily visible to the naked eye)
  - Percent presence of macroalgae (attached and/or unattached)
  - Percent presence of unattached macroalgae
  - Percent presence of thick microalgae (1 mm+)
  - Percent presence of thick microalgae (1 mm+), where microalgae present
  - Percent presence of microalgae
  - Percent presence of nuisance algae (macroalgae + thick microalgae (1 mm+))
  - Mean microalgae thickness (mm)
  - Mean microalgae thickness (mm,) where microalgae present
  - Percent presence of macrophytes

Eleven diatom metrics and one diatom IBI ("D18") were computed per Fetscher et al. (2014) from the CCCWP data for Water Years 2012 and 2013 and presented in this report. The diatom IBI ("D18") is computed from five of the eleven metrics, with scoring ranges and values provided by Dr. A. Elizabeth Fetscher (pers comm). After each metric was scored, values were summed and then converted to a 100-point scale. Only diatom data were included in this analysis, because the soft algae taxonomic data were not harmonized with the California Algae and Diatom Taxonomic Working Group's Master Taxa List. The eleven diatom metrics are described in Table 3-3.

**Table 3-3. Metrics used in evaluating algae taxonomy data.**

| Metric Name | Description | Implications | Correlation with Metric Score |
|---|---|---|---|
| Proportion low TN indicators | Proportion of diatoms that are indicators for low Total N (nitrogen) levels | Higher levels indicate lower levels of nutrient enrichment | Positive |
| Proportion low TP indicators * | Proportion of diatoms that are indicators for low Total P (phosphorous) levels | Higher levels indicate lower levels of nutrient enrichment | Positive |
| Proportion halobiontic* | Proportion of diatoms that are brackish-fresh + brackish (i.e., they have a tolerance of, or requirements for, dissolved salts) | Higher levels indicate higher salinity and conductivity, and possibly higher nutirent or sediment levels | Negative |
| Proportion requiring >50% DO saturation * | Proportion of diatoms that require at least 50% dissolved oxygen saturation (sum 50+75+100) | Higher levels indicate less well-oxygenated stream conditions | Positive |
| Proportion requiring nearly 100% DO saturation | Proportion of diatoms that require nearly 100% dissolved oxygen saturation | Higher levels indicate well-oxygenated stream conditions | Positive |
| Proportion N heterotrophs * | Proportion of diatoms that are heterotrophs (i.e., are capable of using energy sources other than photosynthesis; includes both obligate and facultative heterotrophs) | Higher levels indicate possible organic enrichment of the water | Negative |
| Proportion oligo- & beta-mesosaprobic | Proportion of diatoms that are oligosaprobous+beta-mesosaprobous (i.e., they have a low to moderate ability to use decomposing organic material for nutrition) | Higher levels indicate lower levels of organic contamination | Positive |
| Proportion poly- & eutrophic | Proportion of diatoms that are polytrophic+eutrophic (i.e., have a tolerance of, or requirements for, high nutrient levels) | Higher levels indicate higher levels of nutrients (N and P) in the water | Negative |
| Proportion sediment tolerant (highly motile)* | Proportion of diatoms (for which there is information for both the "motility" and "habit" classifications) that are highly motile (for "motility") OR planktonic (for "habit") | Higher levels may indicate the presence of excess silt and sediment | Negative |
| Proportion highly motile | Proportion of diatoms that are highly motile (i.e., have the ability to move through the water column or glide along surfaces) | Higher levels may indicate the presence of excess silt and sediment | Negative |
| Proportion *A. minutissimum* | Proportion of diatoms that are the species *Achnanthidium minutissimum*; Common diatoms that are known to be tolerant of a wide range of conditions | Higher levels tend to be associated with higher quality sites (Betty Fetscher, personal comm.) | Positive |
| * metric is used in calculating the "D18" algae IBI | | | |

### 3.4.2 Physical Habitat Condition

Physical habitat condition was assessed using PHab scores. For this report, PHab scores range from 0 to 60, representing a combined score of three physical habitat sub-categories (epifaunal substrate/cover, sediment deposition, and channel alteration) that each can be scored for a total of 0–20 points. Higher PHab scores reflect higher-quality habitat. Numerous additional PHab endpoints can also be calculated.

Further analyses of various PHab endpoints are possible and will be considered in future reports, as the science becomes further developed.

### 3.4.3 Water and Sediment Chemistry and Toxicity

As part of the Stressor Assessment for this report, water and sediment chemistry and toxicity data generated during Water Years 2012 and 2013 were analyzed and evaluated to identify potential stressors that may be contributing to degraded or diminished biological conditions. Per Table 8.1 of the MRP (SF Bay Water Board, 2009), creek status monitoring data must be evaluated with respect to specified "Results that Trigger a Monitoring Project in Provision C.8.d.i." The trigger criteria listed in MRP Table 8.1 were used as the principal means of evaluating the creek status monitoring data to identify sites where water quality impacts may have occurred. For water and sediment chemistry and toxicity data, the relevant trigger criteria are as follows:

- **Nutrients**: 20% of results in one water body exceed one or more water quality standard or established threshold. (Note: per MRP Table 8.1, this group of constituents includes variants of nitrogen and phosphorous, as well as other common, "conventional" constituents.)
- **Water Toxicity**: if toxicity results are less than 50% of Laboratory Control results, resample and retest; if second sample yields less than 50% of Laboratory Control results, proceed to C.8.d.i. (Stressor/Source Identification).
- **Sediment Toxicity**: toxicity results are statistically different from and more than 20% less than results for Laboratory Control.
- **Sediment Chemistry**: three or more chemicals exceed Threshold Effect Concentrations (TECs), mean Probable Effects Concentrations (PEC) Quotient greater than 0.5, or pyrethroids Toxicity Unit (TU) sum is greater than 1.0.

For sediment chemistry trigger criteria, threshold effect concentrations (TECs) and probable effects concentrations (PECs) are as defined in MacDonald et al. (2000). For all non-pyrethroid contaminants specified in MacDonald et al. (2000), the ratio of the measured concentration to the respective TEC value was computed as the TEC quotient. All results where a TEC quotient was equal to or greater than 1.0 were identified. PEC quotients were also computed for those same non-pyrethroid sediment chemistry constituents using PEC values from MacDonald et al. (2000). For each site the mean PEC quotient was then computed, and sites where mean PEC quotient was equal to or greater than 0.5 were identified. Pyrethroids toxic unit equivalents (TUs) were computed for individual pyrethroid results, based on available literature values for pyrethroids in sediment LC50 values.[16] Because organic carbon mitigates the toxicity of pyrethroid pesticides in sediments, the LC50 values were derived on the basis of TOC-normalized pyrethroid concentrations. Therefore, the pyrethroid concentrations as reported by the lab were divided by the measured total organic carbon (TOC) concentration at each site, and the TOC-normalized concentrations were then used to compute TU equivalents for each pyrethroid. Then for each site, the TU equivalents for the various individual pyrethroids were summed, and sites where the summed TU was equal to or greater than 1.0 were identified.

## 3.5 Quality Assurance & Control

Data quality assessment and quality control procedures are described in detail in the BASMAA RMC QAPP (BASMAA, 2014a). They generally involved the following:

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

Data Quality Objectives (DQOs) were established to ensure that data collected were of sufficient and adequate quality for the intended use. DQOs include both quantitative and qualitative assessment of the acceptability of data. The qualitative goals include representativeness and comparability. The quantitative goals include completeness, sensitivity (detection and quantitation limits), precision, accuracy, and contamination. To ensure consistent and comparable field techniques, pre-monitoring field training and in-situ field assessments were conducted.

Data were collected according to the procedures described in the relevant SOPs (BASMAA, 2014b), including appropriate documentation of data sheets and samples, and sample handling and custody. Laboratories providing analytical support to the RMC were selected based on demonstrated capability to adhere to specified protocols.

All data were thoroughly reviewed by the Programs responsible for collecting them, for conformance with QAPP requirements and field procedures were reviewed for compliance with the methods specified in the relevant SOPs. Data quality was assessed and qualifiers were assigned as necessary in accordance with SWAMP requirements. Evaluations of Program-specific data quality associated with monitoring conducted in Water Years 2012 and 2013 are contained elsewhere in the individual Program-specific portions of the IMR.

# 4.0 Results and Discussion

The MRP requires monitoring to address the management question, "What are the sources to urban runoff that contribute to receiving water problems?" The RMC accomplishes this through a multi-step process that involves conducting monitoring to provide data to inform an assessment of conditions and identification of stressors that may be impacting water quality and/or biological conditions. The information generated through the condition assessment and stressor assessment will then be used to help direct efforts to identify sources of problematic pollutants or other stressors in urban runoff discharges.

In this section, following a brief statement of data quality, the biological, physical, chemical and toxicity testing monitoring data are evaluated against the trigger criteria shown in MRP Table 8.1 and, for sediment triad data, Table H-1 (SF Bay Water Board, 2009) to provide a preliminary identification of potential stressors. The results of the initial stressor assessment evaluation (BASMAA, 2013) are currently being used in follow-up efforts to plan and implement stressor/source identification (SSID) projects.

## 4.1 Statement of Data Quality

The RMC established a set of guidance and tools to help ensure data quality and consistency implemented through collaborating Programs. Additionally, the RMC participants continue to meet and coordinate on an ongoing basis to plan and coordinate monitoring, data management, and reporting activities, among others.

A comprehensive QA/QC program was implemented by each of the RMC programs, which is solely responsible for the quality of the data submitted on its behalf, covering all aspects of the regional/probabilistic monitoring. In general, QA/QC procedures were implemented as specified in the RMC QAPP (BASMAA, 2012a), and monitoring was performed according to protocols specified in the RMC SOPs (BASMAA, 2012b), and in conformity with SWAMP protocols. Details of the results of evaluations of laboratory-generated QA/QC results are included elsewhere in the Program-specific IMR and other appendices if applicable. Issues noted by the laboratories and/or RMC field crews are summarized below.

### 4.1.1 Bioassessment

During Water Year 2013, there were relatively minor field data collection issues. Two reaches were shortened to 100 m due to physical barriers on both ends. All streams had ample water and substrate for both algae and BMI collection. One FSURMP BMI sample was particularly difficult to analyze (see section 3.2.1) and a modified sub-sampling procedure was used.

### 4.1.2 Sediment Chemistry

Several issues were reported by the analytical laboratory (Caltest), and the sediment chemistry data were qualified accordingly. These issues included:

- Low level contamination noted in Method Blanks
- Matrix Spike recoveries outside of control limits noted due to possible matrix interferences
- Many laboratory reporting limits (RLs) exceed RMC QAPP RLs due to the dry weight conversion, as well as target and non-target matrix interferences, which required the laboratories to concentrate less than normal.

### 4.1.3 Water Chemistry

Several issues were noted with respect to water chemistry analyses, including:

- In both 2012 and 2013, RMC field crews noted numerous instances where free chlorine was measured with the Hach field kits at concentrations higher than total chlorine.
- A limited number of Lab QA/QC sample results for nutrients and conventional parameters were reported by the laboratory as qualified data due to elevated minor issues not thought to affect the accuracy of sample results.
- Results of required field duplicates for several analytes exceeded QAPP MQOs. As the control limits for field duplicates are identical to those of lab duplicate analyses, this is not a surprising occurrence. Individual Programs' data were qualified as dictated by comparison with RMC MQOs (BASMAA, 2014a).

### 4.1.4 Sediment Toxicity

In Water Year 2012, for several sediment toxicity samples, during laboratory testing for chronic toxicity of ambient sediment to *Hyalella azteca*, the dissolved oxygen (DO) level dropped below 2.5 mg/L during testing; aeration was initiated following this observation per the EPA testing manual. It is possible that hypoxia could have had a role in the significantly reduced survival observation of *Hyalella azteca*. The low DO conditions were not experienced associated with Water Year 2013 sampling.

### 4.1.5 Water Toxicity

In both Water Year 2012 and Water Year 2013, multiple aquatic toxicity samples were identified by the analytical laboratory as being affected during testing by pathogen-related mortality (PRM), a cause of interference in aquatic sample toxicity tests with ambient surface waters. In some cases in 2012, the affected samples were retested using a modified approach per Geis et al. (2003). In 2013, these retests used the standard EPA 20-replicate test (USEPA, 2000) to assess impacts of PRM.[17]

## 4.2 Condition Assessment

Condition assessment addresses the RMC core management question ***"What is the condition of aquatic life in creeks in the RMC area; are aquatic life beneficial uses supported?"*** The designated beneficial uses listed in the San Francisco Bay Region Basin Plan (SF Bay Water Board, 2013) for RMC creeks sampled from East Bay sites are shown in Table 4-1. Statistical properties of the aquatic life use indicators used for this condition assessment that were observed at Solano County sites sampled in Water Years 2012 and 2013 are reported in Sections 4.2.1 (benthic macroinvertebrates) and 4.2.2 (algae), and discussed in relation to aquatic life beneficial uses designated by the SF Bay Water Board (Table 4-1) in section 4.2.3. Due to the relatively small sample size available after the second year of implementing the RMC regional probabilistic monitoring design, results are presented only in terms of their comparative statistical ranges within urbanized portions of Solano County. Future reports will provide additional analysis at the countywide level, as well as comparisons between urban and non-urban land use sites.

[17] As part of contracting for WY 2014 creek status monitoring, RMC Programs have asked the laboratory to provide more comprehensive documentation supporting PRM identification, when applicable.

**Table 4-1. RMC creeks and associated designated beneficial uses listed in the San Francisco Bay Region Basin Plan (SFBRWQCB 2013). Creeks not listed in Chapter 2 of the Basin Plan do not appear in this table.**

| | | ← Human Consumptive Uses → | | | | | | | ← Aquatic Life Uses → | | | | | | | | Wildlife Use | Recreational Uses | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site ID | Waterbody | AGR | MUN | FRSH | GWR | IND | PROC | COMM | SHELL | COLD | EST | MAR | MIGR | RARE | SPWN | WARM | WILD | REC-1 | REC-2 | NAV |
| ***ALAMEDA COUNTY*** | | | | | | | | | | | | | | | | | | | | |
| 205R00110 | Agua Caliente (Zone 6 Line F) | | | | | | | | | | | | | | | E | E | E | E | |
| 204R00356 | Arroyo de la Laguna | | | | E | | | | | E | | | E | | E | E | E | E | E | |
| 204R00100 | Arroyo Mocho | | | | E | | | | | E | | | E | | E | E | E | E | E | |
| 204R00191 | Arroyo del Valle | | E | | E | | | | | E | | | P | E | E | E | E | E | E | |
| 204R00340 | Big Canyon Creek, Line 7-J-1 | | | | | | | | | | | | | | | E | E | E | E | |
| 204R00047 | Castro Valley Creek | | | | | | | | | E | | | | E | | E | E | E | E | |
| 204R00303 | Chabot Creek | | | | | | | | | E | | | | E | | E | E | E | E | |
| 204R00068 | Collier Canyon Creek | | | | | | | | | | | | | E | | E | E | E | E | |
| 204R00647 | Dry Creek | | | | | | | | | | | | | E | | E | E | E | E | |
| 204R00084 | Dublin Creek | | | | | | | | | | | | | | | E | E | E | E | |
| 205R00430 | Line 6D | | | | | | | | | | | | | | | E | E | E | E | |
| 205R00535 | Plummer Creek (Zone 5 Line F-1) | | | | | | | | | | E | | | E | | | E | E | E | |
| 204R00639 | San Lorenzo Creek | | E | E | E | | | | | E | | | E | | E | E | E | E | E | |
| 204R00319 | Sausal Creek | | | | | | | | | E | | | | E | E | E | E | E | E | |
| 204R00383 | Sulphur Creek | | | | | | | | | | | | | | | E | E | E | E | |
| 204R00367 | Ward Creek | | | | | | | | | | | | | | | E | E | E | E | |
| 204R00455 | Zeile Creek | | | | | | | | | | | | | | | E | E | E | E | |
| 205R00686 | Canada Del Aliso | | | | | | | | | | | | | | | E | E | E | E | |
| 204R00967 | Crandall Creek | | | | | | | | | | | | | | | E | E | E | E | |
| 204R00852 | Alamo Creek | | | | E | | | | | P | | | E | E | E | E | E | E | E | |
| 204R00334 | Arroyo del Valle | | E | | E | | | | | E | | | P | E | E | E | E | E | E | |

| Site ID | Waterbody | AGR | MUN | FRSH | GWR | IND | PROC | COMM | SHELL | COLD | EST | MAR | MIGR | RARE | SPWN | WARM | WILD | REC-1 | REC-2 | NAV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 204R00590 | Arroyo del Valle | | E | | E | | | | | E | | | P | E | E | E | E | E | E | |
| 204R00473 | Arroyo Mocho | | | | E | | | | | E | | | E | | E | E | E | E | E | |
| 205R01134 | Agua Caliente | | | | | | | | | | | | | | | E | E | E | E | |
| 204R00724 | Dublin Creek | | | | | | | | | | | | | | | E | E | E | E | |
| 204R01316 | Arroyo de la Laguna | | | | E | | | | | E | | | E | | E | E | E | E | E | |
| 205R00174 | Line 6-K | | | | | | | | | | | | | | | E | E | E | E | |
| 204R00623 | San Lorenzo Creek | | E | E | E | | | | | E | | | E | | E | E | E | E | E | |
| 204R00063 | Peralta Creek | | | | | | | | | | | | | | | E | E | E | E | |
| 204R00751 | Redwood Canyon Creek | | | E | | | | | | E | | | | | E | E | E | E | E | |
| 203R00983 | Strawberry Creek | | | | | | | | | | | | | | | E | E | E | E | |
| 204R01471 | Arroyo Mocho | | | | E | | | | | E | | | E | | E | E | E | E | E | |
| 205R01198 | Zone 6 Line G | | | | | | | | | | | | | | | E | E | E | E | |
| 205R01390 | Zone 6 Line G | | | | | | | | | | | | | | | E | E | E | E | |
| ***CONTRA COSTA COUNTY*** | | | | | | | | | | | | | | | | | | | | |
| 203R00039 | Cerrito Creek | | | | | | | | | | | | | | | E | E | E | E | |
| 543R00137 | Deer Creek | E | E | | | | | | | E | | | E | | E | E | E | E | E | |
| 207R00011 | Grayson Creek | | | | | | | | | E | | | E | E | | E | E | E | E | |
| 207R00139 | Las Trampas Creek | | | | | | | | | E | | | | E | | E | E | E | E | |
| 543R00219 | Marsh Creek | | | | | | | E | | | | | | E | | E | E | P | P | |
| 543R00245 | Marsh Creek | | | | | | | E | | | | | | E | | E | E | P | P | |
| 206R00155 | San Pablo Creek | | | E | | | | | | E | | | E | E | E | E | E | E* | E | |
| 206R00215 | San Pablo Creek | | | E | | | | | | E | | | E | E | E | E | E | E* | E | |
| 207R00247 | Walnut Creek | | | | | | | | | E | | | E | E | E | E | E | E | E | |
| 206R00727 | Pinole Creek | | | | | | | | | E | | | E | E | E | E | E | E | E | |
| 207R00375 | Galindo Creek | | | | | | | | | E | | | | | | E | E | E | E | |
| 207R00395 | Las Trampas Creek | | | | | | | | | E | | | | E | | E | E | E | E | |

| Site ID | Waterbody | AGR | MUN | FRSH | GWR | IND | PROC | COMM | SHELL | COLD | EST | MAR | MIGR | RARE | SPWN | WARM | WILD | REC-1 | REC-2 | NAV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 207R00503 | Pine Creek | | | | | | | | | E | | | E | E | E | E | E | E | E | |
| 207R00567 | Walnut Creek | | | | | | | | | E | | | E | E | E | E | E | E | E | |
| 207R00631 | Grayson Creek | | | | | | | | | E | | | E | E | | E | E | E | E | |
| 207R00788 | San Ramon Creek | | | | | | | | | | | | | | | E | E | E | E | |
| 544R00281 | Marsh Creek | | | | | | | E | | | | | | E | | E | E | P | P | |
| ***SOLANO - FSURMP*** | | | | | | | | | | | | | | | | | | | | |
| 207R00236 | Laurel Creek | | | E | | | | | | E | | | E | | E | E | E | E | E | |
| 207R01452 | Laurel Creek | | | E | | | | | | E | | | E | | E | E | E | E | E | |
| 207R00476 | Ledgewood Creek | | | E | | | | | | E | | | E | | E | E | E | E | E | |
| ***SOLANO - Vallejo*** | | | | | | | | | | | | | | | | | | | | |
| 207R00064 | Blue Rock Springs Creek | | | E | | | | | | | | | | | | E | E | E | E | |
| 207R04080 | Blue Rock Springs Creek | | | E | | | | | | | | | | | | E | E | E | E | |
| 207R05524 | Blue Rock Springs Creek | | | E | | | | | | | | | | | | E | E | E | E | |
| 207R03504 | Rindler Creek | | | E | | | | | | | | | | | | E | E | E | E | |

**Notes:**

COLD = Cold Fresh Water Habitat
FRSH = Freshwater Replenishment
GWR - Groundwater Recharge
MIGR = Fish Migration
MUN = Municipal and Domestic Water
NAV = Navigation
RARE= Preservation of Rare and Endangered Species
REC-1 = Water Contact Recreation
REC-2 = Non-contact Recreation
WARM = Warm Freshwater Habitat
WILD = Wildlife Habitat
P = Potential Use
E = Existing Use
L = Limited Use.
* = "Water quality objectives apply; water contact recreation is prohibited or limited to protect public health" (SFBRWQCB 2013).

### 4.2.1 Benthic Macroinvertebrate Metrics

From a regional perspective, BMI metrics for 60 sites sampled within the RMC area in the spring index period of Water Year 2012 exhibited a wide range of scores, as shown on Figure 4-1 and described in the 2012 Regional UCMR (BASMAA, 2013).

Key BMI taxonomic metrics and SoCal B-IBI scores are shown in Figure 4-2 and Table 4-2 for the Solano County sites monitored in the spring index period of Water Year 2013. BMI metrics for the 8 urban sites sampled in Fairfield and Vallejo generally exhibited low scores, particularly for metrics such as presence of intolerant taxa/organisms and diversity of functional feeding groups. There was wide variety in taxonomic richness among the sites.

### 4.2.2 Algae Metrics

Algae metrics for sites sampled within the RMC area in the spring index period of Water Year 2012 exhibited a wide range of scores. For RMC Water Year 2012 data, in the absence of an available algae IBI pertaining to this region, diatom sensitivity and tolerance to pollutants were presented in the 2012 Regional UCMR (BASMAA, 2013) in an exploratory data analytical mode. Pollutant tolerant dominant diatom taxa comprised a total of 33% of the RMC sample counts, while pollutant intolerant diatom taxa comprised 27% (Figure 4-3).

The diatom A-IBI scores and five associated algae metrics calculated for the 8 samples collected from sites in Solano County in Water Year 2013 are shown in Table 4-3. The results for the other six diatom metrics not included in the calculation of the “D18” A-IBI score are shown in Table 4-4. This analysis is also considered to be in a preliminary, exploratory mode, as the diatom A-IBI and other metrics have not been fully tested for application to SF Bay Area streams.

Most A-IBI scores for Solano County bioassessment locations were in the “poor” range, though one station (207R03504) had a “high” score and one (207R00476) had a “fair” score. The mean score for all locations was poor: 41 out of 100 (n=8).

Overall, the scores were low for ‘Proportion of low TP indicators’, with 6 of the 8 stations receiving a score less than 3, suggesting that many of the sites had relatively high total phosphorous concentrations. This pattern appears to match with the ‘Proportion of low TN indicators’ values. Stations with higher proportions of diatoms requiring >50% dissolved oxygen saturation tended to have higher IBI scores. Fetscher et al. (2014) found the diatom IBI (“D18”) to be responsive to stream order, watershed area, and percent fines, so those watershed characteristics also could play a role in the observed A-IBI scores.

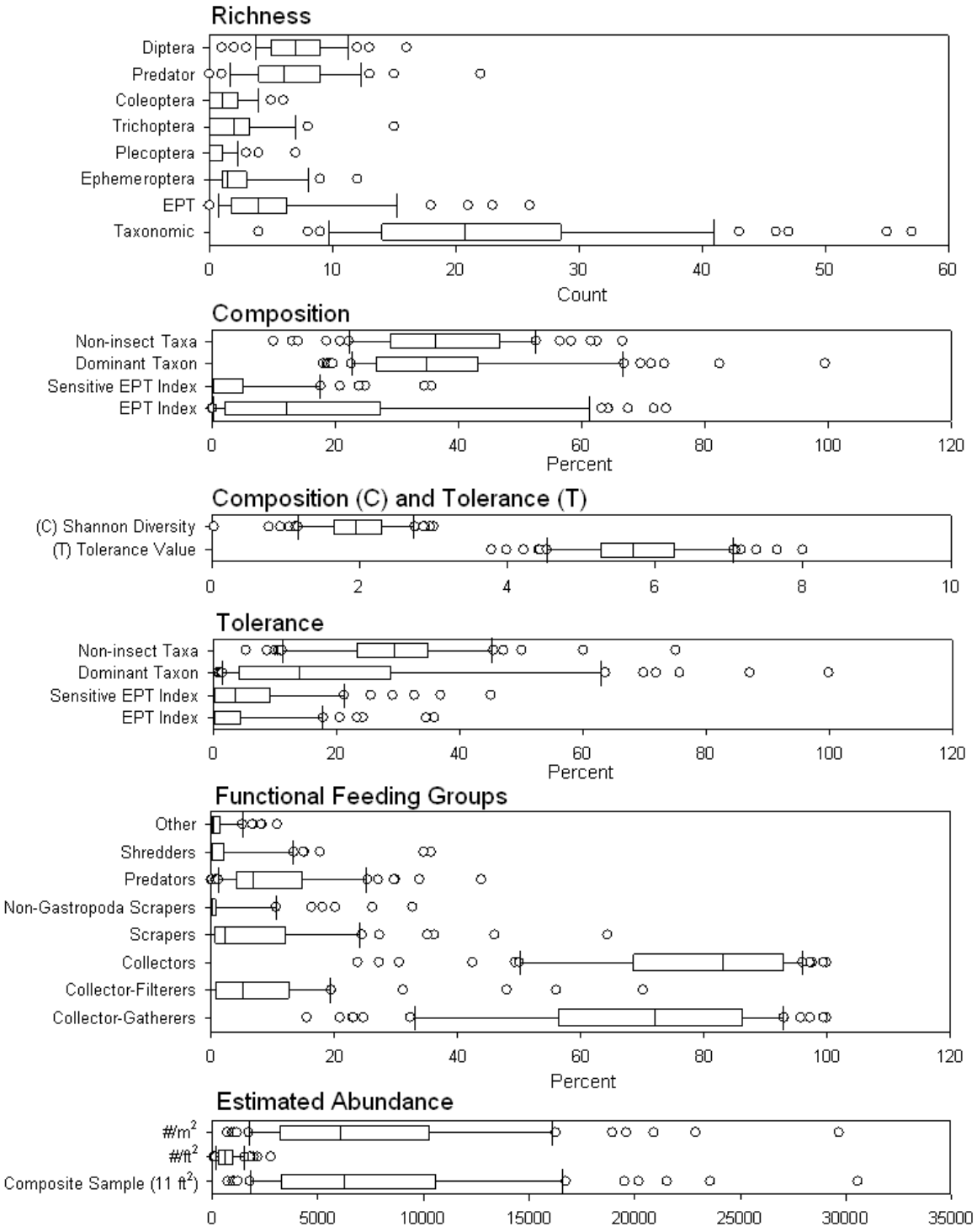


**Figure 4-1. Benthic macroinvertebrate metric values derived from RMC sites sampled in Water Year 2012. Statistics include minimum (lower whisker), maximum (upper whisker), 25th percentile (lower box), median (box midline) and 75th percentile (upper box).**

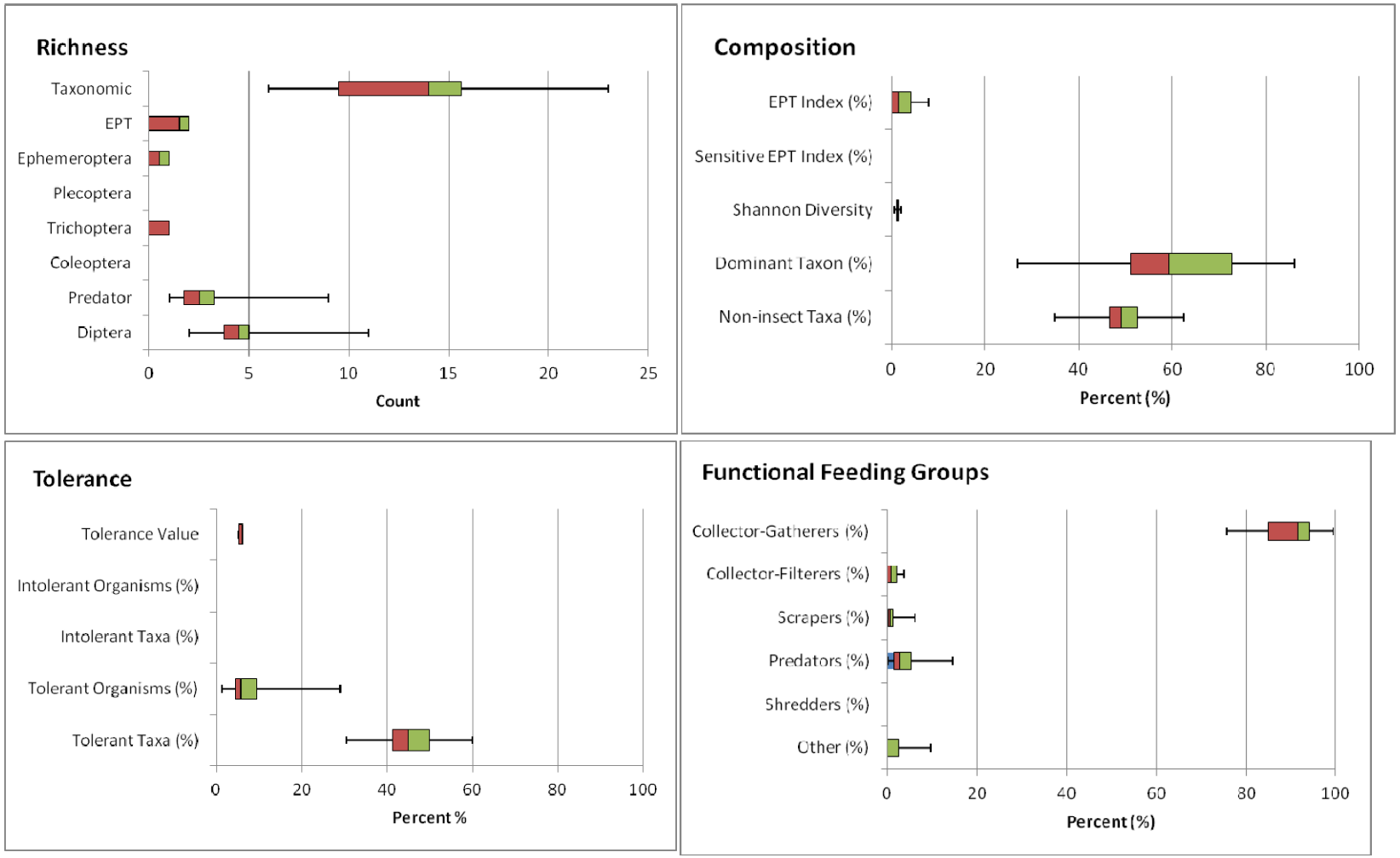


**Figure 4-2. Benthic macroinvertebrate metric values derived from Solano County sites sampled in Water Year 2013. Statistics include minimum (lower whisker), maximum (upper whisker), 25th percentile (lower box), median (box midline) and 75th percentile (upper box).**

**Table 4-2. Benthic macroinvertebrate metrics and B-IBI scores for Solano County bioassessment samples collected in Water Year 2013 (all urban).**

| | Program | FSURMP | | | | Vallejo | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Creek | Union Ave. | Union Ave. | Ledgewood | Laurel | Blue Rock Springs | Blue Rock Springs | Rindler | Blue Rock Springs | | |
| | Station ID | 207R00556 | 207R00428 | 207R00476 | 207R01452 | 207R00064 | 207R00688 | 207R03504 | 207R04080 | Mean | s.d. |
| Richness | Taxonomic | 10 | 8 | 6 | 13 | 16 | 15 | 13.5 | 23 | **13.1** | **5.3** |
| | EPT | 0 | 0 | 0 | 1 | 2 | 2 | 3.0 | 2 | **1.3** | **1.2** |
| | Ephemeroptera | 0 | 0 | 0 | 0 | 1 | 1 | 2.0 | 1 | **0.6** | **0.7** |
| | Plecoptera | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0 | **0.0** | **0.0** |
| | Trichoptera | 0 | 0 | 0 | 1 | 1 | 1 | 1.0 | 1 | **0.6** | **0.5** |
| | Coleoptera | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0 | **0.0** | **0.0** |
| | Predator | 1 | 1 | 2 | 3 | 2 | 4 | 3.0 | 9 | **3.1** | **2.6** |
| | Diptera | 4 | 3 | 2 | 4 | 5 | 5 | 6.5 | 11 | **5.1** | **2.8** |
| Composition | EPT Index (%) | 0.0 | 0.0 | 0.0 | 8.0 | 0.5 | 6.3 | 48.2 | 2.6 | **8.2** | **16.5** |
| | Sensitive EPT Index (%) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **0.0** | **0.0** |
| | Shannon Diversity | 0.6 | 0.5 | 1.3 | 1.7 | 1.2 | 1.5 | 1.6 | 2.2 | **1.3** | **0.6** |
| | Dominant Taxon (%) | 86 | 85 | 56 | 37 | 68 | 56 | 38.0 | 27 | **56.8** | **22.2** |
| | Non-Insect Taxa (%) | 60 | 63 | 50 | 46 | 50 | 47 | 29.7 | 35 | **47.5** | **11.2** |
| Tolerance | Tolerance Value | 5.2 | 5.2 | 6.0 | 5.5 | 6.0 | 6.0 | 6.2 | 6.1 | **5.8** | **0.4** |
| | Intolerant Organisms (%) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **0.0** | **0.0** |
| | Intolerant Taxa (%) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **0.0** | **0.0** |
| | Tolerant Organisms (%) | 2.5 | 1.4 | 29 | 6.8 | 5.8 | 5.3 | 41.4 | 18 | **13.7** | **14.5** |
| | Tolerant Taxa (%) | 60 | 50 | 50 | 46 | 44 | 40 | 25.8 | 30 | **43.3** | **11.1** |
| Functional Feeding Group | Collector-Gatherers (%) | 99 | 99 | 76 | 86 | 93 | 91 | 91.9 | 82 | **89.8** | **8.1** |
| | Collector-Filterers (%) | 0.2 | 0.0 | 0.0 | 1.0 | 3.8 | 0.7 | 0.7 | 2.0 | **1.0** | **1.3** |
| | Scrapers (%) | 0.0 | 0.3 | 0.0 | 2.9 | 0.8 | 0.8 | 0.2 | 6.1 | **1.4** | **2.1** |
| | Predators (%) | 0.2 | 0.2 | 15 | 2.2 | 2.0 | 4.6 | 6.1 | 7.2 | **4.6** | **4.8** |
| | Shredders (%) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **0.0** | **0.0** |
| | Other (%) | 0.3 | 0.6 | 9.7 | 8.0 | 0.0 | 0.0 | 0.0 | 0.0 | **2.3** | **4.0** |
| Abundance | # organisms/m2 | 4707 | 2917 | 181 | 401 | 5750 | 2606 | 1320.4 | 2889 | **2596.5** | **1959.4** |
| | **SoCal B-IBI score** | **0** | **0** | **7** | **6** | **3** | **6** | **15** | **23** | **7.4** | **7.9** |
| | **SoCal B-IBI score category** | **Very Poor** | **Very Poor** | **Very Poor** | **Very Poor** | **Very Poor** | **Very Poor** | **Very Poor** | **Poor** | | |

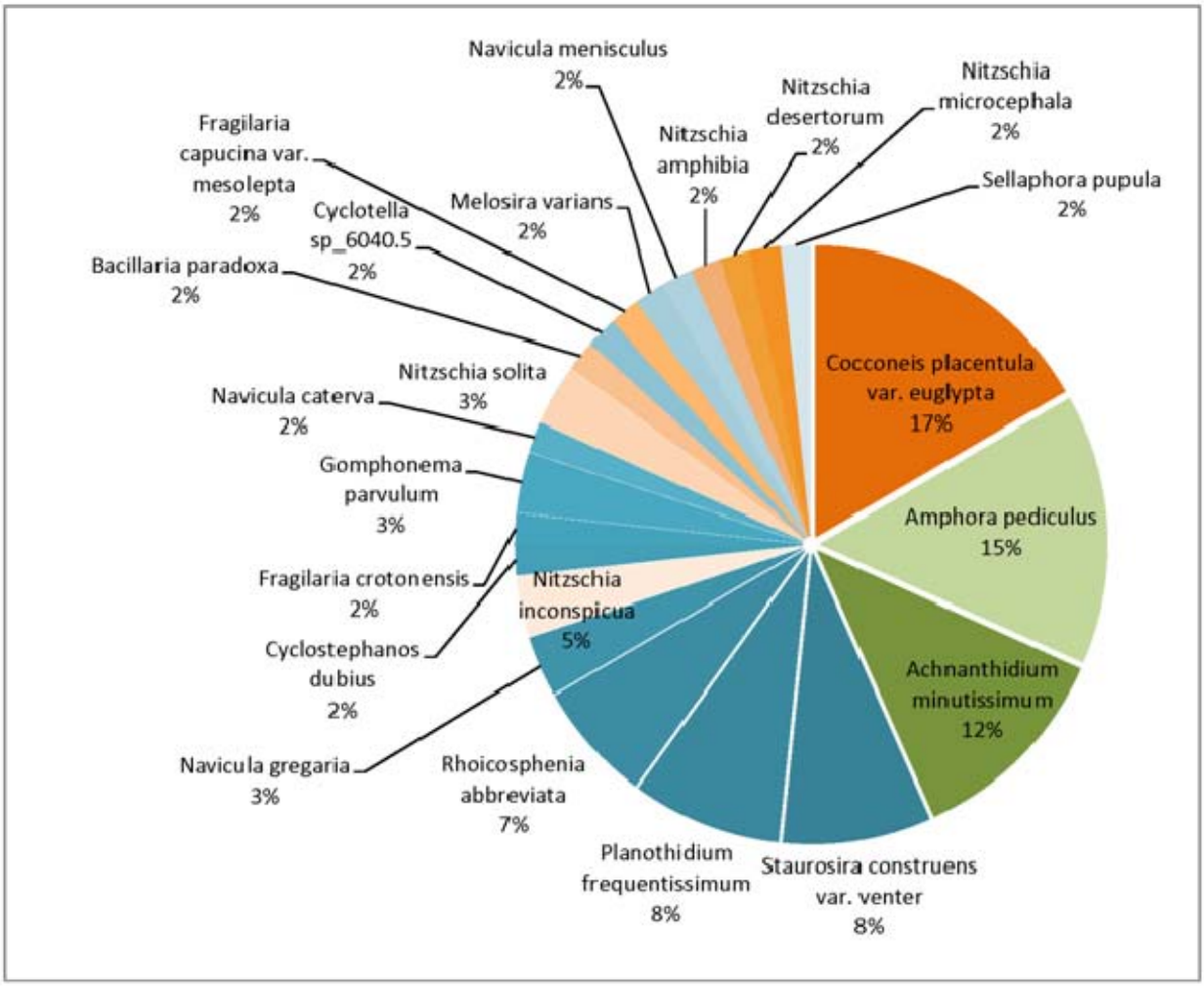


**Figure 4-3. Dominant diatom taxa sampled at RMC sites in Water Year 2012. Green-hued sections indicate sensitive species intolerant to pollutants; orange-hued sections indicate species more tolerant of pollutants, including fine sediment (Blinn and Herbst 2003; Herbst and Blinn 2008).**

**Table 4-3. A-IBI scores and associated metrics for Solano County bioassessment sites sampled in Water Year 2013.**

| Station Code | Sample Date | A-IBI Score | Proportion low TP indicators | Proportion halobiontic | Proportion requiring >50% DO saturation | Proportion N heterotrophs | Proportion sediment tolerant (highly motile) |
|---|---|---|---|---|---|---|---|
| 206R00064 | 5/28/2013 | 26 | 0.025 (1) | 0.545 (0) | 0.695 (8) | 0.064 (8) | 0.396 (2) |
| 206R00688 | 5/29/2013 | 28 | 0.034 (1) | 0.544 (0) | 0.596 (8) | 0.096 (8) | 0.271 (5) |
| 206R03504 | 5/29/2013 | 84 | 0.749 (10) | 0.048 (9) | 0.976 (7) | 0.164 (7) | 0.161 (7) |
| 206R04080 | 5/30/2013 | 46 | 0.035 (1) | 0.317 (4) | 0.782 (8) | 0.078 (8) | 0.195 (6) |
| 207R00142 | 5/28/2013 | 32 | 0.081 (1) | 0.398 (3) | 0.847 (4) | 0.308 (4) | 0.391 (2) |
| 207R00428 | 5/21/2013 | 36 | 0.163 (2) | 0.396 (3) | 0.630 (7) | 0.154 (7) | 0.206 (6) |
| 207R00476 | 5/23/2013 | 52 | 0.270 (4) | 0.275 (5) | 0.857 (8) | 0.062 (8) | 0.345 (3) |
| 207R00556 | 5/15/2013 | 26 | 0.069 (1) | 0.489 (1) | 0.571 (6) | 0.194 (6) | 0.272 (5) |
| Average A-IBI Score: | | 41 | | | | | |
| Notes: Metric scores are shown as raw metric value followed by (score) | | | | | | | |
| IBI Score is calculated by summing the five individual metric scores and multiplying the sum X 2 | | | | | | | |

**Table 4-4. Additional algae metrics for Solano County bioassessment sites sampled in Water Year 2013.**

| Station Code | Sample Date | Proportion low TN indicators | Proportion requiring ~100% DO saturation | Proportion oligo- & beta-mesosaprobic | Proportion poly- & eutrophic | Proportion highly motile | Proportion A. minutissimum |
|---|---|---|---|---|---|---|---|
| 206R00064 | 5/28/2013 | 0.019 | 0.024 | 0.507 | 0.92 | 0.396 | 0 |
| 206R00688 | 5/29/2013 | 0.026 | 0.005 | 0.425 | 0.949 | 0.266 | 0.003 |
| 206R03504 | 5/29/2013 | 0.742 | 0.749 | 0.818 | 0.245 | 0.158 | 0.646 |
| 206R04080 | 5/30/2013 | 0.028 | 0.017 | 0.626 | 0.95 | 0.192 | 0.013 |
| 207R01452 | 5/28/2013 | 0.065 | 0.107 | 0.618 | 0.807 | 0.337 | 0.041 |
| 207R00428 | 5/21/2013 | 0.158 | 0.4 | 0.512 | 0.577 | 0.196 | 0.099 |
| 207R00476 | 5/23/2013 | 0.196 | 0.314 | 0.686 | 0.467 | 0.345 | 0.108 |
| 207R00556 | 5/15/2013 | 0.059 | 0.217 | 0.403 | 0.734 | 0.266 | 0.039 |

### 4.2.3 Analysis of Condition Indicators

The condition assessment relies upon the observed B-IBI scores, as the algae IBI scores and metrics are still considered preliminary. As indicated below, the B-IBI scoring scheme options need to be further investigated, developed, and tested specifically for SF Bay Area creeks.

**Benthic Macroinvertebrate Metrics**

As shown in Table 4-2, seven of the eight sites monitored in WY 2013 received a SoCal B-IBI score of "very poor," and one site was "poor" (see Table 3-2 for score categories). As indicated in Table 4-1, three of the four sites monitored in Fairfield-Suisun and all four of the sites monitored in Solano County are in streams designated as having the WARM (warm water fishery) beneficial use, while three of the

Fairfield-Suisun sites are in creeks designated as having the COLD (cold water fishery) beneficial use. To the extent that benthic conditions may reflect or influence the viability of the fisheries in these water bodies, it may be assumed that benthic conditions (categorized as poor or very poor by the SoCal B-IBI process) may indicate some difficulty in supporting the designated aquatic life beneficial uses. In the absence of an available B-IBI developed for the San Francisco Bay Region, the SoCal B-IBI was used to assess the condition of BMI data sampled in the RMC area, and therefore these results should be considered provisional.

## 4.3 Stressor Assessment

This section addresses the question: ***"What are major stressors to aquatic life in the RMC area?"*** Each monitoring category required by MRP Provision C.8.c, Table 8-1 is associated with a specification for "Results that Trigger a Monitoring Project in Provision C.8.d.i" (Stressor/Source Identification). The definitions of these "Results that Trigger…," as shown in Table 8.1, are considered to represent "trigger criteria," meaning that the relevant monitoring results should be forwarded for consideration as potential Stressor/Source Identification Projects per Provision C.8.d.i. The biological, physical, chemical, and toxicity testing data produced by RMC participants during Water Years 2012 and 2013 were compiled and evaluated, and analyzed against these trigger criteria. When the data analysis indicated that the associated trigger criteria were not met, those sites and results were identified as potentially warranting further investigation.

When interpreting analytical chemistry results, it is important to account for laboratory data reported as either below method detection limits (MDLs) or between detection and reporting limits (RLs). Dealing with data in this range of the analytical spectrum introduces some level of uncertainty, especially when attempting to generate summary statistics for a data set. In the compilation of statistics for analytical chemistry that follow, non-detect data (ND) were substituted with a concentration equal to one-half of the respective MDL as reported by the laboratory. This differs from the 2012 Regional UCMR (BASMAA, 2013), which substituted a value of one-half of the RL for NDs.[18] The use of one-half of the MDL is the most common substitution in environmental science (e.g., Helsel, 2010), and is thought to be more representative of laboratory results. Some of the results may therefore be slightly biased high or low with this associated analytical uncertainty, but this is not expected to affect the conclusions to any great extent.

### 4.3.1 Stressor Indicators

**Physical Habitat Parameters**

A wide range of physical habitat characteristics can influence the biological conditions of urban streams. Physical habitat condition was assessed on a preliminary basis using PHab scores (Table 4-5), computed for Solano County sites from three physical habitat attributes (epifaunal substrate/cover, sediment deposition, and channel alteration) measured in the field during bioassessment monitoring in Water Year 2013. The composite PHab score has a possible range from 0 to 60, with each of the contributing factors scored on a range of 0–20 points. Higher PHab scores reflect higher-quality habitat.

[18] Substitution of one-half of the MRL in several cases brought about a situation where analytical data reported as ND was, for statistical purposes, estimated at higher concentrations than similar data reported between the MDL and RL. Specific instances are discussed in subsequent sections.

In an initial evaluation, the PHab scores do not correspond well with either the B-IBI scores or the A-IBI scores; therefore the PHab scores initially do not have substantial value as stressor indicators as reflected in composite biological condition scores.

To illustrate this point, Site 207R03504 (Rindler Creek) is the only concrete channel sampled in Solano County during this reporting period, and produced a relatively low PHab score (20), yet had by far the highest A-IBI score (see Table 4-3) and the second highest (though still poor) B-IBI score (see Table 4-2). This is an indication that the factors affecting biological and physical conditions in streams are complex, and as a result stream condition is not easy to predict.

**Table 4-5. Physical habitat scores for Solano County bioassessment sites sampled in Water Year 2013.**

| | Site | Epifaunal Substrate/Cover | Sediment Deposition | Channel Alteration | Total |
|---|---|---|---|---|---|
| FSURMP | 207R00428 | 12 | 15 | 5 | **32** |
| | 207R00556 | 12 | 15 | 5 | **32** |
| | 207R00476 | 10 | 4 | 5 | **19** |
| | 207R01452 | 13 | 8 | 3 | **24** |
| | **Mean score** | 11.75 | 10.50 | 4.50 | **26.75** |
| Vallejo | 207R00064 | 14 | 10 | 13 | **37** |
| | 207R00688 | 8 | 6 | 6 | **20** |
| | 207R03504 | 1 | 17 | 2 | **20** |
| | 207R04080 | 8 | 6 | 8 | **22** |
| | **Mean score** | 7.75 | 9.75 | 7.25 | **24.75** |

## Water Chemistry Parameters

Table 4-6 provides a summary of descriptive statistics for the nutrients and related conventional constituents collected in association with the bioassessments in receiving waters. For the purposes of data analysis, Total Nitrogen was calculated as the sum of nitrate + nitrite + Total Kjeldahl Nitrogen (TKN).

**Table 4-6. Descriptive statistics for water chemistry results collected at RMC sites during Water Years 2012 and 2013. Results include two years of monitoring for ACCWP and CCCWP and one year (2013) for FSURMP and Vallejo.**

| "Nutrients" | N | N ≥ RL | Min | Max | Max Detected | Mean |
|---|---|---|---|---|---|---|
| Chloride | 68 | 68 | 17 | 410 | 410 | 85 |
| Chlorophyll-a | 68 | 55 | <5.14 | 414.14 | 414.14 | 106.50 |
| Dissolved Organic Carbon | 68 | 66 | <0.3 | 14 | 14 | 4.0 |
| Ammonia as N | 68 | 22 | <0.04 | 0.79 | 0.79 | 0.09 |
| Nitrate as N | 68 | 47 | <0.01 | 7.50 | 7.50 | 0.69 |
| Nitrite as N | 68 | 4 | <0.002 | 0.19 | 0.19 | 0.012 |
| Nitrogen, Total Kjeldahl | 68 | 68 | 0.11 | 2.10 | 2.10 | 0.55 |
| OrthoPhosphate as P | 68 | 60 | <0.006 | 0.85 | 0.85 | 0.10 |
| Phosphorus as P | 68 | 65 | <0.007 | 3.5 | 3.5 | 0.16 |
| Suspended Sediment Concentration | 68 | 47 | <2 | 171 | 171 | 14 |
| Silica as SiO2 | 68 | 68 | 5.9 | 43 | 43 | 22 |

In comparing the effect of using one-half the MDL in place of one-half the MRL to estimate values of NDs, the differences are relatively minor (Table 4-7). The greatest difference is observed in calculation of chlorophyll-a, while relatively minor differences are observed elsewhere.

**Table 4-7. Calculation of mean concentration of water chemistry parameters using MDL- vs. MRL-based substitutions for non-detects.**

| "Nutrients" | MDL-based | MRL-based |
|---|---|---|
| Chloride | 85 | 85 |
| Chlorophyll-a | 106.50 | 114.61 |
| Dissolved Organic Carbon | 4.0 | 4.0 |
| Ammonia as N | 0.09 | 0.10 |
| Nitrate as N | 0.69 | 0.69 |
| Nitrite as N | 0.012 | 0.018 |
| Nitrogen, Total Kjeldahl | 0.55 | 0.55 |
| OrthoPhosphate as P | 0.10 | 0.10 |
| Phosphorus as P | 0.16 | 0.16 |
| Suspended Sediment Concentration | 14 | 14 |
| Silica as SiO2 | 22 | 22 |

### Water and Sediment Toxicity Testing

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

For water sample toxicity tests, MRP Table 8.1 identifies toxicity results of less than 50% of the control as requiring follow-up action. For sediment sample tests, MRP Table H-1 identifies toxicity results more

than 20% less than the control as requiring follow-up action.[19] Therefore, in the tables that follow, samples that are identified by the lab as toxic (based on statistical comparison of samples vs. Control at $p < 0.05$) are further evaluated to determine whether the result was less than 50% of the associated control (for water samples) or statistically different and more than 20% less than the Control (for sediment samples).

Samples for triad sites (not present in Solano County) were targeted to be collected within creeks at sites where bioassessments were conducted in the same water year, where flow regime was assessed as perennial, and where sufficient fine-grained surficial sediments were likely to be present during dry season. The toxicity testing results are presented in context of the following three groups:

1. wet season water samples
2. dry season water samples
3. dry season sediment samples

For each of these groups, the results are first presented in a table indicating which samples were found to be toxic by virtue of a statistically significant difference from the Control as determined by the laboratory. Detailed results are then presented in a subsequent table for the toxic samples, along with an assessment as to whether the toxic effect was less than 50% of the Control for water samples, or more than 20% less than the Control for sediment samples.

<u>Wet Season Aquatic Toxicity</u>

Per the MRP, ambient water samples were collected by the four collaborating Programs from five sites throughout the region during storm events in March 2012, and seven locations in March and April of 2013, and tested for toxic effects using four species: an aquatic plant (*Selenastrum capricornutum*), two aquatic invertebrates (*Ceriodaphnia dubia* and *Hyalella azteca*), and one fish species (*Pimephales promelas* or fathead minnow). Testing in 2013 also included retests at those locations sampled in 2012 where samples met MRP-defined thresholds triggering follow-up monitoring. The following sections discuss the results of 2012 and 2013 monitoring in the context of MRP triggers.

In 2012, no samples were found to be toxic to either *C. dubia* or *S. capricornutum*. Three of five samples were identified as toxic to *H. azteca* (Table 4-7). Two of five samples generated a toxic response within *P. promelas*. Of those two, one was identified with significant toxicity relative to the chronic endpoint (growth), and one relative to the acute endpoint criterion (survival). Both of these test results were identified by the toxicity-testing laboratory as having been affected by interference due to pathogen-related mortality (PRM), an acknowledged source of laboratory interference in receiving water samples. The lab reports for these samples include the following statement relative to the PRM-affected samples: "observations of PRM are not associated with or indicative of stormwater toxicity." In those three cases, the samples were retested using a method developed to minimize PRM interference (Geis et al., 2003). In both cases, no toxic response was observed.

In 2013, ambient water samples were collected from a total of 10 sites during storm events in March and April 2013. Sampling was unable to be conducted synoptically due to the lack of storm events that met the mobilization criteria for sampling regionwide. Of the monitoring conducted, 7 sites were tested

[19] Footnote #162 to Table H-1 of the MRP reads, "Toxicity is exhibited when Hyallela (sic) survival statistically different than and < 20 percent of control." Consistent with the UCMR (BASMAA, 2013), for the purposes of this report, this is assumed to be intended to read "…statistically different than and more than 20 percent less than control."

with the four MRP test species identified previously. In addition, samples were collected from three sites sampled in 2012, as discussed previously, that required retest per the MRP; these samples were analyzed only with the test species for which 2012 samples met MRP-defined triggers.

As shown in Table 4-8, none of the 2013 samples analyzed against the full suite of test species were found to be toxic to *S. capricornutum*. Two samples were identified as toxic to *C. dubia*, both for the chronic endpoint (growth). Two samples were reported as toxic to *H. azteca*.

In 2013, one sample was identified as toxic to *P. promelas*, with significant toxicity relative to the acute endpoint criterion (survival). As in 2012, this toxic result was identified by the laboratory as having been caused by interference due to PRM. Following up on the initial identification of PRM, the laboratory was requested to retest the sample media using the 20-replicate EPA (2000) protocol, which resulted in removal of the toxic response, supporting the initial identification of PRM as a contributor to mortality.

**Table 4-8. Summary of WY 2012 and WY 2013 wet-season water toxicity results for four-species tests. Shaded cells indicate monitoring conducted in WY 2012.**

| Wet-Season Water Samples | | | | Toxicity Relative to the Lab Control Treatment? | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | ***S. capricornutum*** | ***C. dubia*** | | ***H. azteca*** | ***P. promelas*** | |
| **County/ Program** | **Sample Station** | **Collection Date** | **Date of Analysis** | **Growth** | **Sur-vival** | **Repro-duction** | **Survival** | **Sur-vival** | **Growth** |
| ACCWP | 204R00047 | 3/14/12 | 3/15/12 | No | No | No | **Yes** | No | **Yes**[1] |
| ACCWP | 204R00084 | 3/14/12 | 3/15/12 | No | No | No | No | No | No |
| ACCWP | 204R00100 | 3/14/12 | 3/15/12 | No | No | No | No | **Yes**[1] | No |
| ACCWP | 204R00327 | 3/6/13 | 3/6/13 | No | No | **Yes** | No | No | No |
| ACCWP | 204R00447 | 3/6/13 | 3/6/13 | No | No | No | **Yes** | No | No |
| ACCWP | 205R00686 | 3/6/13 | 3/6/13 | No | No | **Yes** | No | No | No |
| CCCWP | 207R00011 | 3/14/12 | 3/15/12 | No | No | No | **Yes** | No | No |
| CCCWP | 544R00025 | 3/14/12 | 3/17/12 | No | No | No | **Yes** | No | No |
| CCCWP | 207R00271 | 3/6/13 | 3/6/13 | No | No | No | No | **Yes**[2] | No |
| CCCWP | 544R00281 | 4/4/13 | 4/5/13 | No | No | No | **Yes** | No | No |
| FSURMP | 207R00236 | 3/20/13 | 3/21/13 | No | No | No | No | No | No |
| Vallejo | 207R00064 | 3/20/13 | 3/21/13 | No | No | No | No | No | No |

Notes:

[1] PRM was identified by laboratory in multiple replicates for this stormwater sample; toxicity was not observed in retests using Geis technique.

[2] PRM was identified by laboratory in multiple replicates for this stormwater sample; toxicity was not observed in retests using EPA 20-replicate method (USEPA 2000).

Table 4-9 provides detailed results for RMC wet-weather receiving water samples in Water Years 2012 and 2013 tested against the four target species and found to be toxic relative to the laboratory control. Samples collected in 2012 at sites 204R00047, 207R00011, and 544R00025, and a sample collected in 2013 at site 544R00281 each exhibited *H. azteca* survival that was significantly different from and less than 50% of the control.

**Table 4-9. Comparison between laboratory control and receiving water sample toxicity results (*H. azteca* and *C. dubia*) for RMC samples collected in WY 2012 and WY 2013 wet season, in the context of MRP trigger criteria.**

| County/ Program | Test Initiation Date | Species Tested | Treatment/ Sample ID | 10-Day Mean % Survival | Mean Reproduction (# neonates/ female) | Comparison to MRP Table 8.1 Trigger Criteria |
|---|---|---|---|---|---|---|
| ACCWP | 3/15/12 | *Hyalella azteca* | Lab Control | 100 | NA | NA |
| | 3/15/12 | | 204R00047 | **48*** | | **<50% of Control** |
| CCCWP | 3/15/12 | | Lab Control | 100 | | NA |
| | 3/15/12 | | 207R00011 | **32*** | | **<50% of Control** |
| | 3/15/12 | | Lab Control | 94 | | NA |
| | 3/15/12 | | 544R00025 | **0*** | | **<50% of Control** |
| ACCWP | 3/07/13 | *H. azteca* | Lab Control | 98 | NA | NA |
| | 3/07/13 | | 204R00447 | **60*** | | Not <50% of control |
| | 3/06/13 | *C. dubia* | Lab Control | 100 | 36.6 | NA |
| | 3/06/13 | | 204R00327 | 100 | **28.1*** | Not <50% of control |
| | 3/06/13 | | Lab Control | 100 | 36.6 | NA |
| | 3/06/13 | | 205R00686 | 80 | **24.6*** | Not <50% of control |
| CCCWP | 4/4/13 | *H. azteca* | Lab Control | 100 | NA | NA |
| | 4/4/13 | | 544R00281 | **0*** | | **<50% of control** |

* The response at this test treatment was significantly less than the Lab Control at $p < 0.05$.

For the retests following up on 2012 triggers, three samples were retested with *H. azteca*, the species exhibiting toxic response, and two of these again showed an acute toxic response (Table 4-10). The two samples identified with significant toxicity, 207R00011 and 544R00025, both again met MRP triggers that would typically require follow-up retesting (Table 4-11). The single sample collected in 2013 that met triggers for retesting (544R00281) will be similarly incorporated into 2014 monitoring.

**Table 4-10. Summary of WY 2013 wet-season water toxicity testing conducted as retests of 2012 results.**

| Wet Season Water Samples | | | | Toxicity Relative to the Lab Control Treatment? |
|---|---|---|---|---|
| | | | | ***H. azteca*** |
| **County/ Program** | **Sample Station** | **Collection Date** | **Date of Analysis** | **Survival** |
| ACCWP | 204R00047 | 3/5/2013 | 3/6/2013 | No |
| CCCWP | 207R00011 | 3/6/2013 | 3/6/2013 | **Yes** |
| CCCWP | 544R00025 | 4/4/2013 | 4/5/2013 | **Yes** |

**Table 4-11. Comparison between laboratory control and receiving water sample toxicity results (*H. azteca)* for RMC samples retested in WY 2013 wet season, in the context of MRP trigger criteria**

| County/ Program | Test Initiation Date (Time) | Species Tested | Treatment/ Sample ID | 10-Day Mean % Survival | Mean Reproduction (# neonates/ female) | Comparison to MRP Table 8.1 Trigger Criteria |
|---|---|---|---|---|---|---|
| CCCWP | 3/6/13 | *H. azteca* | Lab Control | 100 | | NA |
| | 3/6/13 | | 207R00011 | **4*** | | **< 50% of control** |
| | 4/4/13 | | Lab Control | 100 | | NA |
| | 4/4/13 | | 544R00025 | **20*** | | **< 50% of control** |

* The response at this test treatment was significantly less than the Lab Control at $p < 0.05$.

Table 4-12 provides detailed results for the *P. promelas* tests that were noted to have statistically different results from laboratory controls, as well as the results of retesting using a version of the Geis technique (for 2012 samples) or USEPA (2000) 20-replicate test (for 2013 samples). In three of the four cases, the original *P. promelas* tests were identified by the laboratory to be affected by PRM interference, based upon visual examination of test organisms. When retested using a technique designed to prevent PRM interference, toxicity was not observed in these samples, supporting the original determination of PRM interference in the initial tests.

As indicated in Table 4-12, while significantly less than the associated laboratory Control values in some cases, the affected results were in each case not less than the associated MRP threshold of less than 50% of the Control values for either survival or biomass growth.

**Table 4-12. Comparison between laboratory control and receiving water sample toxicity results for *P. promelas* for RMC samples collected in the WY 2012 and WY 2013 wet seasons, in the context of MRP trigger criteria. Shaded cells indicate monitoring conducted in WY 2012**

| County/ Program | Test Initiation Date (Time) | Treatment/ Sample ID | Mean % Survival | Mean Biomass Value (mg) | Comparison to MRP Table 8.1 Trigger Criteria; Identification of PRM Effects and PRM Method Retests |
|---|---|---|---|---|---|
| ACCWP | 3/15/12 | Lab Control | 100 | 0.52 | NA |
| | 3/15/12 | 204R00047 | 95 (a) | **0.42*** (a) | Not <50% of control; PRM noted |
| | 3/15/12 | 204R00100 | **72.5*** (a) | 0.46 | Not <50% of control; PRM noted |
| | 3/23/12 | Lab Control | 100 | 0.27 | PRM method retest (Geis et al., 2003) |
| | 3/23/12 | 204R00047 | 90 | 0.29 | PRM method retest (Geis et al., 2003) |
| | 3/23/12 | 204R00100 | 100 | 0.34 | PRM method retest (Geis et al., 2003) |
| CCCWP | 3/6/13 | Lab Control | 97.5 | 0.73 | NA |
| | 3/6/13 | 207R00271 | **50*** (a) | 0.52 | Not <50% of control; PRM noted and retested |
| | 3/15/13 | Lab Control | 92.5 | 0.50 | PRM method retest (20-replicate test) |
| | 3/15/13 | 207R00271 | 90 | 0.55 | PRM method retest (20-replicate test) |

* The response at this test treatment was significantly less than the Lab Control at $p < 0.05$.
(a) PRM was observed in multiple replicates for this stormwater sample

## Dry-Season Aquatic Toxicity

Water samples were collected during the summer 2012 and 2013 periods from the same sites where wet season sampling occurred (five sites in 2012 and seven sites in 2013), and were again tested for aquatic toxicity using the same four test species. The results are summarized in Table 4-13. In comparisons to the control samples, no samples collected in 2012 were found to be toxic to the test species.

There were multiple samples collected in 2013 where aquatic toxicity was observed by the laboratory. These included samples toxic to *C. dubia* (207R00064), *H. azteca* (204R00447 and 207R00271), and *P. promelas* (204R00327, 204R00447, 205R00686, 207R00271, and 544R00281).

**Table 4-13. Summary of WY 2012 and WY 2013 dry-season aquatic toxicity results**

| Dry-Season Water Samples | | | Toxicity Relative to the Lab Control Treatment? | | | | | |
|---|---|---|---|---|---|---|---|---|
| County/ Program | Sample Station | Collection Date | *S. capricornutum* | *C. dubia* | | *H. azteca* | *P. promelas* | |
| | | | Growth | Survival | Reproduction | Survival | Survival | Growth |
| ACCWP | 204R00047 | 7/25/12 | No | No | No | No | No | No |
| ACCWP | 204R00084 | 7/25/12 | No | No | No | No | No | No |
| ACCWP | 204R00100 | 7/25/12 | No | No | No | No | No | No |
| CCCWP | 207R00011 | 7/25/12 | No | No | No | No | No | No |
| CCCWP | 544R00025 | 7/25/12 | No | No | No | No | No | No |
| ACCWP | 204R00327 | 7/9/13 | No | No | No | No | No | **Yes** |
| ACCWP | 204R00447 | 7/9/13 | No | No | No | **Yes** | No | **Yes** |
| ACCWP | 205R00686 | 7/9/13 | No | No | No | No | No | **Yes** |
| CCCWP | 207R00271 | 7/9/13 | No | No | No | **Yes** | **Yes** | No |
| CCCWP | 544R00281 | 7/9/13 | No | No | No | No | No | **Yes** |
| FSURMP | 207R00236 | 7/11/13 | No | No | No | No | No | No |
| Vallejo | 207R00064 | 7/11/13 | No | No | **Yes** | No | No | **Yes** |

For samples identified with significant toxicity, one of the two samples toxic to *H. azteca*, collected at site 207R00271, met the MRP criterion for triggering follow-up retesting (Table 4-13). The single sample identified as toxic to *C. dubia* did not meet the MRP trigger for follow-up testing.

**Table 4-14. Comparison between laboratory control and receiving water sample toxicity results (*C. dubia* and *H. azteca)* for RMC samples collected in WY 2012 and WY 2013 dry seasons and reported as toxic, in the context of MRP trigger criteria.**

| County/ Program | Test Initiation Date | Species Tested | Treatment/ Sample ID | 10-Day Mean % Survival | Mean Reproduction (# neonates/ female) | Comparison to MRP Table 8.1 Trigger Criteria |
|---|---|---|---|---|---|---|
| ACCWP | 7/10/13 | *H. azteca* | Lab Control | 100 | **NA** | NA |
| | 7/10/13 | | 204R00447 | **94*** | | Not <50% of control |
| CCCWP | 7/10/13 | *H. azteca* | Lab Control | 96 | | NA |
| | 7/10/13 | | 207R00271 | **2*** | | **<50% of control** |
| Vallejo | 7/10/13 | *C. dubia* | Lab Control | 100 | 36.3 | NA |
| | 7/10/13 | | 207R00064 | 100 | **24.0*** | Not <50% of control |

* The response at this test treatment was significantly less than the Lab Control at $p < 0.05$.

Multiple dry-season *P. promelas* tests were noted to have statistically different results from laboratory control, each associated with monitoring in Water Year 2013. As shown in Table 4-15, only one of the samples reported as significantly toxic to *P. promelas* fell below the MRP threshold of being <50% of the control (207R00271). This sample was identified as affected by PRM, and retested using the standard EPA 20-replicate method (USEPA, 2000). Toxicity was not observed in the retest, again supporting the original determination of PRM interference in the initial test.

**Table 4-15. Comparison between laboratory control and receiving water sample toxicity results for *P. promelas* for RMC samples identified as toxic collected in the WY 2012 and WY 2013 dry seasons, in the context of MRP trigger criteria.**

| County/ Program | Test Initiation Date | Treatment/ Sample ID | Mean % Survival | Mean Biomass Value (mg) | Comparison to MRP Table 8.1 Trigger Criteria; Identification of PRM effects and PRM Method Retests |
|---|---|---|---|---|---|
| ACCWP | 7/10/13 | Lab Control | 95 | 0.80 | NA |
| | 7/10/13 | 204R00327 | 92.5 | **0.68*** | Not <50% of control |
| | 7/10/13 | Lab Control | 95 | 0.80 | NA |
| | 7/10/13 | 204R00447 | 97.5 | **0.70* (a)** | Not <50% of control |
| | 7/10/13 | Lab Control | 95 | 0.80 | NA |
| | 7/10/13 | 205R00686 | 77.5 (a) | **0.66*** | Not <50% of control |
| CCCWP | 7/10/13 | Lab Control | 95 | 0.80 | NA |
| | 7/10/13 | 207R00271 | **27.5* (a)** | 0.36 | **< 50% of Control** |
| | 7/18/13 | Lab Control | 97.5 | 0.56 | PRM retest using 20 replicate method |
| | 7/18/13 | 207R00271 | 97.5 | 0.53 | PRM retest using 20 replicate method |
| | 7/10/13 | Lab Control | 95 | 0.80 | NA |
| | 7/10/13 | 544R00281 | 97.5 | **0.67*** | Not <50% of control |
| Vallejo | 7/11/13 | Lab Control | 98.8 | 0.21 | NA |
| | 7/11/13 | 207R00064 | 97.5 | **0.16*** | Not <50% of control |

* The response at this test treatment was significantly less than the Lab Control at $p < 0.05$.
(a) PRM was observed in multiple replicates for this stormwater sample

## Dry Season Sediment Toxicity

During the dry season, sediment samples were collected at the same sites where water toxicity samples were collected[1] and tested for both sediment toxicity and an extensive list of sediment chemistry constituents. For sediment toxicity, testing was performed with just one species, *H. azteca*, a common benthic invertebrate. Both acute (survival) and chronic (growth) endpoints were reported.

The results of the sediment toxicity testing in Water Years 2012 and 2013 are summarized in Table 4-16. Three of the five samples collected in Water Year 2012 by the collaborating programs were determined to be toxic to *H. azteca* for the acute endpoint (survival). There were no determinations of significant toxicity based upon the chronic endpoint (growth) in 2012. In 2013, three of seven samples collected were determined to be toxic to *H. azteca* for survival, and two of seven samples were identified as toxic for growth.

1. An exception is in Vallejo, where site 207R00064, monitored for wet/dry season water toxicity and bioassessment, did not have sufficient sediment to run toxicity tests. Sediment samples were therefore taken approximately 2160 meters downstream, at site 207R05524.

**Table 4-16. Summary of WY 2012 and WY 2013 dry-season sediment toxicity results. Shaded cells indicate monitoring conducted in WY 2012.**

| Dry-Season Sediment Samples | | | Date of Analysis | Toxicity relative to the Lab Control treatment? | |
|---|---|---|---|---|---|
| | | | | *H. azteca* | |
| County/ Program | Sample Station | Collection Date | | Survival | Growth |
| ACCWP | 204R00047 | 7/25/12 | 7/28/12 | **Yes** | N/A* |
| ACCWP | 204R00084 | 7/25/12 | 7/28/12 | No | No |
| ACCWP | 204R00100 | 7/25/12 | 7/28/12 | No | No |
| ACCWP | 204R00327 | 7/9/13 | 7/14/13 | No | No |
| ACCWP | 204R00447 | 7/9/13 | 7/14/13 | No | **Yes** |
| ACCWP | 205R00686 | 7/9/13 | 7/14/13 | No | **Yes** |
| CCCWP | 207R00011 | 7/25/12 | 7/28/12 | **Yes** | N/A* |
| CCCWP | 544R00025 | 7/25/12 | 7/28/12 | **Yes** | N/A* |
| CCCWP | 207R00271 | 7/9/13 | 7/14/13 | **Yes** | N/A* |
| CCCWP | 544R00281 | 7/9/13 | 7/14/13 | **Yes** | N/A* |
| FSURMP | 207R00236 | 7/11/13 | 7/14/13 | **Yes** | N/A* |
| Vallejo | 207R05524 | 7/18/13 | 7/26/13 | No | **Yes** |

* Per EPA guidance, samples with a significant reduction in survival are not evaluated for chronic endpoints (i.e., growth).

Detailed results of dry-season sediment samples identified as having toxic effects in Water Years 2012 and 2013 are shown in Table 4-17, along with comparisons to the relevant trigger criteria from MRP Tables 8.1 and H-1. Over the first two years of monitoring, there was a single instance of a sample exhibiting significant toxicity that did not meet the MRP trigger of *H. azteca* survival reported as more than 20% less than the control (204R00047). For the remaining five samples for which significant toxicity was identified, the magnitude of the acute endpoint results met MRP thresholds potentially triggering follow-up activity.

**Table 4-17. Detailed sediment toxicity results for dry-season samples exhibiting significant toxicity to *H. azteca.* Shaded cells indicate sampling conducted in WY 2012.**

| County/ Program | Test Initiation Date | Treatment/ Sample ID | Mean % Survival | Mean Dry Weight (mg) | Comparison to MRP Tables 8.1 and H-1 Trigger Criteria |
|---|---|---|---|---|---|
| ACCWP | 7/28/12 | Lab Control | 96.3 | 0.23 | NA |
| | 7/28/12 | 204R00047 | **88.8*** | 0.24 | Not more than 20% < Control |
| ACCWP | 7/14/13 | Lab Control | 91.3 | 0.28 | NA |
| | 7/14/13 | 204R00447 | 78.8 | **0.15*** | No MRP comparison for growth endpoint |
| | 7/14/13 | Lab Control | 91.3 | 0.28 | NA |
| | 7/14/13 | 205R00686 | 87.5 | **0.24*** | No MRP comparison for growth endpoint |
| CCCWP | 7/28/12 | Lab Control | 96.3 | 0.23 | NA |
| | 7/28/12 | 207R00011 | **43.8*** | 0.09 | **More than 20% < Control** |
| | 7/28/12 | Lab Control | 96.3 | 0.23 | NA |
| | 7/28/12 | 544R00025 | **60*** | 0.23 | **More than 20% < Control** |
| CCCWP | 7/14/13 | Lab Control | 91.3 | 0.281 | NA |
| | 7/14/13 | 207R00271 | **0*** | - | **More than 20% < Control** |
| | 7/14/13 | Lab Control | 91.3 | 0.281 | NA |
| | 7/14/13 | 544R00281 | **53.8*** | 0.109 | **More than 20% < Control** |
| FSURMP | 7/14/13 | Lab Control | 98.8 | 0.23 | NA |
| | 7/14/13 | 207R00236 | **71.2*** | 0.09 | **More than 20% < Control** |
| Vallejo | 7/26/13 | Lab Control | 98.8 | 0.21 | NA |
| | 7/26/13 | 207R05524 | 97.5 | **0.16*** | No MRP comparison for growth endpoint |

* The response at this test treatment was significantly less than the Lab Control treatment response at $p < 0.05$.

**Sediment Chemistry Parameters**

Descriptive statistics for sediment chemistry data for samples collected in Water Years 2012 and 2013 are provided in Table 4-18. Analytes are presented in alphabetical order.

It should be noted that a number of the sediment chemistry constituents assessed per the list in MacDonald et al. (2000) required some grouping of analytes. For example, the MacDonald "chlordane" constituent required the combination of "chlordane, cis" and "chlordane, trans" from the laboratory data, and the MacDonald "total DDTs" parameter required the aggregation of six isomers of DDD, DDE, and DDT. The MacDonald list also includes 10 individual PAH compounds, as well as "Total PAHs." For this report, "Total PAHs" was computed as the sum of 24 PAH compounds reported by the laboratory, including biphenyl. Biphenyl is often not considered to be a member of the PAH class, but as a compound with two benzene rings it can be considered a closely related compound. Biphenyl was not detected in the 10 RMC sediment samples analyzed in Water Year 2012, and was not counted in the list of 23 PAH compounds summed for the "Total PAHs" parameter in the 2013 Urban Creeks Monitoring Report.

**Table 4-18. Descriptive statistics for WY 2012 and WY 2013 sediment chemistry results.[1]**

| Analyte | N | N ≥ MDL | Min | Max | Max Detected | Mean |
|---|---|---|---|---|---|---|
| Acenaphthene | 12 | 2 | <3.1 | 48 | 48 | 16 |
| Acenaphthylene | 12 | 1 | <3.1 | 7.1 | 7.1 | 12 |
| Anthracene | 12 | 1 | <3.1 | 220 | 220 | 30 |
| Arsenic | 12 | 12 | 2.1 | 26 | 26 | 7 |
| Benz(a)anthracene | 12 | 3 | <3.1 | 700 | 700 | 72 |
| Benzo(a)pyrene | 12 | 2 | <3.1 | 230 | 230 | 34 |
| Benzo(b)fluoranthene | 12 | 4 | <3.1 | 430 | 430 | 61 |
| Benzo(e)pyrene | 12 | 2 | <3.1 | 170 | 170 | 33 |
| Benzo(g,h,i)perylene | 12 | 3 | <3.1 | 230 | 230 | 38 |
| Benzo(k)fluoranthene | 12 | 1 | <3.1 | 170 | 170 | 26 |
| Bifenthrin | 12 | 12 | <0.19 | 58 | 58 | 15 |
| Biphenyl | 12 | 1 | <3.4 | <610 | 11 | 66 |
| Cadmium | 12 | 12 | <0.066 | 0.72 | 0.72 | 0.3 |
| chlordane, cis- | 12 | 0 | <1.3 | <21 | NA | 2 |
| chlordane, trans- | 12 | 0 | <1.3 | <21 | NA | 2 |
| Chromium | 12 | 12 | <8.5 | 58 | 58 | 29 |
| Chrysene | 12 | 4 | <3.1 | 870 | 870 | 92 |
| Copper | 12 | 12 | 8.6 | 92 | 92 | 33 |
| Cyfluthrin, total | 12 | 10 | <0.31 | 15 | 15 | 5 |
| Cyhalothrin, lambda, total | 12 | 3 | <0.076 | 4.2 | 4.2 | 1 |
| Cypermethrin, total | 12 | 5 | <0.13 | 3.6 | 3.6 | 1 |
| DDD(o,p') | 12 | 0 | <0.58 | <43 | NA | 4 |
| DDD(p,p') | 12 | 3 | <1.2 | 17 | 17 | 4 |
| DDE(o,p') | 12 | 0 | <0.52 | <43 | NA | 4 |
| DDE(p,p') | 12 | 4 | <1.3 | 240 | 240 | 24 |
| DDT(o,p') | 12 | 1 | <0.6 | 4.7 | 4.7 | 5 |
| DDT(p,p') | 12 | 1 | <0.8 | 9.2 | 9.2 | 2 |
| Deltamethrin/Tralomethrin | 12 | 6 | <0.15 | 23 | 23 | 3 |
| Dibenz(a,h)anthracene | 12 | 0 | <3.1 | <92 | NA | 12 |
| Dibenzothiophene | 12 | 1 | <3.4 | 44 | 44 | 70 |
| Dieldrin | 12 | 0 | <1.4 | <92 | NA | 3 |
| Dimethylnaphthalene, 2,6- | 12 | 8 | <3.1 | 360 | 360 | 84 |
| Endrin | 12 | 0 | <0.78 | <11 | NA | 2 |
| Esfenvalerate/Fenvalerate, total | 12 | 1 | <0.16 | 1.2 | 1.2 | 0.4 |
| Fluoranthene | 12 | 8 | <3.1 | 2100 | 2100 | 243 |
| Fluorene | 12 | 1 | <3.1 | 67 | 67 | 17 |
| HCH, gamma- | 12 | 0 | <0.66 | <15 | NA | 2 |
| Heptachlor epoxide | 12 | 0 | <0.63 | <17 | NA | 2 |
| Indeno(1,2,3-c,d)pyrene | 12 | 1 | <3.1 | 220 | 220 | 30 |
| Lead | 12 | 12 | 4.9 | 51 | 51 | 16 |
| Mercury | 12 | 12 | <0.025 | 0.29 | 0.29 | 0.1 |
| Methylnaphthalene, 1- | 12 | 0 | <3.1 | <92 | NA | 12 |
| Methylnaphthalene, 2- | 12 | 0 | <3.1 | <92 | NA | 12 |
| Methylphenanthrene, 1- | 12 | 0 | <3.1 | <92 | NA | 12 |
| Naphthalene | 12 | 2 | <3.1 | 14 | 14 | 13 |
| Nickel | 12 | 12 | 9.8 | 96 | 96 | 40 |
| Permethrin, cis- | 12 | 7 | <0.14 | 9.3 | 9.3 | 3 |
| Permethrin, trans- | 12 | 3 | <0.14 | 2.4 | 2.4 | 1 |
| Perylene | 12 | 1 | <3.1 | 54 | 54 | 16 |
| Phenanthrene | 12 | 5 | <3.1 | 1100 | 1100 | 117 |
| Pyrene | 12 | 9 | <3.1 | 1900 | 1900 | 233 |
| Total Organic Carbon | 12 | 12 | <0.38 | 9.2 | 9.2 | 3 |
| Zinc | 12 | 12 | <9.8 | 740 | 740 | 187 |

[1] "N" = number of samples; "N > MDL" = number of samples detected above the laboratory method detection limit

### 4.3.2 Stressor Analysis

Stressor analysis provides an analysis of the water and sediment chemistry and toxicity testing results in comparison to various thresholds included in the MRP. This analysis is intended to provide a means of identifying potential stressors that may impact beneficial uses at the creek status monitoring locations.

**Water Chemistry Parameters**

According to MRP Table 8.1, the trigger criterion ("Results that Trigger a Monitoring Project in Provision C.8.d.i) for the "Nutrients" constituents analyzed in conjunction with the bioassessment monitoring is *"20% of results in one waterbody exceed one or more water quality standard or established threshold*." A search for relevant water quality standards or accepted thresholds was conducted using available sources, including the SF Basin Water Quality Control Plan ("Basin Plan"; SF Bay Water Board, 2013), the California Toxics Rule (CTR) (USEPA, 2000a), and various USEPA sources. Of the 11 water quality constituents monitored in association with the bioassessment monitoring (referred to collectively as "Nutrients" in MRP Table 8.1), water quality standards or established thresholds are available only for ammonia (unionized form), chloride, and nitrate plus nitrite – the latter two for waters with MUN beneficial use only, as indicated in Table 4-19.

For ammonia, the standard provided in the Basin Plan (p. 3-7) applies to the un-ionized fraction, as the underlying criterion is based on un-ionized ammonia, which is the more toxic form. Conversion of RMC monitoring data from the measured total ammonia to un-ionized ammonia was therefore necessary. The conversion was based on a formula provided by the American Fisheries Society,[20] and calculates un-ionized ammonia in freshwater systems from analytical results for total ammonia and field-measured pH, temperature, and electrical conductivity.

For chloride, a Secondary Maximum Contaminant Level (MCL) of 250 mg/L applies to those waters with MUN beneficial use, per the Basin Plan (Table 3-5), Title 22 of the California Code of Regulations (CDPH, internet source), and the USEPA Drinking Water Quality Standards (USEPA, internet source). This same threshold is additionally established in the Basin Plan (Table 3-7) for waters in the Alameda Creek watershed above Niles. For all other waters, the Criteria Maximum Concentration (CMC) water quality criterion of 860 mg/L (acute) and the Criterion Continuous Concentration (CCC) of 230 mg/L (USEPA Water Quality Criteria 2009)[21] for the protection of aquatic life were used for comparison purposes.[22]

The nitrate + nitrite primary MCL applies to those waters with MUN beneficial use, per the Basin Plan (Table 3-5), Title 22 of the California Code of Regulations, and the USEPA Drinking Water Quality Standards.

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[20] http://fisheries.org/hatchery

[21] National Recommended Water Quality Criteria. EPA's compilation of national recommended water quality criteria is presented as a summary table containing recommended water quality criteria for the protection of aquatic life and human health in surface water for approximately 150 pollutants. These criteria are published pursuant to Section 304(a) of the Clean Water Act (CWA) and provide guidance for states and tribes to use in adopting water quality standards.
http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm.

[22] Per UCMR (BASMAA, 2012) the RMC participants used the 230 mg/L threshold as a conservative benchmark for comparison purposes for all locations not specifically identified within the Basin Plan, i.e. sites not within the Alameda Creek watershed above Niles nor identified as MUN; rather than the maximum concentration criterion of 830mg/L.

**Table 4-19. Water quality thresholds available for comparison to Water Year 2012 and 2013 water chemistry constituents.**

| Sample Parameter | Threshold | Units | Frequency/ Period | Application | Source |
|---|---|---|---|---|---|
| Ammonia | 0.025 | mg/L | Annual median | Unionized ammonia, as N. [Maxima also apply to Central Bay and u/s (0.16) and Lower Bay (0.4)] | SF Bay Basin Plan Ch. 3, p. 3-7 |
| Chloride | 230 | mg/L | Criterion Continuous Concentration | Freshwater aquatic life | USEPA Nat'l. Rec. WQ Criteria, Aquatic Life Criteria |
| Chloride | 860 | mg/L | Criteria Maximum Concentration | Freshwater aquatic life | USEPA Nat'l. Rec. WQ Criteria, Aquatic Life Criteria Table |
| Chloride | 250 | mg/L | Secondary Maximum Contaminant Level | Alameda Creek Watershed above Niles and MUN waters, Title 22 Drinking Waters | SF Bay Basin Plan Ch. 3, Tables 3-5 and 3-7; CA Code Title 22; USEPA Drinking Water Stds. Secondary MCL |
| Nitrate + Nitrite (as N) | 10 | mg/L | Maximum Contaminant Level | Areas designated as Municipal Supply | SF Bay Basin Plan Ch. 3, Table 3-5 |

The comparisons of the measured nutrients data to the thresholds listed in Table 4-19 are shown in Table 4-20. The results for these three constituents are plotted against the prevailing thresholds on Figures 4-4 through 4-6. Of the 68 sites monitored, the water quality standard was exceeded at one site for chloride (204R00068 in 2012).[23] Two results (sites 205R00686 and 207R03504, both sampled in 2013) exceeded the un-ionized ammonia standard.[24] No samples exceeded the nitrate + nitrite standard. The MRP Table 8.1 trigger criterion for "Nutrients" (20% of results in one water body exceed one or more water quality standards or applicable thresholds) was therefore considered to be exceeded at only 3 of the 68 sites.

[23] This assessment is unaffected by usage of the CCC of 230 mg/L or CMC of 860 mg/L, as the single instance occurred at a site within Alameda Creek above Niles, and is therefore measured against the criterion of 250 mg/L.
[24] It should be noted that this standard is an annual median concentration, and comparison to an acute threshold may change this determination.

**Table 4-20. Comparison of water quality (nutrient) data to associated water quality thresholds for WY 2012 and WY 2013 water chemistry results. (NDs estimated as ½ MDL). Shaded cells indicate monitoring conducted in WY 2012.**

| County/ Program | Site Code | Alameda Creek Above Niles | MUN | Parameter and Threshold | | | # of Parameters >Threshold/ Water Body | % of Parameters >Threshold/ Water Body |
|---|---|---|---|---|---|---|---|---|
| | | | | Un-ionized Ammonia (as N) | Chloride | Nitrate + Nitrite (as N) | | |
| | | | | 25 µg/L | 230/250 mg/L [1] | 10 mg/L [2] | | |
| ACCWP | 204R00047 | | | 25.0 | 97 | NA | 0 | 0% |
| ACCWP | 204R00068 | X | | 10.1 | **410** | NA | 1 | **50%** |
| ACCWP | 204R00084 | X | | 0.14 | 64 | NA | 0 | 0% |
| ACCWP | 204R00100 | X | | 2.27 | 87 | NA | 0 | 0% |
| ACCWP | 204R00191 | X | X | 1.26 | 57 | 0.26 | 0 | 0% |
| ACCWP | 204R00303 | | | 2.48 | 46 | NA | 0 | 0% |
| ACCWP | 204R00319 | | | 4.36 | 24 | NA | 0 | 0% |
| ACCWP | 204R00340 | X | | 1.47 | 160 | NA | 0 | 0% |
| ACCWP | 204R00356 | X | | 3.10 | 110 | NA | 0 | 0% |
| ACCWP | 204R00367 | | | 1.59 | 54 | NA | 0 | 0% |
| ACCWP | 204R00383 | | | 1.46 | 54 | NA | 0 | 0% |
| ACCWP | 204R00391 | | | 1.47 | 93 | NA | 0 | 0% |
| ACCWP | 204R00455 | | | 1.20 | 36 | NA | 0 | 0% |
| ACCWP | 204R00583 | | | 5.67 | 51 | NA | 0 | 0% |
| ACCWP | 204R00596 | X | | 0.67 | 240 | NA | 0 | 0% |
| ACCWP | 204R00639 | | X | 8.99 | 64 | 0.06 | 0 | 0% |
| ACCWP | 204R00647 | | | 0.67 | 39 | NA | 0 | 0% |
| ACCWP | 205R00110 | | | 1.16 | 32 | NA | 0 | 0% |
| ACCWP | 205R00430 | | | 4.61 | 80 | NA | 0 | 0% |
| ACCWP | 205R00535 | | | 0.87 | 110 | NA | 0 | 0% |
| ACCWP | 203R00983 | | | 0.47 | 17 | NA | 0 | 0% |
| ACCWP | 204R00063 | | | 2.53 | 29 | NA | 0 | 0% |
| ACCWP | 204R00327 | | | 0.72 | 39 | NA | 0 | 0% |
| ACCWP | 204R00334 | x | x | 0.32 | 63 | 0.07 | 0 | 0% |
| ACCWP | 204R00447 | x | | 6.04 | 230 | NA | 0 | 0% |
| ACCWP | 204R00473 | x | | 1.45 | 42 | NA | 0 | 0% |
| ACCWP | 204R00590 | x | x | 2.63 | 50 | 0.01 | 0 | 0% |
| ACCWP | 204R00623 | | | 2.34 | 47 | NA | 0 | 0% |
| ACCWP | 204R00724 | x | | 0.49 | 79 | NA | 0 | 0% |
| ACCWP | 204R00751 | | | 0.28 | 29 | NA | 0 | 0% |
| ACCWP | 204R00852 | x | | 0.79 | 130 | NA | 0 | 0% |
| ACCWP | 204R00967 | | | 2.81 | 110 | NA | 0 | 0% |
| ACCWP | 204R01316 | x | | 2.16 | 120 | NA | 0 | 0% |
| ACCWP | 204R01471 | x | | 1.92 | 190 | NA | 0 | 0% |
| ACCWP | 205R00174 | | | 3.98 | 150 | NA | 0 | 0% |
| ACCWP | 205R00686 | | | **46.55** | 140 | NA | 1 | **50%** |
| ACCWP | 205R00878 | | | 6.75 | 68 | NA | 0 | 0% |
| ACCWP | 205R01134 | | | 0.00 | 30 | NA | 0 | 0% |
| ACCWP | 205R01198 | | | 0.00 | 94 | NA | 0 | 0% |
| ACCWP | 205R01390 | | | 0.49 | 90 | NA | 0 | 0% |
| CCCWP | 203R00039 | | | 1.41 | 38 | NA | 0 | 0% |

| County/ Program | Site Code | Alameda Creek Above Niles | MUN | Parameter and Threshold | | | # of Parameters >Threshold/ Water Body | % of Parameters >Threshold/ Water Body |
|---|---|---|---|---|---|---|---|---|
| | | | | Un-ionized Ammonia (as N) | Chloride | Nitrate + Nitrite (as N) | | |
| | | | | 25 µg/L | 230/250 mg/L [1] | 10 mg/L [2] | | |
| CCCWP | 206R00155 | | | 2.57 | 23 | NA | 0 | 0% |
| CCCWP | 206R00215 | | | 0.51 | 97 | NA | 0 | 0% |
| CCCWP | 207R00011 | | | 5.23 | 80 | NA | 0 | 0% |
| CCCWP | 207R00139 | | | 1.40 | 40 | NA | 0 | 0% |
| CCCWP | 207R00247 | | | 4.05 | 46 | NA | 0 | 0% |
| CCCWP | 543R00137 | | | 9.49 | 210 | NA | 0 | 0% |
| CCCWP | 543R00219 | | | 3.57 | 140 | NA | 0 | 0% |
| CCCWP | 543R00245 | | | 0.19 | 180 | NA | 0 | 0% |
| CCCWP | 544R00025 | | | 2.30 | 160 | NA | 0 | 0% |
| CCCWP | 206R00727 | | | 3.19 | 39 | NA | 0 | 0% |
| CCCWP | 207R00271 | | | 0.00 | 23 | NA | 0 | 0% |
| CCCWP | 207R00375 | | | 1.05 | 160 | NA | 0 | 0% |
| CCCWP | 207R00395 | | | 3.15 | 43 | NA | 0 | 0% |
| CCCWP | 207R00503 | | | 6.11 | 110 | NA | 0 | 0% |
| CCCWP | 207R00532 | | | 13.74 | 62 | NA | 0 | 0% |
| CCCWP | 207R00567 | | | 0.69 | 110 | NA | 0 | 0% |
| CCCWP | 207R00631 | | | 3.42 | 83 | NA | 0 | 0% |
| CCCWP | 207R00788 | | | 2.84 | 35 | NA | 0 | 0% |
| CCCWP | 544R00281 | | | 7.75 | 130 | NA | 0 | 0% |
| FSURMP | 207R00428 | | | 1.13 | 48 | NA | 0 | 0% |
| FSURMP | 207R00476 | | | 0.04 | 17 | NA | 0 | 0% |
| FSURMP | 207R00556 | | | 0.90 | 61 | NA | 0 | 0% |
| FSURMP | 207R01452 | | | 1.69 | 46 | NA | 0 | 0% |
| Vallejo | 207R03504 | | | **112.69** | 34 | NA | 1 | **50%** |
| Vallejo | 207R04080 | | | 10.28 | 44 | NA | 0 | 0% |
| Vallejo | 207R00688 | | | 13.50 | 35 | NA | 0 | 0% |
| Vallejo | 207R00064 | | | 3.61 | 38 | NA | 0 | 0% |
| **# Values >Threshold:** | | | | 2 | 1 | 0 | | |
| **% Values >Threshold:** | | | | 3% | 1% | 0% | | |
| **Overall Number and % of Sites Meeting Trigger Criterion [3]:** | | | | | | | **3** | **4%** |

[1] 250 mg/L threshold applies for sites with MUN beneficial use and Alameda Creek above Niles per Basin Plan

[2] Nitrate + nitrite threshold applies only to sites with MUN beneficial use

[3] Sites where >20% of results exceed one or more water quality standard or established threshold

NA = threshold does not apply

Bolded value exceeds threshold.

**Figure 4-4. Plot of unionized ammonia (calculated from total ammonia, pH, temperature, and electrical conductivity) with threshold indicated, WY 2012 and WY 2013 data.**

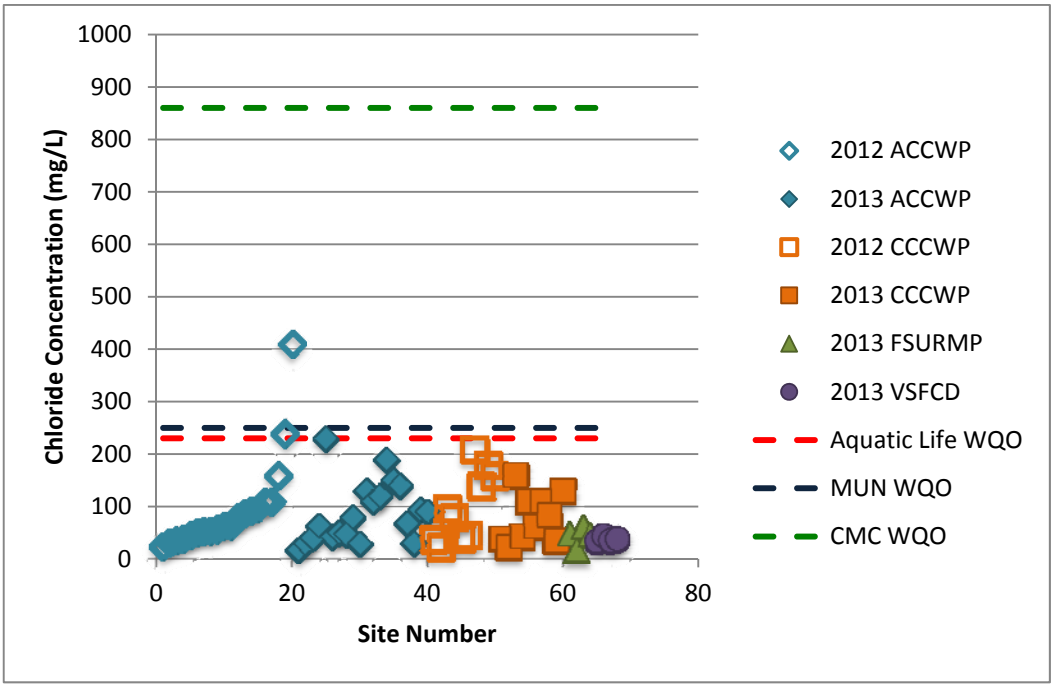


**Figure 4-5. Plot of chloride with Aquatic Life and MUN thresholds indicated, WY 2012 and WY 2013 data.**

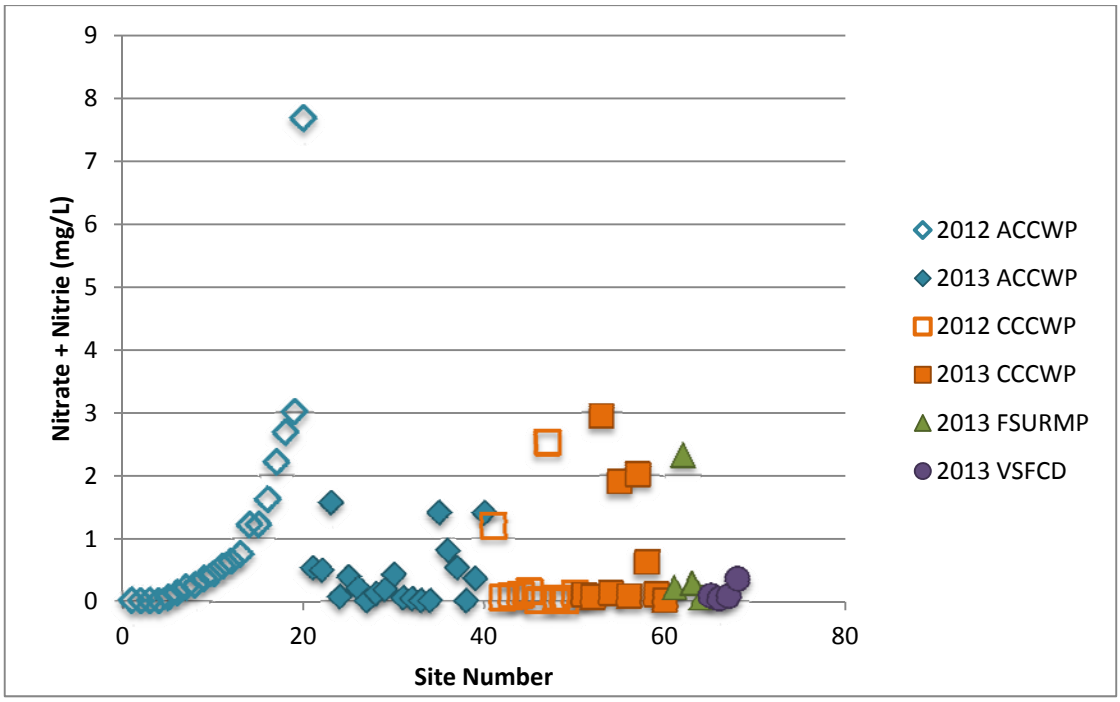


**Figure 4-6. Plot of nitrate and nitrite as N, WY 2012 and WY 2013 data (threshold not shown = 10 mg/L for MUN only).**

### Free and Total Chlorine Testing

The results of field testing for free and total chlorine and comparisons to the MRP Table 8.1 trigger threshold are summarized in Table 4-17. The MRP trigger criterion for chlorine states, "After immediate resampling, concentrations remain >0.08 mg/L".

There were 35 site measurements for free and total chlorine in 2012 collected by ACCWP and CCCWP, as the toxicity sites were each tested twice (spring and summer). In 2013, there were 45 measurements collected, with the added participation of FSURMP and Vallejo. Of the 74 measurements collected overall, 15% exceeded the threshold for free chlorine, and 12% exceeded the threshold for total chlorine; as noted previously, there appears to be an issue with the field kits and free chlorine measurements sometimes exceeded those for total chlorine. Overall, the percentage of samples meeting the trigger threshold for free and/or total chlorine was 19%.

**Table 4-21. Summary of chlorine testing results for samples collected in WY 2012 and WY 2013 in comparison to Municipal Regional Permit trigger criteria. Shaded cells represent data collected in WY 2012.**

| County/ Program | Site Code | Sample Date | Chlorine, Free | Chlorine, Total | Meets Trigger Threshold? |
|---|---|---|---|---|---|
| ACCWP | 204R00047 | 6/6/12 | **0.12** | 0.08 | **Yes** |
| ACCWP | 204R00047 | 7/25/12 | 0 | 0.04 | No |
| ACCWP | 204R00068 | 5/31/12 | 0 | 0.04 | No |
| ACCWP | 204R00084 | 5/24/12 | 0 | **0.10** | **Yes** |
| ACCWP | 204R00084 | 7/25/12 | 0 | 0 | No |
| ACCWP | 204R00100 | 5/30/12 | **0.12** | 0.04 | **Yes** |
| ACCWP | 204R00100 | 7/25/12 | **0.12** | 0.08 | **Yes** |
| ACCWP | 204R00191 | 5/29/12 | **0.10** | 0 | **Yes** |
| ACCWP | 204R00303 | 6/14/12 | 0 | 0 | No |
| ACCWP | 204R00319 | 6/7/12 | 0 | 0 | No |
| ACCWP | 204R00340 | 6/11/12 | 0.08 | 0.08 | No |
| ACCWP | 204R00356 | 6/4/12 | 0.04 | 0.04 | No |
| ACCWP | 204R00367 | 6/12/12 | 0 | 0 | No |
| ACCWP | 204R00383 | 6/11/12 | **0.12** | **0.12** | **Yes** |
| ACCWP | 204R00391 | 6/6/12 | 0.02 | 0.02 | No |
| ACCWP | 204R00455 | 6/13/12 | **0.10** | 0 | **Yes** |
| ACCWP | 204R00583 | 6/13/12 | **0.12** | **0.16** | **Yes** |
| ACCWP | 204R00596 | 5/31/12 | **0.12** | **0.12** | **Yes** |
| ACCWP | 204R00639 | 6/19/12 | 0.04 | 0.04 | No |
| ACCWP | 204R00647 | 6/18/12 | 0 | 0 | No |
| ACCWP | 205R00110 | 6/18/12 | 0 | 0 | No |
| ACCWP | 205R00430 | 6/5/12 | 0.04 | 0 | No |
| ACCWP | 205R00535 | 6/20/12 | 0.02 | 0.02 | No |
| ACCWP | 203R00983 | 6/6/13 | 0 | 0 | No |
| ACCWP | 204R00063 | 6/4/13 | 0 | 0 | No |
| ACCWP | 204R00327 | 5/7/13 | 0 | 0 | No |
| ACCWP | 204R00334 | 5/8/13 | 0 | 0 | No |
| ACCWP | 204R00447 | 4/22/13 | 0.06 | 0.03 | No |
| ACCWP | 204R00473 | 5/9/13 | 0 | 0 | No |
| ACCWP | 204R00590 | 5/8/13 | 0 | 0 | No |
| ACCWP | 204R00623 | 6/3/13 | 0 | 0 | No |
| ACCWP | 204R00724 | 5/21/13 | 0.04 | **0.2** | **Yes** |
| ACCWP | 204R00751 | 6/5/13 | 0 | 0 | No |
| ACCWP | 204R00852 | 5/6/13 | 0 | 0 | No |
| ACCWP | 204R00967 | 4/25/13 | 0.02 | 0.02 | No |
| ACCWP | 204R01316 | 5/22/13 | 0.04 | 0.02 | No |
| ACCWP | 204R01471 | 5/22/13 | **0.12** | **0.16** | **Yes** |
| ACCWP | 205R00174 | 4/23/13 | 0.02 | 0.02 | No |
| ACCWP | 205R00686 | 4/24/13 | 0.02 | 0.02 | No |
| ACCWP | 205R00878 | 4/24/13 | 0.02 | 0.02 | No |
| ACCWP | 205R01134 | 5/20/13 | 0.02 | 0.02 | No |
| ACCWP | 205R01198 | 5/20/13 | 0.02 | 0 | No |
| ACCWP | 205R01390 | 5/23/13 | 0 | 0 | No |

| County/ Program | Site Code | Sample Date | Chlorine, Free | Chlorine, Total | Meets Trigger Threshold? |
|---|---|---|---|---|---|
| ACCWP | 204R00327 | 7/9/13 | 0 | 0.02 | No |
| ACCWP | 204R00447 | 7/9/13 | 0 | 0 | No |
| ACCWP | 205R00686 | 7/9/13 | 0 | 0 | No |
| CCCWP | 203R00039 | 5/14/12 | 0 | 0.02 | No |
| CCCWP | 206R00155 | 5/16/12 | 0.01 | 0.01 | No |
| CCCWP | 206R00215 | 5/23/12 | 0 | 0 | No |
| CCCWP | 207R00011 | 5/22/12 | 0 | 0 | No |
| CCCWP | 207R00011 | 7/25/12 | 0.04 | 0.02 | No |
| CCCWP | 207R00139 | 5/17/12 | **0.12** | 0.04 | **Yes** |
| CCCWP | 207R00247 | 5/22/12 | 0.03 | 0.04 | No |
| CCCWP | 543R00137 | 5/15/12 | 0 | 0 | No |
| CCCWP | 543R00219 | 5/21/12 | 0.04 | 0.06 | No |
| CCCWP | 543R00245 | 5/21/12 | 0.04 | 0 | No |
| CCCWP | 544R00025 | 5/15/12 | 0 | 0 | No |
| CCCWP | 544R00025 | 7/25/12 | 0 | **0.12** | **Yes** |
| CCCWP | 206R00727 | 5/13/13 | 0.04 | 0.05 | No |
| CCCWP | 207R00271 | 4/29/13 | 0 | 0 | No |
| CCCWP | 207R00375 | 5/1/13 | 0 | 0 | No |
| CCCWP | 207R00395 | 5/14/13 | 0.04 | 0.04 | No |
| CCCWP | 207R00503 | 5/2/13 | 0 | 0 | No |
| CCCWP | 207R00532 | 4/29/13 | 0 | 0 | No |
| CCCWP | 207R00567 | 4/30/13 | 0 | 0 | No |
| CCCWP | 207R00631 | 5/16/13 | 0.02 | 0.02 | No |
| CCCWP | 207R00788 | 5/15/13 | 0 | 0 | No |
| CCCWP | 544R00281 | 5/15/13 | 0 | 0 | No |
| CCCWP | 207R00271 | 7/9/13 | 0 | 0 | No |
| CCCWP | 544R00281 | 7/9/13 | 0 | 0 | No |
| FSURMP | 207R00428 | 5/21/13 | 0.06 | 0.04 | No |
| FSURMP | 207R00476 | 5/23/13 | **0.2** | **0.12** | **Yes** |
| FSURMP | 207R00556 | 5/15/13 | NR | **0.2** | **Yes** |
| FSURMP | 207R01452 | 5/28/13 | **0.16** | **0.1** | **Yes** |
| FSURMP | 207R00236 | 8/14/13 | 0.07 | 0.05 | No |
| Vallejo | 207R03504 | 5/29/13 | 0.02 | 0.02 | No |
| Vallejo | 207R04080 | 5/30/13 | 0 | 0 | No |
| Vallejo | 207R00688 | 5/29/13 | 0.02 | 0.00 | No |
| Vallejo | 207R00064 | 5/28/13 | 0 | 0 | No |
| **Number of samples exceeding 0.08 mg/L:** | | | 12 | 10 | 16 |
| **Percentage of samples exceeding 0.08 mg/L:** | | | 16% | 14% | 22% |

### Water and Sediment Toxicity Testing

The analysis of toxicity testing results and comparisons to MRP trigger thresholds, as presented in detail earlier in this section, are summarized in Table 4-22 for those Water Year 2012 samples that initially exceeded thresholds.

The MRP Table 8.1 trigger criterion for water column toxicity stipulates "If toxicity results less than 50% of control results, repeat sample. If 2nd sample yields less than 50% of control results, proceed to C.8.d.i." Therefore the three 2012 water samples indicated in Table 4-22 as having results "< 50% of Control" were retested in 2013.

Three sites were retested in wet season 2013 for the test species that triggered the retest. While the ACCWP retest (site 204R00047) did not exhibit toxicity in the retest, the two CCCWP sites again exhibited significant toxicity to *H. azteca*, with survival less than the MRP trigger of 50% of the Control. Results of these retests are summarized in Table 4-23.

**Table 4-22. Overall summary of 2012 aquatic and sediment toxicity samples with toxic response in comparison to Municipal Regional Permit trigger criteria.**

| County/ Program | Test Initiation Date | Species Tested | Test Regimen | Treatment/ Sample ID | Comparison to Table 8.1 (Water) and Table H-1 (Sediment) Trigger Criteria |
|---|---|---|---|---|---|
| **Water** | | | | | |
| ACCWP | 3/15/12 | *H. azteca* | Acute (survival) | 204R00047 | **<50% of control** |
| CCCWP | 3/15/12 | *H. azteca* | Acute (survival) | 207R00011 | **<50% of control** |
| CCCWP | 3/15/12 | *H. azteca* | Acute (survival) | 544R00025 | **<50% of control** |
| **Sediment** | | | | | |
| CCCWP | 7/28/12 | *H. azteca* | Acute (survival) | 207R00011 | **More than 20% < control** |
| CCCWP | 7/28/12 | *H. azteca* | Acute (survival) | 544R00025 | **More than 20% < control** |

**Table 4-23. Overall summary of WY 2013 aquatic toxicity retests triggered by WY 2012 MRP toxicity trigger criteria.**

| County/ Program | Test Initiation Date | Species Tested | Treatment/ Sample ID | 10-Day Mean % Survival | Comparison to MRP Table 8.1 Trigger Criteria |
|---|---|---|---|---|---|
| ACCWP | 3/7/13 | *H. azteca* | Lab Control | 98 | NA |
| | 3/7/13 | | 204R00047 | 98 | No significant difference |
| CCCWP | 3/7/13 | *H. azteca* | Lab Control | 98 | NA |
| | 3/7/13 | | 207R00011 | **4*** | **<50% of control** |
| CCCWP | 4/5/13 | *H. azteca* | Lab Control | 100 | NA |
| | 4/5/13 | | 544R00025 | **20*** | **<50% of control** |

* The response at this test treatment was significantly less than the Lab Control treatment response at $p < 0.05$.

The analysis of toxicity testing results and comparisons to MRP trigger thresholds, also as detailed earlier, are summarized in Table 4-24 for those Water Year 2013 samples that initially exceeded thresholds. In addition to the results identified, there was one additional toxicity test, *P. promelas* collected at site 207R00271 in July 2013, for which significant toxicity was identified in the initial analysis, but the 20-replicate reanalysis (USEPA, 2000) to address PRM identified by the laboratory removed the toxic response.[25]

[25] See discussion in Section 4.3.1, Dry Season Aquatic Toxicity, and Table 4-11.

**Table 4-24. Overall summary of 2013 toxicity results in comparison to Municipal Regional Permit trigger criteria**

| County/ Program | Test Initiation Date | Species Tested | Test Regimen | Treatment/ Sample ID | Comparison to Table 8.1 (Water) and Table H-1 (Sediment) Trigger Criteria |
|---|---|---|---|---|---|
| **Water** | | | | | |
| CCCWP | 4/5/13 | *H. azteca* | Acute (survival) | 544R00281 | **< 50% of control** |
| CCCWP | 7/10/13 | *H. azteca* | Acute (survival) | 207R00271 | **< 50% of control** |
| **Sediment** | | | | | |
| CCCWP | 7/14/13 | *H. azteca* | Acute (survival) | 544R00281 | **More than 20% < control** |
| CCCWP | 7/14/13 | *H. azteca* | Acute (survival) | 207R00271 | **More than 20% < control** |
| FSURMP | 7/14/13 | *H. azteca* | Acute (survival) | 207R00236 | **More than 20% < control** |

### Sediment Chemistry Parameters

Sediment chemistry results are evaluated as potential stressors in three ways, based upon the following criteria from MRP Table H-1:

- Calculation of threshold effect concentration (TEC) quotients by analyte; determine whether site has three or more TEC quotients greater than or equal to 1.0.[26]
- Calculation of probable effect concentration (PEC) quotients for all analytes at a given site; determine whether site has mean PEC quotient greater than or equal to 0.5.
- Calculation of pyrethroid toxic unit (TU) equivalents as sum of TU equivalents for all measured pyrethroids; determine whether site has sum of TU equivalents greater than or equal to 1.0.

More detail is provided below on each of these three factors.

For sediment chemistry results, Table 4-25 provides threshold effect concentration (TEC) quotients for all non-pyrethroid sediment chemistry constituents, calculated as the measured concentration divided by the TEC value, per MacDonald et al. (2000). This table also provides a count of the number of constituents that exceed TEC values for each site, as evidenced by a TEC quotient greater than or equal to 1.0.

The number of TEC quotients greater than or equal to 1.0 for each site ranges from a low of 0 to a high of 13, out of 27 constituents included in MacDonald et al. (2000). Ten of twelve sites sampled met the relevant trigger criterion from MRP Table H-1, which is interpreted to stipulate three or more constituents with TEC quotients greater than or equal to 1.0.

Table 4-26 provides PEC quotients for all non-pyrethroid sediment chemistry constituents, and calculated mean values of the PEC quotients for each site, with the mean PEC quotient highlighted for

[26] Consistent with 2012 Regional UCMR (BASMAA, 2013) interpretation, this analysis assumes that there is a typographical error in Table H-1 and that the criterion is meant to read, “3 or more chemicals exceed TECs.”

sites where mean PEC quotient greater than or equal to 0.5. One site (544R00025) met the MRP Table H-1 action criteria with a mean PEC greater than 0.5. The mean PEC quotients are shown graphically by site on Figure 4-7.

Table 4-27 provides a summary of the calculated toxic unit equivalents for the pyrethroids for which there are published LC50 values in the literature, as well as a sum of calculated toxic unit (TU) equivalents for each site. Because organic carbon mitigates the toxicity of pyrethroid pesticides in sediments, the LC50 values were derived on the basis of TOC-normalized pyrethroid concentrations. Therefore, the pyrethroid concentrations as reported by the lab were divided by the measured TOC concentration at each site, and the TOC-normalized concentrations were then used to compute TU equivalents for each pyrethroid. The individual TU equivalents were then summed to produce a total pyrethroid TU equivalent value for each site. Eight of the 12 sites meet the MRP Table H-1 action criterion with at least one TU quotient greater than or equal to 1.0. These results are shown graphically on Figure 4-8. In most cases, the greatest contributor to the TU sum is bifenthrin (greater than 1.0 TU in 6 of the 12 samples). Both deltamethrin and cyfluthrin exceeded 1.0 TUs in 1 of the 12 samples.

Some of the calculated numbers for TEC quotients, PEC quotients, and pyrethroid TU equivalents may be artificially elevated due to the method used to account for filling in non-detect data (as discussed previously, concentrations equal to one-half of the respective laboratory MDLs were substituted for non-detect data so these statistics could be computed). This, however, is not expected to greatly influence assessments.

In assessing the effect of using one-half of the MDL in place of one-half of the MRL to estimate ND results for statistical purposes, relatively large differences were observed in some cases for the 2012 assessments reported in the UCMR (BASMAA 2013), which have been recalculated for this report. For example, assessments for trace metals remain unchanged, as there were no NDs reported for any of the metals analyzed. In comparison, calculated TEC quotients for individual and total PAHs are lower across-the-board using the MDL due to the relatively large proportion of NDs and the difference between MDLs and MRLs reported. For example, for site 204R00047, the number of TEC quotients above the 1.0 threshold dropped from six to one. Similar to the case for PAHs, the TEC quotients for OC pesticides showed decreases associated with the change in estimation technique. However, there remain multiple cases where the TEC quotient is greater than 1.0; it should be noted that 2012 analyses are predominantly non-detects, and therefore that the TEC quotients calculated are driven by the MDL rather than quantified laboratory results. TEC quotients for OC pesticides calculated for this report are approximately one-half of UCMR reported calculations.

**Table 4-25. Threshold Effect Concentration (TEC) quotients for 2012 and 2013 sediment chemistry constituents. Yellow highlighted cells indicate sites where 3 or more constituents have TEC>1.0.**

| Stormwater Program, Site ID | ACCWP 204R00047 (2012) | ACCWP 204R00084 (2012) | ACCWP 204R00100 (2012) | ACCWP 204R00327 (2013) | ACCWP 204R00447 (2013) | ACCWP 205R00686 (2013) | CCCWP 207R00011 (2012) | CCCWP 544R00025 (2012) |
|---|---|---|---|---|---|---|---|---|
| **Metals (mg/kg DW)** | | | | | | | | |
| Arsenic | 0.32 | 0.55 | 0.51 | 0.26 | 0.84 | 0.25 | 0.21 | 0.46 |
| Cadmium | 0.23 | 0.63 | 0.08 | 0.55 | 0.73 | 0.17 | 0.07 | 0.16 |
| Chromium | 0.20 | 0.76 | **1.34** | 0.55 | **1.24** | 0.21 | 0.20 | 0.65 |
| Copper | 0.70 | 0.70 | 0.85 | 0.76 | **2.91** | 0.92 | 0.27 | 0.89 |
| Lead | 0.36 | 0.59 | 0.25 | **1.42** | 0.59 | 0.17 | 0.18 | 0.36 |
| Mercury | 0.28 | 0.21 | **1.61** | 0.67 | 0.83 | 0.22 | 0.83 | 0.14 |
| Nickel | 0.57 | **1.32** | **4.23** | **1.15** | **3.30** | 0.57 | 0.43 | **1.15** |
| Zinc | **1.40** | 0.79 | 0.44 | **1.32** | **6.12** | **3.14** | 0.38 | 0.74 |
| **PAHs (µg/kg DW)** | | | | | | | | |
| Anthracene | 0.45 | 0.19 | 0.04 | **3.85** | 0.09 | 0.07 | 0.53 | 0.80 |
| Fluorene | 0.33 | 0.14 | 0.03 | 0.87 | 0.06 | 0.05 | 0.39 | 0.59 |
| Naphthalene | 0.14 | 0.06 | 0.01 | 0.08 | 0.07 | 0.02 | 0.17 | 0.26 |
| Phenanthrene | 0.69 | 0.05 | 0.01 | **5.39** | 0.14 | 0.12 | 0.15 | 0.23 |
| Benz(a)anthracene | 0.24 | 0.10 | 0.02 | **6.48** | 0.12 | 0.20 | 0.28 | 0.43 |
| Benzo(a)pyrene | 0.41 | 0.07 | 0.02 | **1.53** | 0.03 | 0.03 | 0.20 | 0.31 |
| Chrysene | 0.15 | 0.07 | 0.01 | **5.24** | 0.31 | 0.29 | 0.18 | 0.28 |
| Fluoranthene | 0.90 | 0.15 | 0.01 | **4.96** | 0.10 | 0.12 | 0.50 | 0.11 |
| Pyrene | **2.15** | 0.36 | 0.01 | **9.74** | 0.23 | 0.38 | **1.03** | 0.24 |
| Total PAHs | **1.31** | 0.34 | 0.05 | **5.38** | 0.20 | 0.40 | **1.04** | **1.01** |
| **Pesticides (µg/kg DW)** | | | | | | | | |
| Chlordane | **6.48** | 0.90 | 0.49 | 0.40 | 0.65 | 0.52 | **2.59** | **4.01** |
| Dieldrin | **6.84** | 0.92 | 0.50 | 0.37 | 0.61 | 0.50 | **2.63** | **3.95** |
| Endrin | **2.48** | 0.34 | 0.18 | 0.34 | 0.54 | 0.45 | 0.95 | **1.44** |
| Heptachlor Epoxide | **3.44** | 0.47 | 0.24 | 0.13 | 0.40 | 0.17 | **1.36** | **2.02** |
| Lindane (gamma-BHC) | **3.16** | 0.42 | 0.23 | 0.14 | 0.44 | 0.18 | **1.24** | **1.88** |
| Sum DDD | **6.15** | **4.08** | 0.44 | 0.76 | 0.35 | 0.28 | **2.43** | **5.43** |
| Sum DDE | **10.92** | **1.47** | 0.79 | 0.94 | **2.12** | 0.38 | **4.27** | **79.91** |
| Sum DDT | **6.73** | **2.91** | 0.48 | **1.23** | 0.27 | 0.23 | **2.64** | **3.92** |
| Total DDTs | **17.52** | **6.94** | **1.26** | **2.23** | **1.81** | 0.66 | **6.88** | **55.93** |
| **Number of constituents with TEC quotient ≥ 1.0** | **12** | **5** | **4** | **13** | **6** | **1** | **10** | **11** |

| Stormwater Program, Site ID | CCCWP 207R00271 (2013) | CCCWP 544R00281 (2013) | FSURMP 207R00236 (2013) | Vallejo 207R05524 (2013) |
|---|---|---|---|---|
| **Metals (mg/kg DW)** | | | | |
| Arsenic | 0.25 | 0.72 | **1.12** | **2.66** |
| Cadmium | 0.08 | 0.20 | 0.15 | 0.23 |
| Chromium | 0.28 | 0.92 | 0.99 | 0.81 |
| Copper | 0.31 | **1.08** | **1.68** | **1.55** |
| Lead | 0.14 | 0.27 | 0.53 | 0.39 |
| Mercury | 0.23 | 0.46 | 0.23 | **1.00** |
| Nickel | 0.57 | **3.22** | **2.42** | **2.03** |
| Zinc | 0.46 | 0.99 | **1.32** | **1.40** |
| **PAHs (µg/kg DW)** | | | | |
| Anthracene | 0.03 | 0.06 | 0.10 | 0.09 |
| Fluorene | 0.02 | 0.04 | 0.07 | 0.06 |
| Naphthalene | 0.01 | 0.02 | 0.03 | 0.03 |
| Phenanthrene | 0.01 | 0.02 | 0.03 | 0.05 |
| Benz(a)anthracene | 0.01 | 0.03 | 0.05 | 0.05 |
| Benzo(a)pyrene | 0.01 | 0.02 | 0.04 | 0.03 |
| Chrysene | 0.01 | 0.04 | 0.03 | 0.03 |
| Fluoranthene | 0.00 | 0.02 | 0.01 | 0.03 |
| Pyrene | 0.01 | 0.04 | 0.08 | 0.10 |
| Total PAHs | 0.02 | 0.10 | 0.10 | 0.13 |
| **Pesticides (µg/kg DW)** | | | | |
| Chlordane | 0.40 | 0.43 | 0.69 | 0.65 |
| Dieldrin | 0.37 | 0.39 | 0.63 | 0.61 |
| Endrin | 0.34 | 0.36 | 0.59 | 0.54 |
| Heptachlor Epoxide | 0.13 | 0.14 | 0.22 | 0.20 |
| Lindane (gamma-BHC) | 0.14 | 0.15 | 0.23 | 0.23 |
| Sum DDD | 0.21 | 0.23 | 0.37 | 0.35 |
| Sum DDE | 0.29 | **4.20** | 0.47 | 0.45 |
| Sum DDT | 0.17 | 0.18 | 0.29 | 0.27 |
| Total DDTs | 0.50 | **2.86** | 0.85 | 0.80 |
| | | | | |
| **Number of constituents with TEC quotient ≥ 1.0** | **0** | **4** | **4** | **5** |

**Table 4-26. Probable Effect Concentration (PEC) quotients for WY 2012 and WY 2013 sediment chemistry constituents. Yellow highlighted cells indicate sites where mean PEC quotient ≥ 0.5 (trigger threshold per MRP Table H-1); bolded values indicate individual PEC quotients > 1.0.**

| Stormwater Program, Site ID | ACCWP 204R00047 (2012) | ACCWP 204R00084 (2012) | ACCWP 204R00100 (2012) | ACCWP 204R00327 (2013) | ACCWP 204R00447 (2013) | ACCWP 205R00686 (2013) | CCCWP 207R00011 (2012) | CCCWP 544R00025 (2012) |
|---|---|---|---|---|---|---|---|---|
| **Metals (mg/kg DW)** | | | | | | | | |
| Arsenic | 0.09 | 0.16 | 0.15 | 0.08 | 0.25 | 0.07 | 0.06 | 0.14 |
| Cadmium | 0.05 | 0.12 | 0.02 | 0.11 | 0.14 | 0.03 | 0.01 | 0.03 |
| Chromium | 0.08 | 0.30 | 0.52 | 0.22 | 0.49 | 0.08 | 0.08 | 0.25 |
| Copper | 0.15 | 0.15 | 0.18 | 0.16 | 0.62 | 0.19 | 0.06 | 0.19 |
| Lead | 0.10 | 0.16 | 0.07 | 0.40 | 0.16 | 0.05 | 0.05 | 0.10 |
| Mercury | 0.05 | 0.03 | 0.27 | 0.11 | 0.14 | 0.04 | 0.14 | 0.02 |
| Nickel | 0.27 | 0.62 | **1.98** | 0.53 | **1.54** | 0.27 | 0.20 | 0.53 |
| Zinc | 0.37 | 0.21 | 0.12 | 0.35 | **1.61** | 0.83 | 0.10 | 0.19 |
| **PAHs (µg/kg DW)** | | | | | | | | |
| Anthracene | 0.03 | 0.01 | 0.00 | 0.26 | 0.01 | 0.00 | 0.04 | 0.05 |
| Fluorene | 0.05 | 0.02 | 0.00 | 0.13 | 0.01 | 0.01 | 0.06 | 0.09 |
| Naphthalene | 0.05 | 0.02 | 0.00 | 0.02 | 0.02 | 0.01 | 0.05 | 0.08 |
| Phenanthrene | 0.12 | 0.01 | 0.00 | 0.94 | 0.02 | 0.02 | 0.03 | 0.04 |
| Benz(a)anthracene | 0.02 | 0.01 | 0.00 | 0.67 | 0.01 | 0.02 | 0.03 | 0.04 |
| Benzo(a)pyrene | 0.04 | 0.01 | 0.00 | 0.16 | 0.00 | 0.00 | 0.02 | 0.03 |
| Chrysene | 0.02 | 0.01 | 0.00 | 0.67 | 0.04 | 0.04 | 0.02 | 0.04 |
| Fluoranthene | 0.17 | 0.03 | 0.00 | 0.94 | 0.02 | 0.02 | 0.09 | 0.02 |
| Pyrene | 0.28 | 0.05 | 0.00 | **1.25** | 0.03 | 0.05 | 0.13 | 0.03 |
| Total PAHs | 0.09 | 0.02 | 0.00 | 0.38 | 0.01 | 0.03 | 0.07 | 0.07 |
| **Pesticides (µg/kg DW)** | | | | | | | | |
| Chlordane | **1.19** | 0.16 | 0.09 | 0.07 | 0.12 | 0.10 | 0.48 | 0.74 |
| Dieldrin | 0.21 | 0.03 | 0.02 | 0.01 | 0.02 | 0.02 | 0.08 | 0.12 |
| Endrin | 0.03 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.02 |
| Heptachlor Epoxide | 0.53 | 0.07 | 0.04 | 0.02 | 0.06 | 0.03 | 0.21 | 0.31 |
| Lindane (gamma-BHC) | **1.50** | 0.20 | 0.11 | 0.07 | 0.21 | 0.09 | 0.59 | 0.89 |
| Sum DDD | **1.07** | 0.71 | 0.08 | 0.13 | 0.06 | 0.05 | 0.42 | 0.95 |
| Sum DDE | **1.10** | 0.15 | 0.08 | 0.09 | 0.21 | 0.04 | 0.43 | **8.07** |
| Sum DDT | 0.45 | 0.19 | 0.03 | 0.08 | 0.02 | 0.01 | 0.17 | 0.26 |
| Total DDTs | 0.16 | 0.06 | 0.01 | 0.02 | 0.02 | 0.01 | 0.06 | 0.52 |
| | | | | | | | | |
| **Mean PEC Quotient** | 0.31 | 0.13 | 0.14 | 0.29 | 0.22 | 0.08 | 0.14 | **0.51** |

| Stormwater Program, Site ID | CCCWP 207R00271 (2013) | CCCWP 544R00281 (2013) | FSURMP 207R00236 (2013) | Vallejo 207R05524 (2013) |
|---|---|---|---|---|
| **Metals (mg/kg DW)** | | | | |
| Arsenic | 0.07 | 0.21 | 0.33 | 0.79 |
| Cadmium | 0.02 | 0.04 | 0.03 | 0.05 |
| Chromium | 0.11 | 0.36 | 0.39 | 0.32 |
| Copper | 0.07 | 0.23 | 0.36 | 0.33 |
| Lead | 0.04 | 0.08 | 0.15 | 0.11 |
| Mercury | 0.04 | 0.08 | 0.04 | 0.17 |
| Nickel | 0.27 | **1.50** | **1.13** | 0.95 |
| Zinc | 0.12 | 0.26 | 0.35 | 0.37 |
| **PAHs (µg/kg DW)** | | | | |
| Anthracene | 0.00 | 0.00 | 0.01 | 0.01 |
| Fluorene | 0.00 | 0.01 | 0.01 | 0.01 |
| Naphthalene | 0.00 | 0.01 | 0.01 | 0.01 |
| Phenanthrene | 0.00 | 0.00 | 0.00 | 0.01 |
| Benz(a)anthracene | 0.00 | 0.00 | 0.01 | 0.00 |
| Benzo(a)pyrene | 0.00 | 0.00 | 0.00 | 0.00 |
| Chrysene | 0.00 | 0.01 | 0.00 | 0.00 |
| Fluoranthene | 0.00 | 0.00 | 0.00 | 0.01 |
| Pyrene | 0.00 | 0.00 | 0.01 | 0.01 |
| Total PAHs | 0.00 | 0.01 | 0.01 | 0.01 |
| | | | | |
| Chlordane | 0.07 | 0.08 | 0.13 | 0.12 |
| Dieldrin | 0.01 | 0.01 | 0.02 | 0.02 |
| Endrin | 0.00 | 0.00 | 0.01 | 0.01 |
| Heptachlor Epoxide | 0.02 | 0.02 | 0.03 | 0.03 |
| Lindane (gamma-BHC) | 0.07 | 0.07 | 0.11 | 0.11 |
| Sum DDD | 0.04 | 0.04 | 0.06 | 0.06 |
| Sum DDE | 0.03 | 0.42 | 0.05 | 0.05 |
| Sum DDT | 0.01 | 0.01 | 0.02 | 0.02 |
| Total DDTs | 0.00 | 0.03 | 0.01 | 0.01 |
| | | | | |
| **Mean PEC Quotient** | 0.04 | 0.13 | 0.12 | 0.13 |

**Table 4-27. Calculated pyrethroid toxic unit equivalents, 2012 and 2013 sediment chemistry data. Yellow highlighted cells indicate sites where the sum of the pyrethroid TU equivalents is ≥ 1.0; bolded values indicate individual pyrethroid TUs > 1.0.**

| Pyrethroid | LC50 (ng/g dw) | ACCWP 204R00047 (2012) | ACCWP 204R00084 (2012) | ACCWP 204R00100 (2012) | ACCWP 204R00327 (2013) | ACCWP 204R00447 (2013) | ACCWP 205R00686 (2013) | CCCWP 207R00011 (2012) | CCCWP 544R00025 (2012) |
|---|---|---|---|---|---|---|---|---|---|
| Bifenthrin | 0.52 | **1.756** | 0.370 | 0.096 | 0.14 | **1.21** | 0.14 | **1.469** | **3.302** |
| Cyfluthrin | 1.08 | 0.201 | 0.028 | **2.680** | 0.02 | 0.05 | 0.19 | 0.302 | 0.043 |
| Cypermethrin | 0.38 | 0.137 | 0.072 | 0.045 | 0.04 | 0.02 | 0.01 | 0.163 | 0.112 |
| Deltamethrin | 0.79 | 0.083 | 0.041 | 0.025 | 0.01 | 0.06 | 0.05 | 0.092 | 0.064 |
| Esfenvalerate | 1.54 | 0.016 | 0.023 | 0.014 | 0.00 | 0.00 | 0.00 | 0.051 | 0.036 |
| Lambda-Cyhalothrin | 0.45 | 0.025 | 0.036 | 0.022 | 0.02 | 0.01 | 0.01 | 0.081 | 0.056 |
| Permethrin | 10.83 | 0.028 | 0.006 | 0.003 | 0.02 | 0.01 | 0.00 | 0.012 | 0.009 |
| **Sum of Toxic Unit Equivalents per Site** | | **2.245** | 0.575 | **2.886** | 0.26 | **1.37** | 0.41 | **2.17** | **3.62** |

| Pyrethroid | LC50 (ng/g dw) | CCCWP 207R00271 (2013) | CCCWP 544R00281 (2013) | FSURMP 207R00236 (2013) | Vallejo 207R05524 (2013) |
|---|---|---|---|---|---|
| Bifenthrin | 0.52 | **4.58** | 0.96 | **3.17** | 0.12 |
| Cyfluthrin | 1.08 | 0.96 | 0.04 | 0.76 | 0.04 |
| Cypermethrin | 0.38 | 0.10 | 0.01 | 0.56 | 0.01 |
| Deltamethrin | 0.79 | **4.62** | 0.01 | 0.11 | 0.00 |
| Esfenvalerate | 1.54 | 0.01 | 0.00 | 0.05 | 0.00 |
| Lambda-Cyhalothrin | 0.45 | 0.13 | 0.01 | 0.55 | 0.01 |
| Permethrin | 10.83 | 0.08 | 0.00 | 0.06 | 0.00 |
| **Sum of Toxic Unit Equivalents per Site** | | **10.48** | **1.03** | **5.26** | 0.19 |

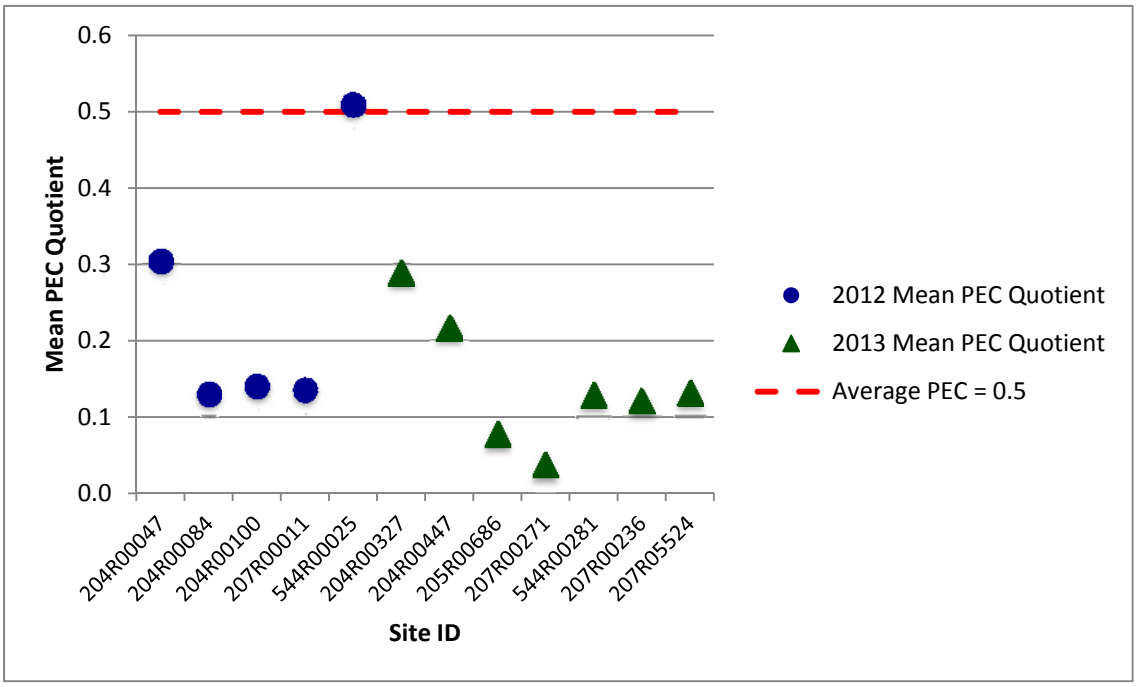


**Figure 4-7. Plot of mean PEC quotient per site, WY 2012 and WY 2013 data.**

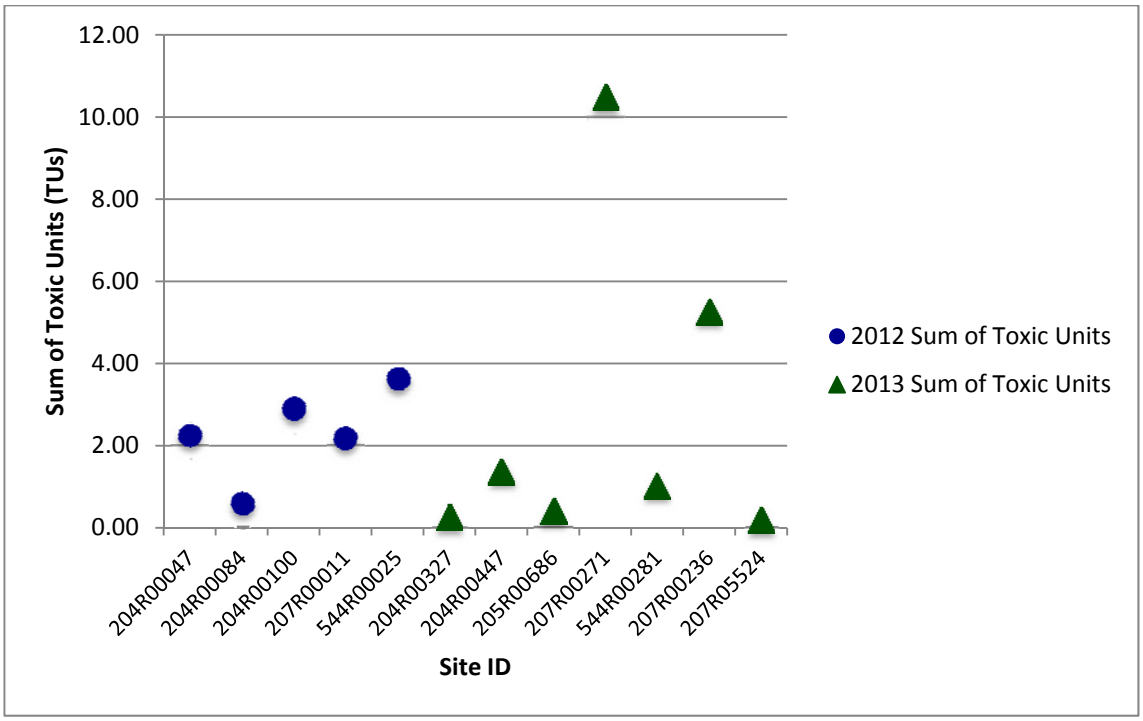


**Figure 4-1. Plot of the sum of pyrethroid toxic unit equivalents per site, WY 2012 and WY 2013 data.**

**Sediment Triad Analysis**

Table 4-28 summarizes stressor evaluation results for those sites with data collected for sediment chemistry, sediment toxicity and bioassessment parameters; due to site conditions only five of the seven 2013 sites planned for triad sampling were monitored for the full suite of bioassessment, sediment chemistry, and water and sediment toxicity. Biological condition assessments are also shown for WY2012 using a provisional regional consensus approach based on the Southern California benthic macroinvertebrate Index of Biological Integrity (B-IBI); condition assessments for WY2013 are discussed elsewhere in the program-specific IMRs.

**Table 4-28. Summary of sediment quality triad evaluation results, WY 2012 (shaded cells) and sediment chemistry/toxicity evaluation results, WY 2013 data. Yellow highlighted cells indicate results above MRP trigger threshold. NA = data not available.**

| Agency/ Program | Waterbody | Site ID | B-IBI Condition Category | Sediment Toxicity | # TEC Quotients ≥ 1.0: | Mean PEC Quotient | Sum of TU Equiv. | Next Step per MRP Table H-1 |
|---|---|---|---|---|---|---|---|---|
| ACCWP | Castro Valley | 204R00047 | Poor | No | 12 | 0.31 | 2.25 | A |
| ACCWP | Dublin Creek | 204R00084 | Very Poor | No | 5 | 0.13 | 0.58 | A |
| ACCWP | Arroyo Mocho | 204R00100 | Very Poor | No | 4 | 0.14 | 2.89 | A |
| CCCWP | Grayson Creek | 207R00011 | Very Poor | Yes | 10 | 0.14 | 2.17 | C |
| CCCWP | Dry Creek | 544R00025 | Very Poor | Yes | 11 | 0.51 | 3.62 | C |
| ACCWP | Line 3A-A-3 | 204R00327 | | No | 13 | 0.29 | 0.26 | |
| ACCWP | Kottinger Creek | 204R00447 | | No | 6 | 0.22 | 1.37 | |
| ACCWP | Canada del Aliso | 205R00686 | | No | 1 | 0.08 | 0.41 | |
| CCCWP | Sycamore Creek | 207R00271 | Very Poor | Yes | 0 | 0.04 | 10.48 | C |
| CCCWP | Marsh Creek | 544R00281 | Very Poor | Yes | 4 | 0.13 | 1.03 | C |
| FSURMP | Laurel Creek | 207R00236 | NA | Yes | 4 | 0.12 | 5.26 | * |
| Vallejo | Blue Rock Springs Cr | 207R05524 | NA | No | 5 | 0.13 | 0.19 | * |

* See notes in text below.

**Key to Next Steps:**

| Action Code | Exceeds Bioassessment/ Toxicity/ Chemistry Threshold | Next Step per MRP Table H-1 |
|---|---|---|
| A | Yes/No/Yes | (1) Identify cause of impacts.<br>(2) Where impacts are under Permittee's control, take management actions to minimize the impacts caused by urban runoff; initiate no later than the second fiscal year following the sampling event. |
| B | No/No/Yes | If PEC exceedance is Hg or PCBs, address under TMDLs. |
| C | Yes/Yes/Yes | (1) Identify cause(s) of impacts and spatial extent.<br>(2) Where impacts are under Permittee's control, take management actions to address impacts. |
| D | No/Yes/Yes | (1) Take confirmatory sample for toxicity.<br>(2) If toxicity repeated, attempt to dentify cause and spatial extent.<br>(3) Where impacts are under Permittee's control, take management actions to minimize upstream sources. |

Because of logistical issues regarding stream flow conditions, the Fairfield-Suisun (Laurel Creek) and Vallejo (Blue Rock Springs Creek) sediment sites shown in Table 4-28 are missing the bioassessment component, and therefore do not have the full complement of monitoring results needed to evaluate the sediment triad. However, given that all eight of the bioassessment sites in Solano County received SoCal B-IBI scores in the "poor" (one site) to "very poor" categories (the other seven sites) per Table 4-2, and given that Laurel Creek was represented with one bioassessment site and Blue Rock Springs was represented with three bioassessment sites at locations other than the sediment chemistry/toxicity testing sites, it may be reasonable to assume that the two sediment chemistry/toxicity sites may also have registered B-IBI scores in the poor to very poor categories, had they been tested for BMI taxonomy.

Had that been the case, hypothetically, for the Laurel Creek sediment testing site (207R00236) the follow-up actions would be per option C in the "Key to Next Steps" shown below Table 4-28, namely:

(1) Identify cause(s) of impacts and spatial extent.

(2) Where impacts are under Permittee's control, take management actions to address impacts.

Hypothetically, assuming a B-IBI score in the "poor" to "very poor" category for the Blue Rock Springs Creek sediment testing site (207R05524), the follow-up actions would be per option A in the "Key to Next Steps" shown below Table 4-28, namely:

(1) Identify cause of impacts.

(2) Where impacts are under Permittee's control, take management actions to minimize the impacts caused by urban runoff; initiate no later than the second fiscal year following the sampling event.

While MacDonald (2000) generated PECs for multiple trace element, PAH, OC pesticide, and pyrethroid pesticide parameters, there was insufficient data at time of its publication to evaluate the consensus PECs generated as to their predictive ability for associated sediment toxicity for each of the analytes reported. Analytes for which predictive ability is particularly uncertain include various PAHs (anthracene, fluorine, and fluoranthene) and OC pesticides (dieldrin, DDDs, DDTs, endrin, heptachlor epoxide, and lindane).

Additionally, MacDonald (2000) TECs and PECs were generated with the assumption that the predictive ability of the thresholds would be acceptable if the prediction were correct 75% of the time. For the 12 samples collected by the four contributing programs, a single sample exceeded the mean PEC criterion of 0.5; significant toxicity was reported associated with this sample (Table 4-26). For the one sample that had more than three analytes exceed associated PECs, statistically significant toxicity was not reported.

When examining pyrethroid concentrations, a similar degree of uncertainty exists. Weston (2005) reported that predictions of sediment toxicity to *H. azteca* were supported by observed results for sites with TU ratios below one (little or no mortality) and above four (high or full mortality). For TUs between one and four, however, the predictive ability of the TU is less certain (Weston, 2005). Half of the 12 samples analyzed by the four collaborating programs in Water Years 2012 and 2013 fell within this range (Table 4-27). This uncertainty can potentially be seen in the RMC results where a sample with a pyrethroid TU of 1.0 was associated with a toxic sample, and one with a TU of 2.9 was not (Table 4-27).

# 5.0 Conclusions and Next Steps

During water years 2012 and 2013, 68 sites were monitored by the four Programs contributing to this report under the RMC regional probabilistic design for bioassessment, physical habitat, and related water chemistry parameters. Twelve sites were also monitored for water and sediment toxicity and sediment chemistry. The water and sediment chemistry and toxicity data were used to evaluate potential stressors that may affect aquatic habitat quality and beneficial uses. Each program also used bioassessment and related data to develop a preliminary condition assessment for the monitored sites, to be used in conjunction with the stressor assessment based on sediment chemistry and toxicity.

The following MRP reporting requirements (Provision C.8.g.iv) were addressed within this report as applicable:

- Descriptions of monitoring purpose and study design rationale.
- QA/QC summaries for sample collection and analytical methods, including a discussion of any limitations of the data.
- Descriptions of sampling protocols and analytical methods.
- Tables and figures describing sample location descriptions (including water body names, and latitutdes and longitudes); sample ID, collection date (and time where relevant), and media (e.g., water, filtered water, bed sediment, tissue); concentrations detected; measurement units; and detection limits.
- Data assessment, analysis, and interpretation for Provision C.8.c.
- Pollutant load and concentration at each mass emissions station.
- A listing of volunteer and other non-Permittee entities whose data are included in the report.
- Assessment of compliance with applicable water quality standards.

Candidate sites classified with unknown sampling status as of Water Year 2013 may continue to be evaluated by the individual stormwater programs for potential sampling in Water Year 2014.

## 5.1 Summary of Stressor Analyses

The stressor analysis revealed the following potential stressors, based on an analysis of the first two years of data collection activities collected by the four Programs under the RMC umbrella:

- **Water Quality –** Of 11 parameters[27] sampled in association with bioassessment monitoring, applicable water quality standards were only identified for ammonia, chloride, and nitrate + nitrite (sites with MUN beneficial use only). Of the results generated at the 68 sites monitored by the four collaborating programs reporting herein for those three parameters, only two un-ionized ammonia concentrations and one chloride concentration exceeded the applicable water quality standard or threshold; each of these occurred at different sites. The MRP Table 8.1 trigger thresholds for “Nutrients” (i.e., 20% of results in one water body exceed one or more water quality standards or applicable thresholds) was therefore exceeded at only three of the 68

[27] Algal mass (ash-free dry weight), chlorophyll-a, dissolved organic carbon, ammonia, nitrate, total nitrogen, dissolved orthophosphate, phosphorus, suspended sediment concentration, silica, and chloride.

sites. One of the Vallejo sites (207R03504) met the Table 8.1 trigger threshold with the highest unionized ammonia reading in the region (112.69 µg/L; see Table 4-20).

- **Water Toxicity –** A total of 96 toxicity endpoints were derived through testing of four species at 24 sites region wide during two wet-season and two dry-season events. Of these endpoints, samples from five sites exhibited significant toxicity to at least one test species with survival and/or growth "<50% of Control," indicating retesting per MRP Table 8.1. Three of these were the result of monitoring in Water Year 2012, and they were retested in Water Year 2013. Of these three retests, two exhibited a toxic response at levels meeting MRP thresholds.
- **Sediment Toxicity –** Of the bedded sediment collected from 12 sites, a toxic response in test species *H. azteca* was observed at 9 sites. Results were more than 20% less than the control at 5 of these sites, meeting the Table H-1 sediment toxicity criterion.
- **Sediment Chemistry –** Results produced evidence of potential stressors in three ways, based on the criteria from MRP Table H-1: (1) at 10 of 12 sites, 3 or more constituents exhibited TEC quotients greater than 1.0,[28] (2) at 1 of 12 sites, the mean PEC quotient was > 0.5, and (3) at 8 of 12 sites, the sum of TU equivalents for all measured pyrethroids was greater than or equal to 1.0.
- **Sediment Triad Analyses (partial) –** for the Solano County sites, sediment chemistry and toxicity results were evaluated as two of the three lines of evidence used in the triad approach for assessing overall stream condition, along with biological community data for other sites, so a full sediment triad analysis was not possible for the Solano County sites in WY 2013.

## 5.2 Next Steps

The preceding analysis has identified a number of potential sites that may deserve further evaluation and/or investigation to provide better understanding of the sources/stressors that may be contributing to reduced water quality and lower biological condition at these sites. During Water Year 2013, the RMC collaboratively reviewed trigger results from Water Year 2012 and selected a total of 10 sites in four counties for implementation of SSID projects based on prioritization of the type, extent, and geographic spread of the triggers. Individual RMC Programs are reporting elsewhere in the IMR on technical studies for SSID projects in their respective jurisdictions, which are to be initiated by the second Fiscal Year following the year in which the potential stressor was identified.

RMC participants will continue to implement the regional probabilistic monitoring design in Water Year 2014. Site evaluation and sampling are planned at new sites for this Water Year, as well as resampling and retesting as may be required to complete the evaluation of trigger thresholds per MRP Table 8.1.

The Fairfield-Suisun and Vallejo Permittees will further evaluate the results to determine if follow-up actions are appropriate or necessary regarding either the high unionized ammonia result from site 207R03504 (Rindler Creek) or the incomplete sediment triad results as discussed above.

[28] For nearly all sites, chromium and nickel concentrations in sediment exceeded TEC values. Considering that both metals are naturally occurring at relatively high levels in Bay Area soils, and concentrations generally exceed TEC values in reference or non-urban sites, TEC values presented in MacDonald et al. (2000) may not be applicable to the Bay Area. These observations should be considered in future evaluations of sediment chemistry data collected by RMC participants in Bay Area creeks.

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# CREEK STATUS MONITORING REPORT – TARGETED PARAMETERS

# Integrated Monitoring Report, Part A - Appendix A.2

***Water Years 2012 and 2013 (October 1, 2011 – September 30, 2013)***

**Submitted in Compliance with Provisions C.8.g.iii**
**NPDES Permit No. CAS612008**

**March 15, 2014**

**Submitted by the Fairfield-Suisun Urban Runoff Management Program and the City of Vallejo and Vallejo Sanitation and Flood Control District**

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# List of Acronyms

| | |
|---|---|
| BASMAA | Bay Area Stormwater Management Agencies Association |
| CDFW | California Department of Fish and Wildlife |
| CRAM | California Rapid Assessment Method |
| DO | Dissolved Oxygen |
| DQO | Data Quality Objective |
| FSURMP | Fairfield Suisun Urban Runoff Management Program |
| MRP | Municipal Regional Permit |
| MWAT | Maximum Weekly Average Temperature |
| QAPP | Quality Assurance Project Plan |
| RMC | Regional Monitoring Coalition |
| SAP | Sampling and Analysis Plans |
| SFBRWQCB | San Francisco Bay Regional Water Quality Control Board |
| SMC | Southern California Stormwater Monitoring Coalition |
| SOP | Standard Operating Procedure |
| SWAMP | Surface Water Ambient Monitoring Program |
| USEPA | United States Environmental Protection Agency |
| VSFCD | Vallejo Sanitation and Flood Control District |
| WQO's | Water Quality Objectives |
| WY | Water Year |

# Table of Contents

List of Acronyms……3
Table of Contents……4
List of Tables ……5
List of Figures……6
Executive Summary……7
1.0 Introduction……9
2.0 Study Area & Monitoring Design……10
2.1 RMC Area……10
2.2 Monitoring Locations ……10
3.0 Monitoring Methods……11
3.1 Field Data Collection Methods……11
3.1.1 General Water Quality Measurements……11
3.1.2 Continuous Temperature Monitoring……12
3.1.3 Pathogen Indicators Sampling……12
3.1.4 Stream Survey Assessment……12
3.2 Quality Assurance and Control……13
3.3 Data Quality Assessment Procedures……13
3.4 Data Analysis and Interpretation……14
3.4.1 Dissolved Oxygen……15
3.4.2 pH……15
3.4.3 Pathogen Indicators……15
3.4.4 Temperature……16
4.0 Results……17
4.1 Statement of Data Quality……17
4.2 Monitoring Results……17
4.2.1 Water Temperature……17
4.2.2 General Water Quality……20
4.2.3 Pathogen Indicators……26
4.2.4 Stream Survey ……26
5.0 Next Steps……28
6.0 References……29

# List of Tables

**Table 1-1**. Creek status monitoring parameters in compliance with MRP Provision C.8.c and the associated reporting format…….....9
**Table 2-1.** Sites and local reporting parameters monitored in Water Year 2013 in Solano County……10
**Table 3-1.** Data quality procedures implemented for targeted monitoring……..14
**Table 3-2.** Description of water quality thresholds for Municipal Regional Permit C.8.c parameters monitored using a targeted design……..15
**Table 3-3.** EPA Recommended Recreational Water Quality Criteria……16
**Table 4-1.** Descriptive statistics for continuous water temperature measured with the HOBO data logger at Union Avenue Creek, May-Sept 2013……18
**Table 4-2.** Percent of continuous water temperature data measured at the Union Avenue Creek site that exceeds water quality criteria (based on the 7-Day Avg. Maximum Daily Water Temperature-MWAT) 19
**Table 4-3.** Summary statistics for YSI data during the spring and summer sampling periods at Union Avenue Creek in Fairfield and Blue Rock Springs Creek in Vallejo……20
**Table 4-4.** Percent of the water temperature, dissolved oxygen, and pH data measured at the 2 sites for both spring and summer monitoring events that exceed water quality criteria identified in Table 3-2……..25
**Table 4-5.** Fecal coliform and E. coli levels measured from water samples taken at Solano County locations on August 14, 2013. Values in bold exceed the trigger threshold for water quality criteria identified in Table 3-2……26
**Table 4-6.** Final attribute and assessment area scores (100 points possible) of CRAM survey sites in Solano County (summer 2013)……27

# List of Figures

**Figure 2-1.** Targeted sites monitored in Solano County in Water Year 2013…….11
**Figure 4-1.** Continuous water temperature data collected with the HOBO data logger at Union Avenue Creek, May-Sept 2013……18
**Figure 4-2.** Seven day average maximum daily water temperature (MWAT) data collected with the HOBO data logger at Union Avenue Creek in Fairfield, May 24-Sept 30, 2013……19
**Figure 4-3.** Continuous water quality data (temperature, DO, pH, specific conductivity) collected May/June 2013 at Union Avenue Creek and Blue Rock Springs Creek……20
**Figure 4-4.** Continuous water quality data (temperature, DO, pH, specific conductivity) collected Aug/Sept 2013 at Union Avenue Creek and Blue Rock Springs Creek…….23

# Executive Summary

This monitoring report documents the results of local/targeted monitoring activities performed by the Fairfield Suisun Urban Runoff Management Program (FSURMP) and the City of Vallejo and Vallejo Sanitation and Flood Control District (VSFCD) during the 2013 Water Year (WY). Together with IMR Part A Appendix A.1, this report submittal completes the required reporting for monitoring requirements specified in Table 8.1, Provision C.8.c of the Municipal Regional Permit for Urban Stormwater issued by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) (MRP Order No. R2-2009-0074). Reporting requirements for Table 8.1 components are established in provision C.8.g.iii and C.8.g.v of the permit.

The permit-required targeted monitoring parameters for FSURMP and VSFCD were temperature, general water quality, pathogen indicators and riparian stream assessments. Hourly water temperature measurements were taken using a HOBO data logger for 130 consecutive days at a Union Avenue Creek site in Fairfield (May 24$^{th}$ through September 30$^{th}$ 2013). The temperature monitoring effort at Blue Rock Springs Creek in Vallejo was unsuccessful due to theft of the HOBO device mid-summer following deployment. General water quality monitoring (temperature, dissolved oxygen, pH, and specific conductivity) was executed using YSI Sondes at two creeks in the County. In Vallejo, general water quality measurements were taken during spring and summer at Blue Rock Springs Creek: May 28$^{th}$ – June7th and August 27$^{th}$-September 6$^{th}$. In Fairfield, Sondes data were collected at Union Avenue Creek during spring and summer: May 13$^{th}$-May 24$^{th}$ and August 29$^{th}$-September 10$^{th}$.

Pathogen indicator samples were collected at Sulfur Springs Creek in Vallejo and Laurel Creek in Fairfield. Grab samples were taken and sent for analysis of concentrations of fecal coliform, E.Coli, and total coliform.

A California Rapid Assessment Method (CRAM) survey was performed along 8 selected riverine wetland habitats in Vallejo and 8 sites in the cities of Fairfield and Suisun. These surveys were conducted in the late summer and will be used to help interpret the trends seen from samplings parameters previously mentioned.

All targeted monitoring data collected were compared and evaluated against Water Quality Objectives (WQO's) and against additional criteria as required in Table 8.1 in the MRP and Region 5 Permit.
A summary of the Results are highlighted below:

- **Temperature:** a maximum weekly average temperature (MWAT) of 20.5°C was used as the applicable criterion. Temperature for the Union Avenue Creek site in Fairfield exceeded this MWAT value for 87.4 % of the monitoring period (Table 4-2). Continuous temperature data were not collected in Vallejo this Water Year due to instrument theft; this monitoring will be performed during WY 2014.

- **Dissolved Oxygen (DO):** Basin Plan WQO's for DO are a minimum of 7.0 mg/L for sites designated for COLD water habitat (COLD) and a minimum of 5.0 mg/L for sites designated as warm water habitat (WARM). Continuous water quality monitoring in the summer (Figure 4-4) did not meet the criteria on one of the creeks monitored (Union Ave. Creek), which fell below the 5.0 mg/L value for 98% of the deployment period.

- **pH:** WQO of 6.5-8.5; The measured pH range was within the acceptable Basin Plan WQO range during both spring and summer time periods for both Blue Rock Springs Creek (Vallejo) and Union Avenue Creek (Fairfield) (Figures 4-3, 4-4).

- **Pathogen Indicator Organisms:** single sample maximum level concentrations of 400 MPN/100mL fecal coliform (SFRWQCB2011) and 410 cfu/100mL E.coli (USEPA 1986) were used as the water contact evaluation criteria standards. Fecal coliform levels met MRP trigger criteria at one Laurel Creek site (500MPN/100mL) and two Sulfur Springs Creek sites (800 and 1700MPN/100mL) (Table 4-5). E. coli levels were above the MRP trigger threshold at one Laurel Creek site (500MPN/100mL) and at one Vallejo site (2800MPN/100mL).

# 1.0 Introduction

The Bay Area Stormwater Management Agencies Association (BASMAA) Regional Monitoring Coalition (RMC) has developed monitoring protocols, sampling and analysis plans (SAPs), data quality objectives (DQOs), standard operating procedures (SOPs), data management tools, and reporting templates and guidelines. This report focuses on the Creek Status and the Long-Term Trends Monitoring activities that were conducted in Water Year 2013 to comply with Provision C.8.c using a targeted (non-probabilistic) monitoring design (Table 1-1).

This report gives a description of the study area and monitoring design (Section 2.0), monitoring methods (Section 3.0), results (Section 4.0), and conclusions and next steps (Section 5.0).

**Table 1-1. Creek Status monitoring parameters sampled in compliance with MRP Provision C.8.c. and the associated reporting format. A subset of regional parameters is reported jointly for Water Years 2012 and 2013 in this report.**

| Biological Response and Stressor Indicators | Monitoring Design | | Reporting | |
|---|---|---|---|---|
| | Regional Ambient (Probabilistic) | Local (Targeted) | Regional WY 2012 (Joint WY 2013) | Local |
| Bioassessment & Physical Habitat Assessment | X | | X | (WY 2013) |
| Chlorine | X | | X (X) | |
| Nutrients | X | | X (X) | |
| Water Toxicity | X | | X (X) | |
| Sediment Toxicity | X | | X (X) | |
| Sediment Chemistry | X | | X (X) | |
| General Water Quality | | X | | X |
| Temperature | | X | | X |
| Bacteria | | X | | X |
| Stream Survey | | X | | X |

# 2.0 Study Area & Monitoring Design

## 2.1 RMC Area

Status and trends monitoring was conducted in non-tidally influenced, flowing water bodies (i.e., creeks, streams and rivers) interspersed among 3,407 square miles of land in the RMC area. The water bodies monitored were drawn from a master list that included all perennial and non-perennial creeks and rivers that run through urban and non-urban areas within the portions of the five participating counties that fall within the SFBRWQCB boundary, and the eastern portion of Contra Costa County that drains to the Central Valley Regional Water Quality Control Board's region.

## 2.2 Monitoring Locations

During Water Year 2013 (October 1, 2012 –September 30, 2013) water temperature, general water quality and pathogen indicators were monitored at the target locations listed in Table 2-1.

**Table 2-1. Sites and local reporting parameters monitored in Water Year 2013 in Solano County.**

| Site ID | Creek Name | Latitude | Longitude | Continuous Temperature | Water Quality | Pathogen Indicators | Stream survey |
|---|---|---|---|---|---|---|---|
| 207R00684* | Union Ave. | 28.28569 | -122.03864 | X | X | | |
| 207RLAU020 | Laurel | 28.29286 | -122.02270 | | | X | |
| 207RLAU030 | Laurel | 28.27980 | -122.01830 | | | X | |
| 207RLAU040 | Laurel | 28.26362 | -122.01844 | | | X | |
| 207R00428* | Union Ave. | 28.26279 | -122.03737 | | | | X |
| 207R00556* | Union Ave. | 28.26025 | -122.03806 | | | | X |
| 207R01452* | Laurel | 28.26364 | -122.01956 | | | | X |
| 207R00476* | Ledgewood | 28.24668 | -122.07040 | | | | X |
| 207R02732* | Laurel | 28.28804 | -122.02087 | | | | X |
| 207R01516* | Green Valley | 28.22621 | -122.15024 | | | | X |
| 207R01340* | American Canyon | 28.19211 | -122.13918 | | | | X |
| 207R00316* | N/A | 28.17163 | -122.12882 | | | | X |
| 207R00064* | Blue Rock Springs | 28.12027 | -122.20084 | (probe stolen) | X | X | X |
| 207RLHC020 | Sulfur Springs | 28.13757 | -122.17048 | | | X | |
| 207RNLH020 | Sulfur Springs | 28.13748 | -122.16990 | | | X | |
| 207R05232* | Sulfur Springs | 28.15209 | -122.17811 | | | | X |
| 207R04784* | Sulfur Springs | 28.13891 | -122.16882 | | | | X |
| 207R02480* | Rindler | 28.13946 | -122.19763 | | | | X |
| 207R03504* | Rindler | 28.13722 | -122.21691 | | | | X |
| 207R00688* | Blue Rock Springs | 28.13018 | -122.22758 | | | | X |
| 207R04080* | Blue Rock Springs | 28.11998 | -122.21640 | | | | X |
| 207R05524* | Blue Rock Springs | 28.12162 | -122.22196 | | | | X |

* Site was part of the RMC probabilistic draw

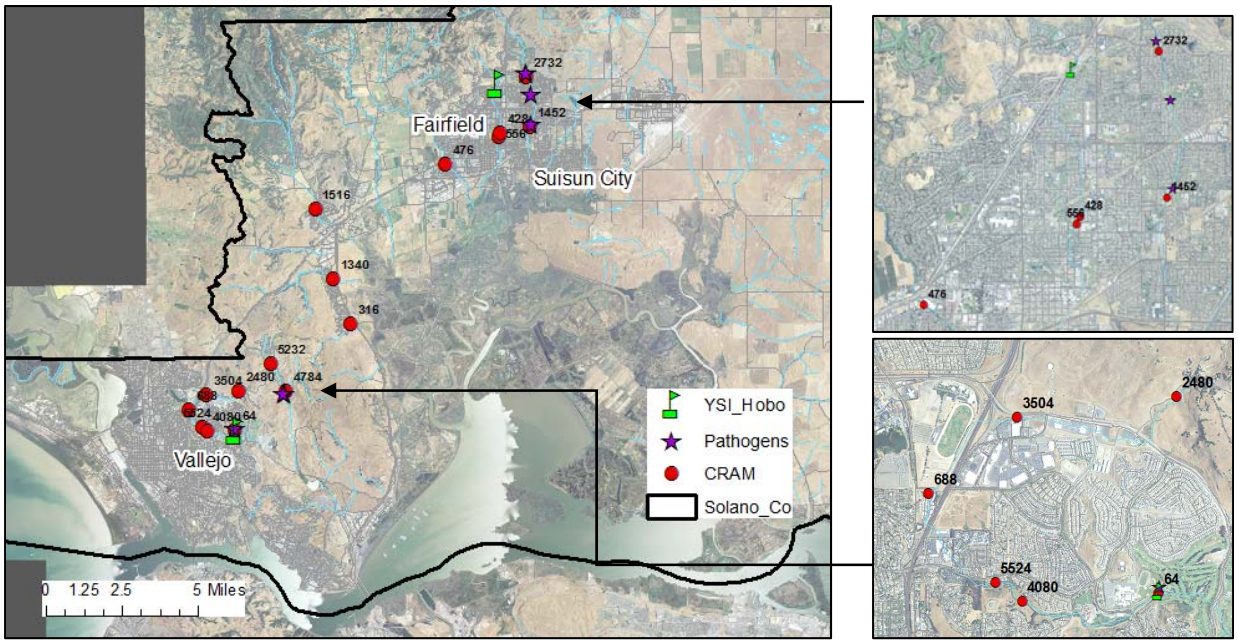


**Figure 2-1. Targeted sites monitored in Solano County in Water Year 2013.**

# 3.0 Monitoring Methods

Targeted monitoring data were collected following the BASMAA RMC quality assurance plan and standard operating procedures. Monitoring data was collected using comparable methods to those outlined in the California Surface Water Ambient Monitoring Program (SWAMP) Quality Assurance Project Plan, and were submitted in SWAMP-compatible format by FSURMP and VSFCD to SFBRWQCB pursuant to Provision C.8.g.

## 3.1 Field Data Collection Methods

Field data were collected in accordance with existing SWAMP-comparable methods and procedures, as described in the RMC Quality Assurance Project Plan (QAPP) (BASMAA 2012a) and the associated Standard Operating Procedures (BASMAA 2014b). The monitoring sites for general water quality (dissolved oxygen, specific conductivity, pH, and temperature) were located at Union Avenue Creek in Fairfield and Blue Rock Springs Creek in Vallejo. The same two creeks were selected for deployment of the HOBO data loggers for continuous temperature monitoring.

### 3.1.1 General Water Quality Measurements

Water quality monitoring devices (YSI 6600 Sondes probes) were deployed once in the spring and once in the summer at both Blue Rock Springs Creek in Vallejo and Union Avenue Creek in Fairfield. The devices were set to record at 15 minute intervals for approximately 2 weeks each time at the time periods listed below:

Fairfield: YSI deployed spring (May13th-May24th) and summer (August 29th-Sept 10th)

Vallejo: YSI deployed spring (May28th-June7th) and summer (August 27th-Sept 6th)

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

### 3.1.2 Continuous Temperature Monitoring

Continuous water temperature data were collected in Fairfield at Union Avenue Creek and in Vallejo at Blue Rock Springs Creek. Digital temperature data loggers (HOBO Water Temp Pro V2) were deployed at each site and were set to record hourly temperature in each waterway. Recording intervals by site are listed below:

Vallejo: The temperature data logger was deployed in late spring. Upon return for test readout to ensure proper device function it was discovered the device had been stolen. No data was retrieved in this water year.

Fairfield: The temperature data logger was deployed on May 24th and retrieved on September 30th.

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

### 3.1.3 Pathogen Indicators Sampling

Water quality samples for pathogen indicator analysis were taken via grab samples at three targeted sites in Fairfield (all on Laurel Creek) and three targeted sites in Vallejo (two on Sulfur Springs Creek and one on Blue Rock Springs Creek). Sampling was executed on August 14th 2013 at both sites. Sampling techniques included direct filling of containers and immediate transfer of samples to analytical laboratories within specified holding time requirements. Sampling and transporting procedures are described in RMC SOP FS-2 (BASMAA 2014b).

### 3.1.4 Stream Survey Assessment

CRAM surveys were conducted along 8 selected riverine wetland habitats in Vallejo and 8 sites in the cities of Fairfield and Suisun (16 sites total) to meet the stream survey requirement in Table 8.1 of the MRP. In consultation with SFBRWQCB staff, all 8 sites where a bio-assessment was performed in Water Year 2013 were surveyed. To increase the sample size and coverage of Solano County watersheds, an additional 8 sites from the RMC probabilistic draw were surveyed as well. These surveys were conducted in the late summer and will be used to help interpret the trends seen from water quality assessments data.

*Preparation*

Staff used aerial imagery to help with interpreting and computing portions of the survey prior to field work. Several metrics within the “Buffer and Landscape Context” and “Hydrology” attributes required some aerial interpretation and consultation with local watershed resource professionals. Any access issues and logistical constraints associated with each site were addressed prior to starting the field surveys.

*Field Surveys*
The survey team was equipped with all the necessary measuring tools, protocol manuals, and data forms as well aerial imagery maps for each field site. Each riverine wetland survey area consisted of the stream channel itself, its active floodplain, and certain portions of the adjacent riparian upland which contribute organic material to the floodplain. At each site, the Basic Information Worksheet for Riverine Wetlands was populated with scores and descriptive information regarding buffer and landscape context, hydrology, physical structure, and biotic structure of each site. In addition, a stressor checklist associated with each attribute category was completed for later interpretation of scores and results. Photo documentation was collected at each site.

*Post Survey Processing*
Attribute scores associated with each category were calculated based on the individual component scores and their metrics (fixed numeric values). The overall score for each survey site was calculated and uploaded to the CRAM wetlands website (www.cramwetlands.org/dataentry).

## 3.2 Quality Assurance & Control

Quality control procedures are described in detail in the BASMAA RMC QAPP (BASMAA 2012a). Data quality objectives (DQO's) were established to ensure quality of both quantitative and qualitative assessments. Field training was conducted among the RMC survey teams along with California Department of Fish and Wildlife (CDFW) staff to ensure that consistent and comparable field techniques were being utilized. All data collected followed the procedures outlined in the SOPs, including documentation of data sheets and samples as well as sample handling and chain of custody. The laboratories that provided technical analytical services to the RMC were selected based on their ability to adhere to the required protocols and handling requirements.

## 3.3 Data Quality Assessment Procedures

Results from field work and laboratory assessments were reviewed by the local Program Quality Assurance Officers for each Program and compared against the methods and procedures outlined in the SOP's and QAPP. Table 3-1 displays the data quality steps taken for targeted monitoring parameters.

**Table 3-1. Data quality procedures implemented for targeted monitoring.**

| Procedure | Temperature (HOBO) | General Water Quality (YSI) | Pathogen Indicators Sampling | Stream Survey (CRAM) |
|---|---|---|---|---|
| Pre-event calibration | X | X | | |
| Readiness review conducted | X | X | X | |
| Check field data sheets for completeness | X | X | X | X |
| Post-deployment accuracy check conducted | X | X | | |
| Post sampling event report completed | X | X | X | |
| Post event calibration conducted | | X | | |
| Data review-compare drift against SWAMP MQO's | | X | | |
| Data review-check for outliers/out of water measurements | X | X | | |

## 3.4 Data Analysis and Interpretation

Continuous water temperature measurements were calculated as daily arithmetic means over a 24 hour period. Seven-day rolling averages of creek temperature were calculated by averaging each daily average temperature with the six subsequent daily average temperatures.

Targeted monitoring data were evaluated against WQO's or other relevant thresholds described in Table 8.1 in the MRP. The targeted monitoring thresholds used for analysis are displayed in Table 3-2. The sub-sections below provide details on the water quality thresholds derived from the San Francisco Basin Plan and USEPA sources, including an explanation of the threshold selected for analysis of temperature data.

**Table 3-2. Description of water quality thresholds for Municipal Regional Permit C.8.c parameters monitored using a targeted design.**

| Monitoring Parameter | Threshold Description |
|---|---|
| Temperature | 20% of results for the deployment period at each monitoring site exceed one or more of the following applicable temp thresholds<br>• For a water body designated as COLD and or supports steelhead trout population (see discussion below):<br>*7-Day Mean Temperature should not exceed 20.5°C<br>• For a water body designated as COLD or WARM (SFRWQCB 2011):<br>*The temperature shall not be increased by more than 2.8°C above natural receiving water temperature. |
| General Water Quality | 20% of results for the deployment period at each monitoring site exceed one or more water quality standards or established thresholds:<br>• Water temperature: (see above)<br>• Dissolved Oxygen: for WARM <5.0 mg/L and for COLD <7.0mg/L (SFRWQCB 2011)<br>• pH: between 6.5 and 8.5 (SFBRWQCB 2011)<br>• Conductivity: N/A |
| Pathogen Indicators | Single sample result meets one or more of the following criteria<br>• Fecal Coliform≥ 400 MPN/100mL (SFRWQCB 2011)<br>• E.coli: ≥ 410 MPN/100mL (USEPA 2012, infrequently used area) |

### 3.4.1 Dissolved Oxygen

The Basin Plan (SF Bay Water Board, 2011) lists WQOs for DO in nontidal waters as follows: 5.0 mg/L minimum for waters designated as warm water habitat (WARM) and 7.0 mg/L minimum for waters designated as COLD. Although these WQOs are suitable criteria for an initial evaluation of water quality impacts, further evaluation may be needed to determine the overall extent and degree that COLD and/or WARM beneficial uses are supported at a site. For example, further analyses may be necessary at sites in lower reaches of a water body that may not support salmonid spawning or rearing habitat, but may be important for upstream or downstream fish migration.

### 3.4.2 pH

WQOs for pH in surface waters are stated in the Basin Plan (SF Bay Water Board, 2011) as follows: the pH shall not be depressed below 6.5 nor raised above 8.5. This range was used in this report to evaluate the pH data collected from creeks.

### 3.4.3 Pathogen Indicators

The Basin Plan (SF Bay Water Board, 2011) includes Water Contact Recreation WQOs of fecal coliform concentrations less than 200 MPN/100 mL (geometric mean of data) and less than 400 MPN/100 mL ($90^{th}$ percentile of data). For Non-contact Water Recreation, the Basin Plan includes WQOs of fecal

coliform concentrations less than 2,000 MPN/100 mL (geometric mean of data) and less than 4,000 MPN/100 mL (90th percentile of data).

In 2012, The EPA released its 2012 Recreational Water Quality Criteria (RWQC) recommendations for protecting human health in all coastal and non-coastal waters designated for primary contact recreation use. The EPA RWQC provides two sets of recommended criteria as shown in Table 3-3. Primary contact recreation is protected if either set of criteria recommendations are adopted into state water quality standards. However, these recommendations are intended as guidance to states, territories, and authorized tribes in developing water quality standards to protect swimmers from exposure to water that contains organisms that indicate the presence of fecal contamination. They are not regulations themselves (U.S. EPA, 2012).

For analysis of single sample results, this report refers to the Basin Plan 90% percentile for fecal coliform (400 MPN/100 mL) and the USEPA 2012 STV recommendation for *E. coli* (410 cfu/100 mL).

**Table 3-3. EPA 2012 Recommended Recreational Water Quality Criteria**

| Criteria Elements | Recommendation 1<br>Estimated Illness Rate 36/1000 | | Recommendation 2<br>Estimated Illness Rate 32/1,000 | |
|---|---|---|---|---|
| Indicator | GM<br>(cfu/100 mL) | STV<br>(cfu/100 mL) | GM<br>(cfu/100 mL) | STV<br>(cfu/100 mL) |
| Enterococci | 35 | 130 | 30 | 110 |
| *E. coli* (fresh) | 126 | 410 | 100 | 320 |

### 3.4.4 Temperature

Temperature is one indicator of the ability of a water body to support either warm water fisheries habitat (WARM) or cold water fisheries habitat (COLD). In California, the beneficial use of COLD is generally associated with suitable spawning habitat and passage for anadromous fish (e.g., salmon and steelhead). In MRP Table 8.1 the temperature trigger threshold specification is footnoted as follows: "31 If temperatures exceed applicable threshold (e.g., Maximum Weekly Average Temperature, Sullivan K., Martin, D.J., Cardwell, R.D., Toll, J.E., Duke, S. 2000. *An Analysis of the Effects of Temperature on Salmonids of the Pacific Northwest with Implications for Selecting Temperature Criteria, Sustainable Ecosystem Institute*) or spike with no obvious natural explanation observed."

The WY 2012 Local Urban Creeks Monitoring Report (ADH 2013) provided an extensive review and discussion of water temperature criteria for steelhead and various other salmonids as they might apply to Contra Costa County streams. Ultimately, the Sullivan et al. (2000) recommendation of an upper temperature threshold of 20.5 degrees C (average of a 7 day maximum temperature) for rearing juvenile steelhead was determined to be the most useful benchmark for evaluating Contra Costa County streams with a COLD beneficial use designation. Therefore the 20.5$^{0}$C MWAT is used in this evaluation as the water temperature criterion for cold water streams in Solano County.

# 4.0 Results

## 4.1 Statement of Data Quality

Field data sheets and lab reports were reviewed by the local Program Quality Assurance Officer and the results were evaluated against the appropriate DQO's. Results were compiled for both qualitative (representativeness and comparability) and quantitative metrics (completeness, precision, and accuracy).

The following information highlights the data quality assessment for each data collection activity:

- Temperature data from Vallejo were not collected due to the theft of the HOBO device after deployment. Temperature data were collected from Union Avenue Creek in Fairfield. A subset of 130 days or 71% of the expected 183 days of data (April –Sep) was collected in Fairfield for the following reasons:
    - The HOBO device was deployed on April 29th at Laurel Creek in Fairfield. Upon returning to the site the following week to check the device, the creek had no measurable flow. The device was pulled and logging was delayed until a second deployment was executed on May 24th at Union Avenue Creek.
- Continuous water quality data (temperature, pH, DO, conductivity) were collected during the spring and summer seasons in both Fairfield (Union Ave. Creek) and Vallejo (Blue Rock Springs Creek) resulting in collection of 100% of the expected data.
- Quality assurance laboratory procedures were implemented for pathogen indicator analyses this year. Samples were collected at six stations in Solano County on August 14, 2013.There were four instances of quality assurance samples failing to meet DQOs:
    - Laboratory control samples for both fecal coliform and for *E. coli* had percent recoveries of 63.6%. This is outside of the DQO range of 80%–120%.
    - RMC participants will review and discuss these results with the laboratory, and develop follow-up actions as appropriate prior to the WY 2014 creek status monitoring.

## 4.2 Monitoring Results

### 4.2.1 Water Temperature

Summary statistics for continuous water temperature data are shown in Table 4-1. Data were collected from May 24th through September 30th and represent hourly measurements taken at Union Avenue Creek in Fairfield for 130 days. Water temperatures measured at Union Avenue Creek and the threshold value of 20.5°C are shown in Figures 4-1 and 4-2. The HOBO instrument was stolen from the Blue Rock Springs Creek site after deployment, and data are therefore not available from that site.

**Table 4-1. Descriptive statistics for continuous water temperature measured with the HOBO data logger at Union Avenue Creek, May -Sep 2013.**

| Site | 207R00684 | 207R00064 |
|---|---|---|
| **Temperature** | **Union Avenue Creek-Fairfield (°C)** | **Blue Rock Springs Creek-Vallejo*** |
| Minimum | 16.49 | n/a |
| Median | 22.49 | n/a |
| Mean | 22.64 | n/a |
| Maximum | 29.92 | n/a |
| Max 7-day mean value | 26.97 | n/a |
| # of Measurements | 3108 | 0 |

*Device stolen from creek after deployment

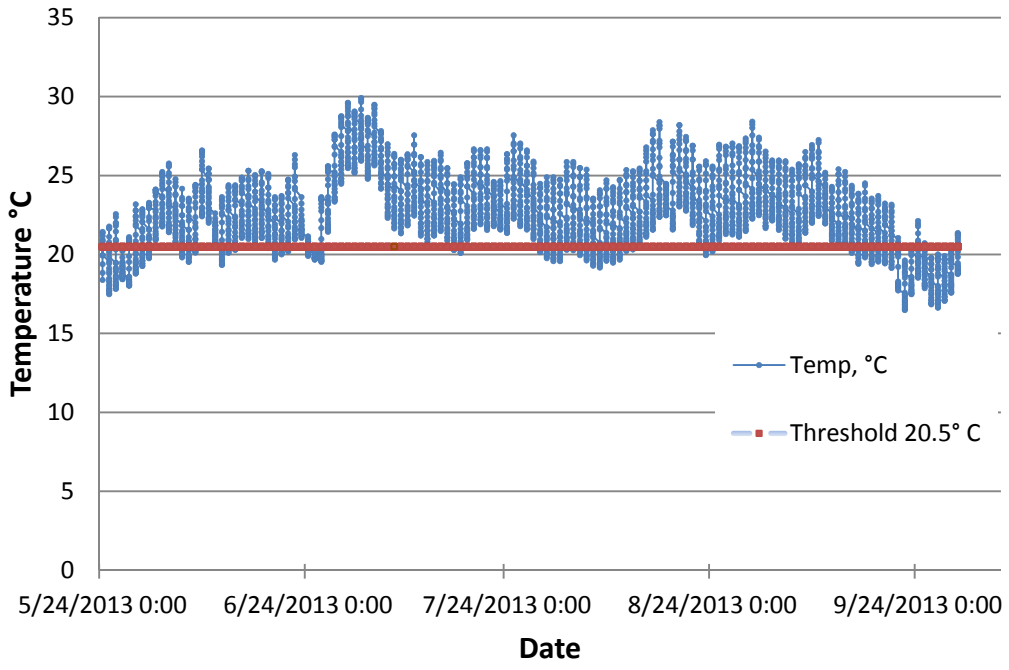


**Figure 4-1. Continuous water temperature data collected with the HOBO data logger at Union Avenue Creek, May - Sep 2013.**

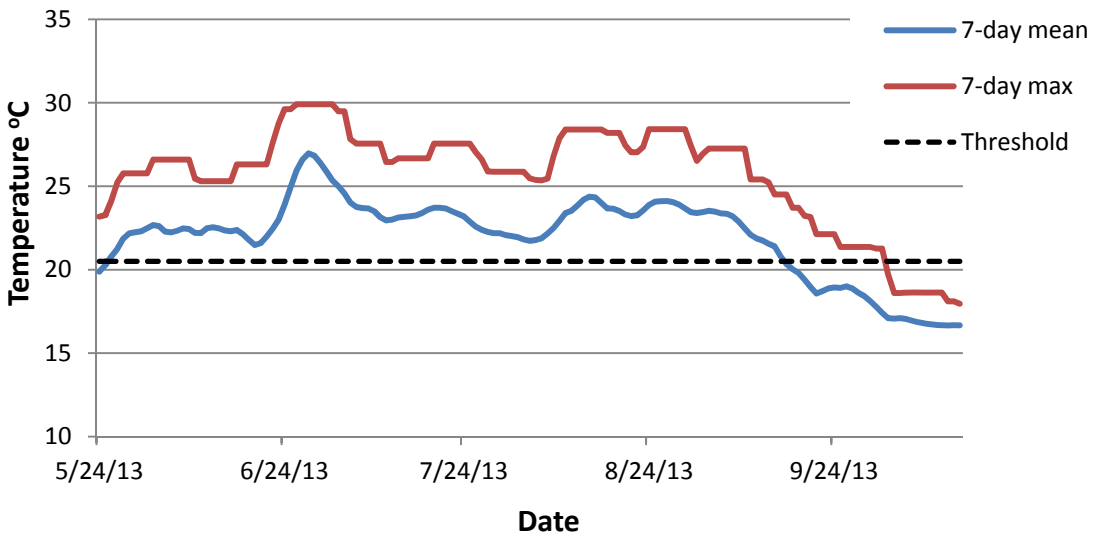


**Figure 4-2. Seven day average maximum daily water temperature (MWAT) data collected with the HOBO data logger at Union Avenue Creek in Fairfield May 24 - Sep 30, 2013.**

Stream temperatures at Union Ave. Creek remained above the threshold of 20.5°C throughout the majority of the deployment period (Table 4-2), occasionally reaching nearly 30 °C. There was a wildfire at this site on July 5, 2013 (the spike in temperature is apparent on Figure 4-2 above), removing any shade that previously existed on the stream. Stream temperature clearly met the trigger criterion of 20% of results above the 20.5°C threshold.

**Table 4-2. Percent of continuous water temperature data measured at the Union Avenue Creek site that exceeds water quality criteria (based on the 7 day avg. maximum daily water temperature-MWAT).**

| Site ID | Creek Name | Monitoring Period | % of Temp Results MWAT> 20.5° C |
|---|---|---|---|
| **207R00684** | Union Avenue Creek | May 24-Sep 30 2013 | 87.4% |
| **207R00064** | Blue Rock Springs Creek | n/a | n/a |

### 4.2.2 General Water Quality

Summary statistics for general water quality data collected using YSI Sondes for Union Avenue and Blue Rock Springs Creeks during the spring and summer seasons are shown in Table 4.3. The data are also shown in Figures 4-3 and 4-4 below.

**Table 4-3. Summary statistics for YSI data during the spring and summer sampling period at Union Avenue Creek in Fairfield and Blue Rock Springs Creek in Vallejo.**

| Parameter | | Union Avenue 207R00684 | | Blue Rock Springs 207R00064 | |
|---|---|---|---|---|---|
| | | Spring | Summer | Spring | Summer |
| Temp °C | Min | 17.24 | 20.23 | 15.03 | 16.09 |
| | Median | 19.95 | 22.19 | 16.84 | 18.53 |
| | Mean | 20.05 | 22.11 | 17.06 | 18.61 |
| | Max | 23.46 | 23.92 | 19.67 | 20.74 |
| | Max 7-Day Mean | 20.06 | 22.20 | 17.20 | 18.78 |
| Dissolved Oxygen (mg/l) | Min | 3.71 | .31 | 5.66 | 7.28 |
| | Median | 5.91 | 3.18 | 7.79 | 7.85 |
| | Mean | 5.88 | 3.16 | 7.77 | 7.87 |
| | Max | 7.88 | 5.9 | 8.86 | 8.43 |
| pH | Min | 7.97 | 7.72 | 7.89 | 7.97 |
| | Median | 8.06 | 7.88 | 8.10 | 8.01 |
| | Mean | 8.06 | 7.88 | 8.09 | 8.01 |
| | Max | 8.13 | 8.09 | 8.17 | 8.06 |
| Specific Conductivity µS/cm | Min | 937 | 1066 | 1283 | 1219 |
| | Median | 1050 | 1078 | 1379 | 1329 |
| | Mean | 1040 | 1080 | 1378 | 1328 |
| | Max | 1100 | 1094 | 1474 | 1429 |

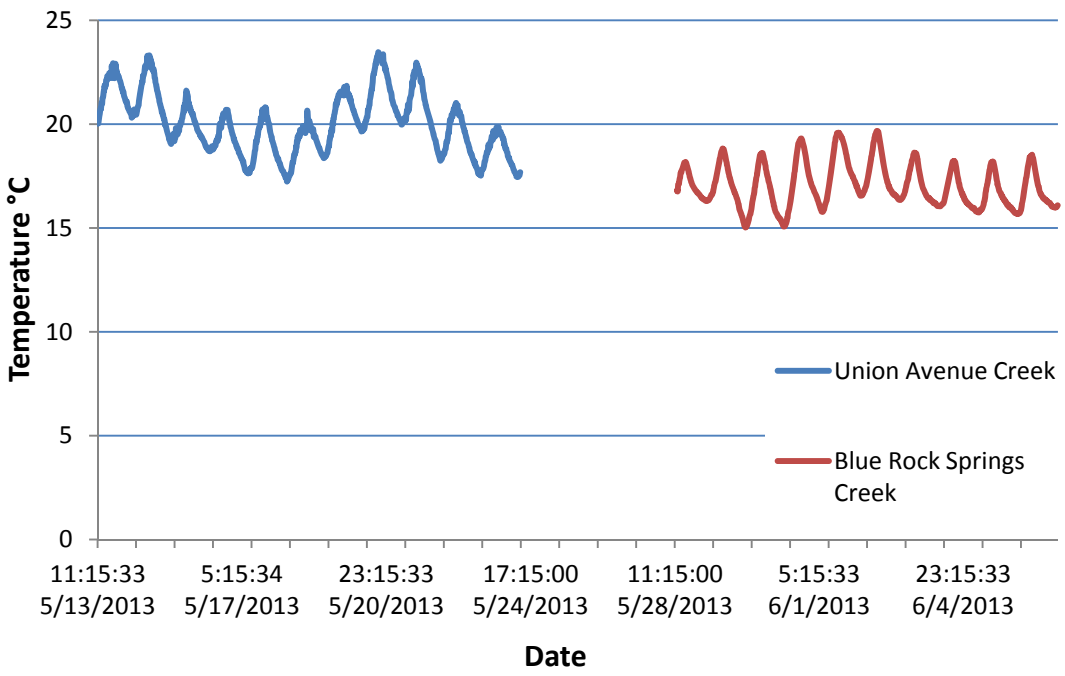


**Figure 4-3a. Continuous water quality data (temperature) collected May/June 2013 at Union Avenue Creek and Blue Rock Springs Creek.**

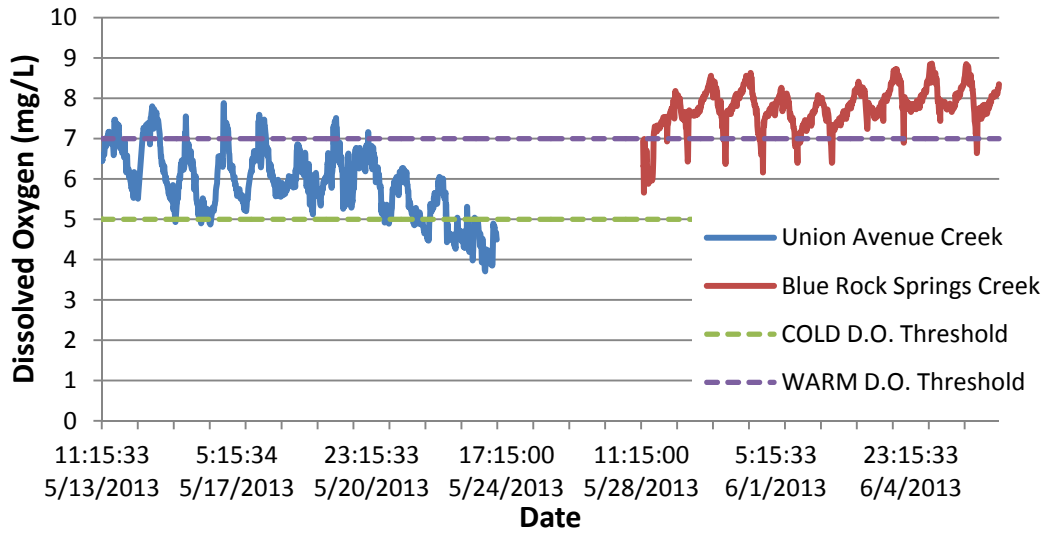


**Figure 4-3b. Continuous water quality data (DO) collected May/June 2013 at Union Avenue Creek and Blue Rock Springs Creek.**

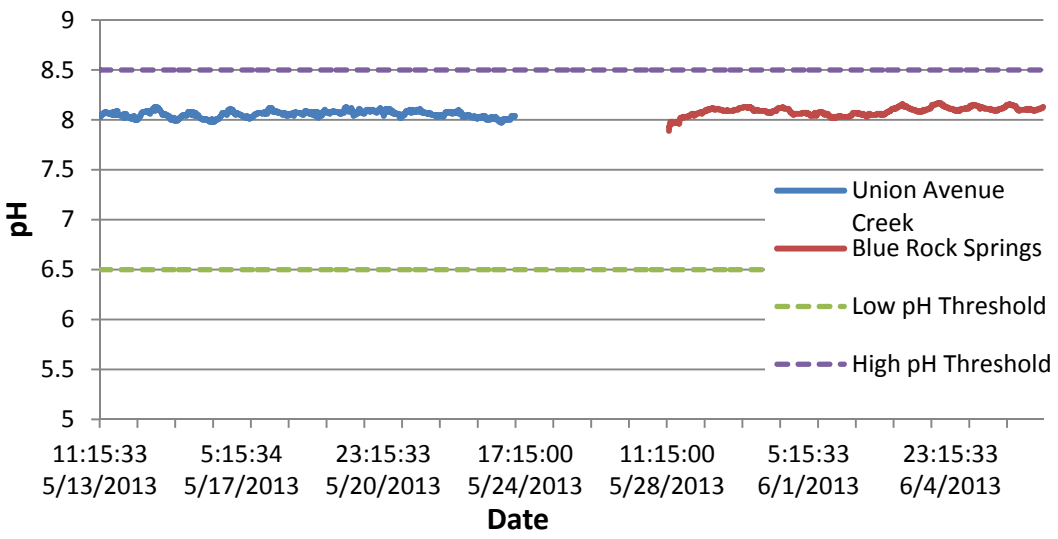


**Figure 4-3c. Continuous water quality data (pH) collected May/June 2013 at Union Avenue Creek and Blue Rock Springs Creek.**

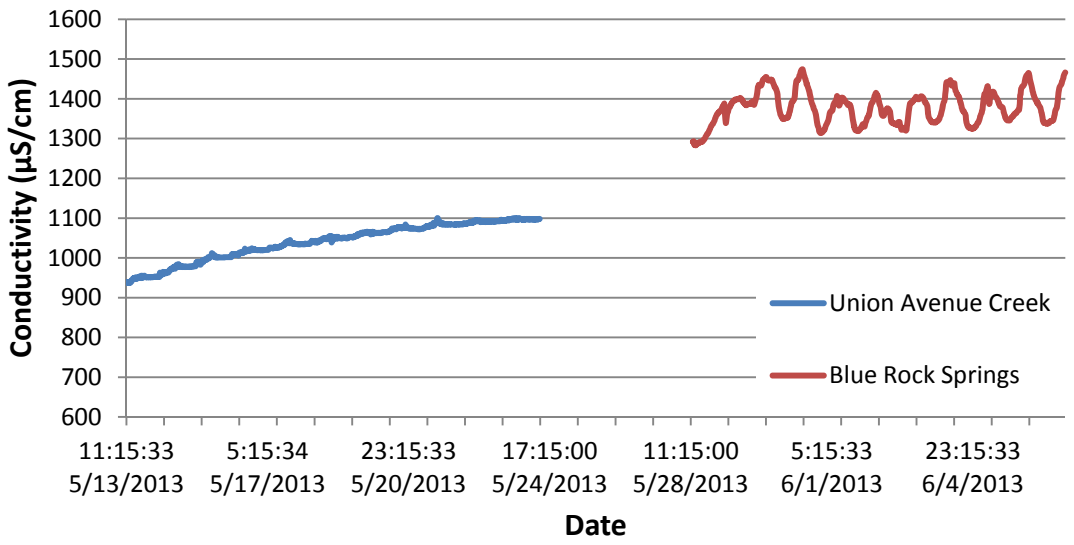


**Figure 4-3d. Continuous water quality data (specific conductivity) collected May/June 2013 at Union Avenue Creek and Blue Rock Springs Creek.**

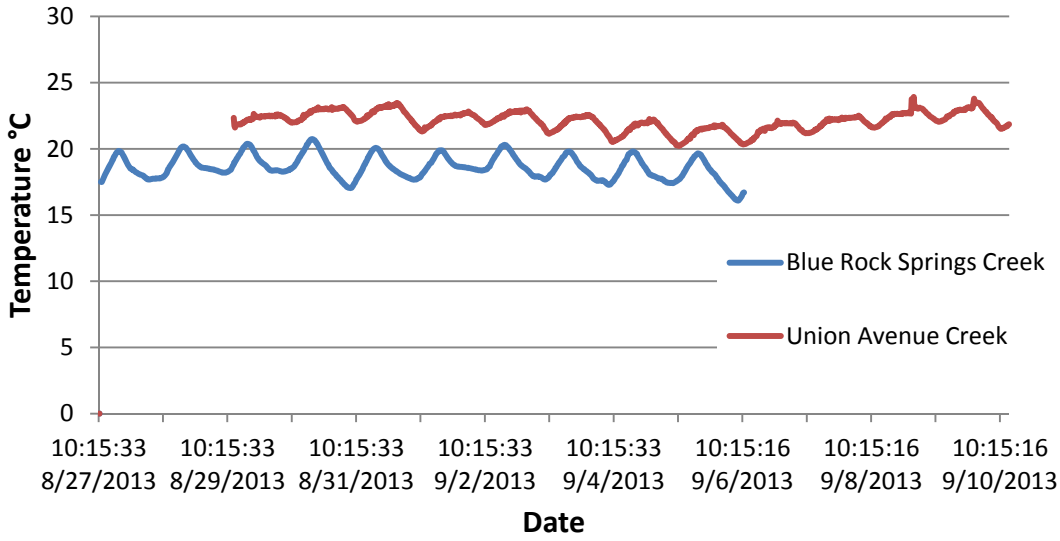


**Figure 4-4a. Continuous water quality data (temperature) collected Aug/Sep 2013 at Union Avenue Creek and Blue Rock Springs Creek.**

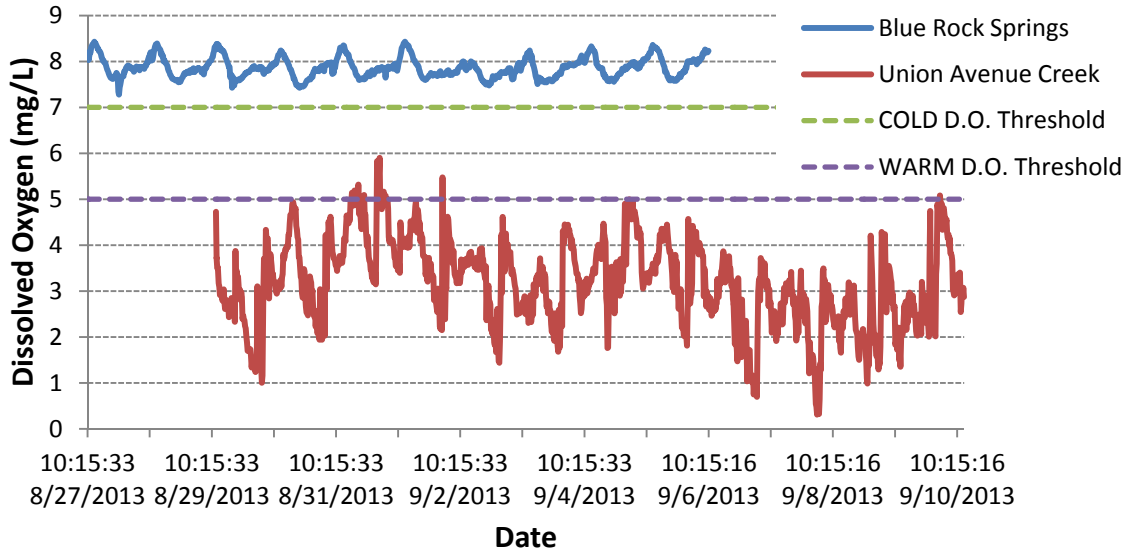


**Figure 4-4b. Continuous water quality data (DO) collected Aug/Sep 2013 at Union Avenue Creek and Blue Rock Springs Creek.**

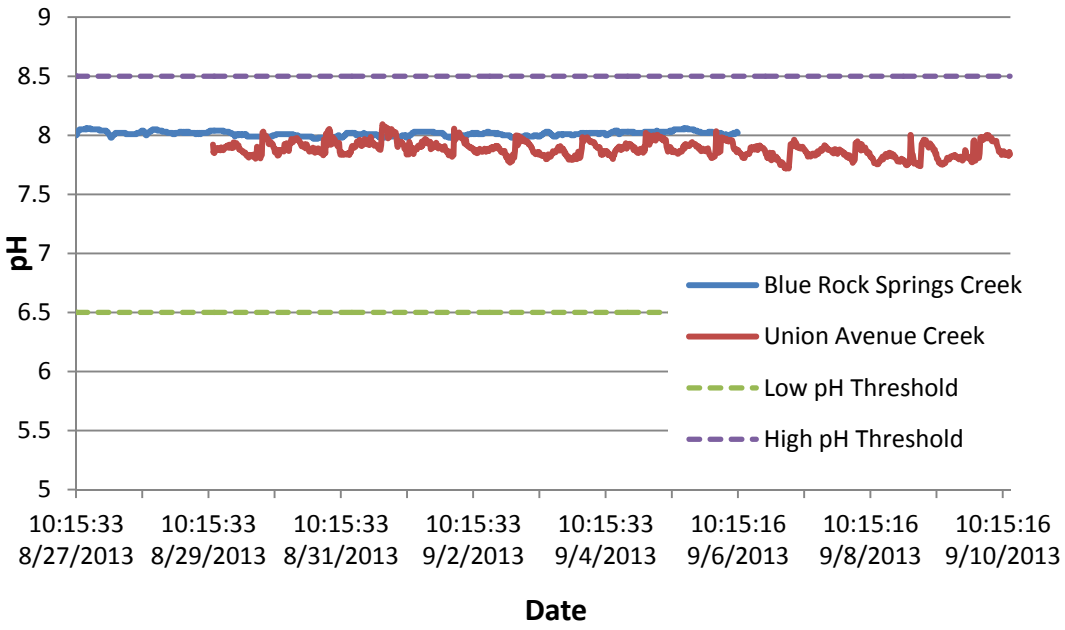


**Figure 4-4c. Continuous water quality data (pH) collected Aug/Sep 2013 at Union Avenue Creek and Blue Rock Springs Creek.**

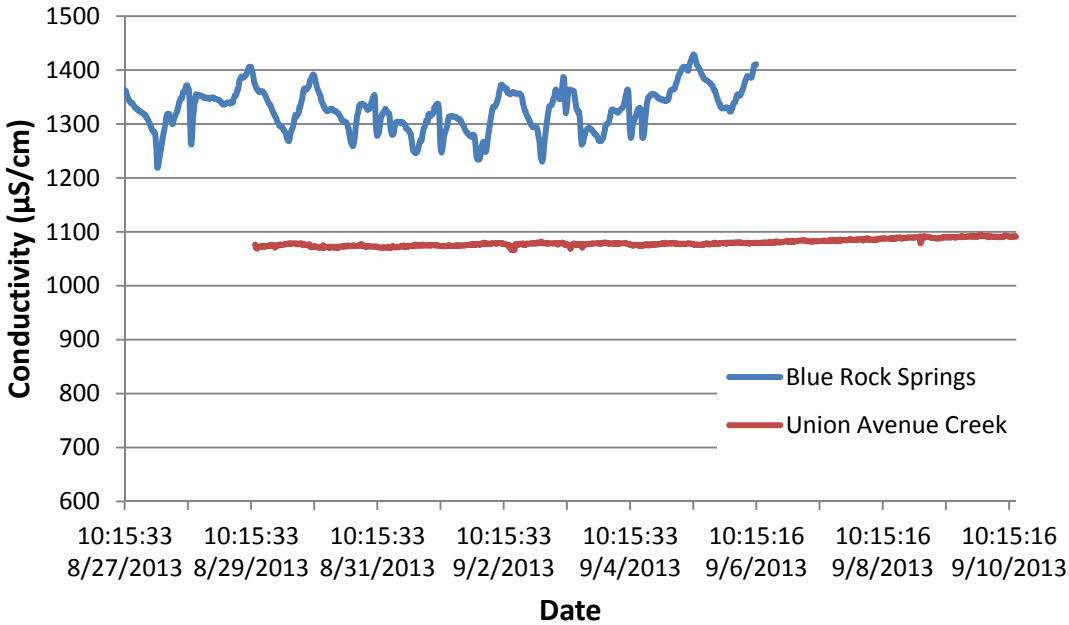


**Figure 4-4d. Continuous water quality data (specific conductivity) collected Aug/Sep 2013 at Union Avenue Creek and Blue Rock Springs Creek.**

Table 4-4 presents the comparisons of the continuous water quality data for temperature, dissolved oxygen, and pH measured at Solano County sites for both deployment periods (May/June and Aug/Sept)to the water quality evaluation criteria specified in Table 3-2 (taken from Table 8.1 of the MRP and Region 5 Permit). The following summarizes any exceedences that were observed at either creek as follows:

Union Avenue Creek:

- Stream temperature (MWAT) remained below the 20.5$^{o}$C threshold throughout the spring deployment period, but was above that threshold for the entirety of the summer deployment period.
- Dissolved oxygen fell below the 5.0mg/l threshold for 17% of the spring deployment period.
- Dissolved oxygen fell below the 5.0 mg/l threshold 98% of the summer deployment period, which meets the trigger threshold for water quality criteria.
- pH remained between the acceptable threshold values for both deployment periods.

Blue Rock Springs Creek:

- Stream temperatures met threshold criteria in both spring and summer deployment periods.
- DO values were above the 5.0mg/l threshold minimum during both spring and summer deployment periods.
- pH remained between the acceptable threshold values for both deployment periods.

Results indicate that possible follow-up actions at Union Avenue Creek to improve water quality would include work on temperature and dissolved oxygen.

**Table 4-4. Percent of the water temperature, dissolved oxygen, and pH data measured at the two sites for both spring and summer monitoring events that exceed water quality criteria identified in Table 3-2.**

| Site ID | Creek Name | Monitoring Period | Temperature % Results MWAT>20.5° C | DO % Results <5.0 mg/l (WARM) | DO % Results <7.0 mg/l (COLD) | pH % Results <6.5 or>8.5 |
|---|---|---|---|---|---|---|
| 207R00684 | Union Ave. | May 13$^{th}$ – May 24$^{th}$ | 0% | 17%* | - | 0% |
| | | Aug 29$^{th}$ –Sept 10$^{th}$ | 100% | 98%* | - | 0% |
| 207R00064 | Blue Rock Springs | May 28$^{th}$-June 7$^{th}$ | 0% | 0% | - | 0% |
| | | Aug 27$^{th}$- Sept 6$^{th}$ | 0% | 0% | - | 0% |

* Union Ave. Creek is not designated as a WARM water body in the SF Bay Basin Plan

### 4.2.3 Pathogen indicators

Pathogen indicator samples were collected in both Vallejo and Fairfield (Figure 2-1) on August 14th 2013. Fairfield collections came from three separate locations along Laurel Creek (upper, mid, and lower creek reaches). Vallejo samples were taken from two locations on Sulfur Springs Creek and one of the probabilistic sites on Blue Rock Springs Creek. Table 4-5 summarizes the results of samples that were analyzed for fecal coliform and E.coli.

**Table 4-5. Fecal coliform and E. coli levels measured from water samples taken at Solano County locations on August 14, 2013. Values in bold exceed the trigger threshold for water quality criteria identified in Table 3-2.**

| Site ID | Creek | Fecal Coliform (MPN/100mL) | E.Coli (MPN/100mL) | Total Coliform |
|---|---|---|---|---|
| 207LAU040 | Laurel | **500** | **500** | 1300 |
| 207LAU030 | Laurel | 30 | 30 | 500 |
| 207LAU020 | Laurel | 80 | 80 | 700 |
| 207RLHC020 | Sulfur Springs | 40 | 60 | 47 |
| 207RNLH020 | Sulfur Springs | **800** | 350 | 190 |
| 207R00064 | Blue Rock Springs | **1700** | **2800** | 3600 |

Pathogen indicator sampling results indicate that there may be opportunity to more extensively monitor streams that met the trigger criteria (particularly Site 207R00064, Blue Rock Springs Creek) to establish where potential pathogen problems may be coming from.

### 4.2.4 Stream Survey

Tables 4-6 and 4-7 below display the results from 16 individual CRAM stream survey assessments completed in the late summer of 2013 (8 sites in Fairfield and 8 sites in Vallejo). The maximum CRAM score possible (100 points) represents the best condition that is likely to be achieved for the type of wetland being assessed in a given region. The overall assessment area score for each of the stream survey sites in Tables 4-6 and 4-7 indicate the current condition relative to that best achievable condition for the riverine wetland type in the state.

**Table 4-6. Final attribute and assessment area scores (100 points possible) of CRAM survey sites in Solano County, summer 2013.**

| Site ID | Assessment Area Name | Buffer and Landscape Context | Hydrology | Physical Structure | Biotic Structure | Overall Assessment Area Score |
|---|---|---|---|---|---|---|
| 00316 | South Cordelia-Unnamed Creek | 63 | 83 | 38 | 47 | **58** |
| 00428 | Union Avenue Creek | 25 | 67 | 50 | 44 | **47** |
| 00476 | Ledgewood Creek | 61 | 75 | 50 | 67 | **63** |
| 00556 | Union Avenue Creek | 27 | 67 | 38 | 42 | **44** |
| 01340 | American Canyon @ Oakbrook | 71 | 58 | 63 | 81 | **68** |
| 01452 | Laurel Creek @East Tabor | 29 | 58 | 25 | 44 | **39** |
| 01516 | Green Valley Creek | 43 | 83 | 75 | 81 | **71** |
| 02732 | Laurel Creek | 75 | 83 | 75 | 78 | **78** |
| 00064 | Blue Rock Springs Creek @ golf course | 43 | 83 | 75 | 64 | **66** |
| 00688 | Blue Rock Springs Creek @ Coach Ln | 25 | 83 | 63 | 50 | **55** |
| 02480 | Rindler Creek @ St. Johns Mine Rd | 83 | 83 | 63 | 50 | **70** |
| 03504 | Rindler Creek @ Home Depot | 29 | 33 | 25 | 33 | **30** |
| 04080 | Blue Rock Springs Creek @ pampas grass | 80 | 83 | 62.5 | 69.4 | **74** |
| 04784 | Hiddenbrook Creek @ Alder Ck. Rd | 83 | 67 | 88 | 83 | **80** |
| 05232 | Sulfur Springs Creek @ Bennington Dr | 25 | 83 | 63 | 67 | **60** |
| 05524 | Blue Rock Springs Creek @ Hanns Park | 68 | 83 | 87.5 | 97 | **84** |

Overall CRAM scores for Solano County streams ranged from 30-84 out of 100 possible points, with a mean score of 61.7.

# 5.0 Next Steps

In Water Year 2014, Fairfield Suisun Urban Runoff Management Program will continue conducting general water quality monitoring according to the parameters and requirements of Provision C.8 in the MRP and Region 5 Permit. The City of Vallejo and Vallejo Sanitation and Flood Control District has performed the required one year of monitoring in Water Year 2013 and will not monitor all of the water quality parameters again in WY 2014. However, the Vallejo team was not able to capture the continuous water temperature data this past year and will complete that activity in Water Year 2014.

The Fairfield Urban Runoff Management Program, City of Vallejo and Vallejo Sanitation and Flood Control District will work with partners at the RMC and Region 5 Water Board to identify pollutant source and stressor identification project areas discovered from the analysis of data gathered in Water Year 2013. Appropriate actions will be taken to address these findings and will be carried out per the requirements of MRP and Region 5 Provision C.8.d.i.

# 6.0 References

BASMAA. 2014a. Creek Status Monitoring Program Quality Assurance Project Plan, Final Draft Version 2.0. Prepared for BASMAA by EOA, Inc. on behalf of the Santa Clara Urban Runoff Pollution Prevention Program and the San Mateo Countywide Water Pollution Prevention Program, Applied Marine Sciences on behalf of the Alameda Countywide Clean Water Program, and Armand Ruby Consulting on behalf of the Contra Costa Clean Water Program. 80 pp. plus appendices.

BASMAA. 2014b. Creek Status Monitoring Program Standard Operating Procedures, Final Draft Version 2.0. Prepared for BASMAA by EOA, Inc. on behalf of the Santa Clara Urban Runoff Pollution Prevention Program and the San Mateo Countywide Water Pollution Prevention Program, Applied Marine Sciences on behalf of the Alameda Countywide Clean Water Program, and Armand Ruby Consulting on behalf of the Contra Costa Clean Water Program. 196 pp.