CONTRA COSTA
CLEAN WATER
PROGRAM

# *Urban Creeks Monitoring Report*
# *Water Year 2015*
# *(October 2014 – September 2015)*

***Submitted in Compliance with Provision C.8.***

***NPDES Permit No. CAS612008***

***and***

***NPDES Permit No. CAS083313***

## *March 31, 2016*

***The Contra Costa Clean Water Program – A Municipal Stormwater Program consisting of Contra Costa County, its 19 Incorporated Cities/Towns, and the Contra Costa County Flood & Water Conservation District***

This report is submitted by the agencies of the

**Program Participants:**

- Cities of: Antioch, Brentwood, Clayton, Concord, Danville (Town), El Cerrito, Hercules, Lafayette, Martinez, Moraga (Town), Oakley, Orinda, Pinole, Pittsburg, Pleasant Hill, Richmond, San Pablo, San Ramon and Walnut Creek
- Contra Costa County
- Contra Costa County Flood Control & Water Conservation District


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# List of Acronyms

| | |
|---|---|
| BASMAA | Bay Area Stormwater Management Agencies Association |
| B-IBI | Benthic Index of Biological Integrity |
| CCCWP | Contra Costa Clean Water Program |
| COLD | Uses of water that support cold water ecosystems |
| CRAM | California Rapid Assessment Method |
| CV | Central Valley |
| CVRWQB | Central Valley Regional Water Quality Control Board |
| DDE | Dichlorodiphenyldichloroethylene (pesticide) |
| DDT | Dichlorodiphenyltrichloroethane (pesticide) |
| DO | Dissolved Oxygen |
| IBI | Index of Biological Integrity |
| IMS | Information Management System |
| LID | Low Impact Development |
| MeHg | Methylmercury |
| mg/L | milligram per liter |
| MPC | Monitoring and Pollutants of Concern Committee |
| MPN | Most Probable Number |
| MRP | Municipal Regional Permit |
| MRP 1.0 | Order R2-2009-0079 |
| MRP 2.0 | Order R2-2015-0049 |
| MUN | Uses of water for community, military, or individual water supply system |
| MWAT | Maximum Weekly Average Temperature |
| NPDES | National Pollutant Discharge Elimination System |
| PCBs | Polychlorinated Biphenyls |
| PEC | Probable Effect Concentration |
| POC | Pollutants of Concern |
| POTW | Publicly Owned Treatment Works |
| QAPP | Quality Assurance Project Plan |
| RMC | Regional Monitoring Coalition |
| RMP | Regional Monitoring Program for Water Quality in the San Francisco Estuary |
| RWQCB | Regional Water Quality Control Board |
| SAP | Sampling and Analysis Plan |
| SC | Steering Committee |

| | |
|---|---|
| SF | San Francisco |
| SFEI | San Francisco Estuary Institute |
| SFBRWQCB | San Francisco Bay Regional Water Quality Control Board |
| SOP | Standard Operating Protocol |
| SSID | Stressor Source Identification |
| STLS | Small Tributaries Loading Strategy |
| SWAMP | Surface Water Ambient Monitoring Program |
| TEC | Threshold Effect Concentration |
| TIE | Toxicity Identification Evaluation |
| TMDL | Total Maximum Daily Load |
| TRE | Toxicity Reduction Evaluation |
| TU | Toxicity Units |
| USEPA | United States Environmental Protection Agency |
| WARM | Uses of water that support warm water ecosystems |
| WLA | Wasteload Allocation |
| WQO | Water Quality Objective |
| WY | Water Year |

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# Water Year Summary Table

| Site ID | Creek Name | Land Use | Latitude | Longitude | Bioassessment | Nutrient | Chlorine | Water Column Toxicity | Sediment Toxicity & Chemistry | Pathogens | Temp. Loggers | General Water Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 207R01271 | Walnut Creek | Region 2/5, Urban | 37.918973 | -122.053884 | | | | | | X | | |
| 206R01319 | San Pablo Creek | Region 2/5, Urban | 37.96689 | -122.35916 | | | | | | X | X | |
| 204R00388 | W. Branch Alamo Creek | Region 2/5, Urban | 37.80352 | -121.89936 | X | X | X | | | X | X | X |
| 204R01156 | Trib. of Alamo Creek | Region 2/5, Urban | 37.79739 | -121.88988 | X | X | X | | | | | |
| 206R00960 | Rodeo Creek | Region 2/5, Urban | 38.00768 | -122.22185 | X | X | X | | | | | |
| 206R01024 | Rodeo Creek | Region 2/5, Urban | 38.01993 | -122.25920 | X | X | X | X | X | | | |
| 207R00891 | Green Valley Creek | Region 2/5, Urban | 37.82838 | -121.98444 | X | X | X | X | X | X | X | |
| 207R01163 | San Ramon Creek | Region 2/5, Urban | 37.88713 | -122.05534 | X | X | X | | | X | X | X |
| 207R01227 | San Ramon Creek | Region 2/5, Urban | 37.87703 | -122.04847 | X | X | X | | | | | |
| 543R01103 | W. Antioch Creek | Region 2/5, Urban | 37.98026 | -121.81226 | X | X | X | | | | | |
| 544R01049 | Dry Creek | Region 2/5, Urban | 37.92213 | -121.71938 | X | X | X | | | | | |
| 544R01305 | Marsh Creek | Region 2/5, Urban | 37.94454 | -121.70527 | X | X | X | | | | | |

# Executive Summary

This Urban Creeks Monitoring Report was prepared by the Contra Costa Clean Water Program (CCCWP) per the Municipal Regional Permit (MRP) for urban stormwater issued by the San Francisco Bay Regional Water Quality Control Board (SFRWQCB; Order No. R2-2015-0049, "MRP 2.0") and the East Contra Costa County Municipal NPDES Permit (Central Valley Permit) issued by the Central Valley Regional Water Quality Control Board (CVRWQCB; Order No. R5-2010-0102). This report (including all appendices and attachments) fulfills the requirements of MRP 2.0 Provision C.8.h.iii for interpreting and reporting monitoring data collected during Water Year (WY) 2015 (October 1, 2014 - September 30, 2015). Monitoring discussed herein was performed in accordance with the Central Valley Permit and the previous MRP (SFRWQCB; Order No. R2-2009-0079; "MRP 1.0"). Key technical findings are summarized below and presented in more detail in the body of the report and in its corresponding appendices. Please note that WY 2015 marked the fourth year of drought and it is important to recognize that these dry conditions may affect the water quality results.

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

Permittees are required to report annually on water quality data collected in compliance with the MRP. For creek status monitoring, the RMC adapted existing creek status monitoring Standard Operating Protocols (SOPs) and Quality Assurance Project Plan (QAPP) developed by the Surface Water Ambient Monitoring Program (SWAMP) to document the field procedures necessary to maintain comparable, high quality data among RMC participants. Additionally, the RMC participants developed an Information Management System (IMS) to provide SWAMP-compatible storage and import/export of data for all RMC programs. For POC loads monitoring, a field manual and QAPP were developed through the Small Tributaries Loading Strategy (STLS) Workgroup. The Bay Area Stormwater Management Agencies Association (BASMAA) contracted with the San Francisco Estuary Institute (SFEI) to design and maintain an IMS for management of data from stations operated by the RMC programs. The IMS provides standardized data storage formats that allow RMC participants to share data among themselves and to submit data electronically to the SFBRWQCB and CVRWQCB.

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

The CCCWP contributes to the San Francisco Estuary Institute's (SFEI's) Regional Monitoring Program (RMP). Specifically, the Status & Trends Monitoring Program and the Pilot and Special Studies efforts are useful tools of the CCCWP. CCCWP staff participates in many of the RMP committees. Findings of Status & Trends Monitoring and Pilot and Special Studies results are summarized and/or referenced in the body of this report.

### Creek Status Monitoring (C.8.d)

The Regional Monitoring Coalition (RMC) regional monitoring strategy for complying with MRP requirements includes a regional ambient/probabilistic monitoring (**Appendix 1**) component and a component based on local/targeted monitoring (**Appendix 2**). During WY 2015, 10 sites were monitored under the regional/probabilistic design for bioassessment, physical habitat, and related water chemistry parameters. Two of the 10 sites were also monitored for water and sediment toxicity and sediment chemistry. In WY 2015, within Contra Costa County, targeted monitoring was conducted at four continuous water temperature monitoring locations, two general water quality monitoring locations, five pathogen indicator monitoring locations, and 10 riparian assessment monitoring locations. Findings from this monitoring are summarized in the body of this report and described in detail in the appendices.

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

The MPR requires Stressor/Source Identification (SSID) Projects when any monitoring result(s) triggers a follow-up project. Permittees were focused on conducting Part B of the SSID projects during WY 2015. In WY 2012 and WY 2013, the CCCWP's Creek Status Monitoring triggered exceedances for water and sediment toxicity parameters. Part A results were reported in the WY 2014 UCMR, and confirmed that current use pesticides, namely pyrethroids were the cause of the toxicity measured in Dry Creek and Grayson Creek. SSID Study Part B efforts to identify potential sources of the pyrethroid pesticides, and therefore potential source controls, are summarized herein, with a full report attached as **Appendix 3**. A summary of the BASMAA Regional Monitoring Coalition SSID projects is attached as **Appendix 4**.

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

Pollutants of Concern (POC) load 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 total maximum daily loads (TMDLs), and help resolve uncertainties associated with loading estimates for these pollutants. An updated Sampling and Analysis Plan, Quality Assurance Project Plan, and Standard Operating Procedures are being developed to implement the POC, toxicity, and pesticide monitoring requirements in MRP 2.0 Provisions C.8.f and C.8.g.

MRP 2.0 places an increased focus on finding watersheds, sources areas, and source properties that are potentially more polluted and upstream from sensitive Bay margin areas (high leverage). To support this focus, a stormwater characterization monitoring program was developed and implemented beginning in WY 2015. This same design is being implemented in the winter of WY 2016 by the RMP and the Santa Clara and San Mateo countywide stormwater programs and will be implemented for CCCWP once acceptable sites are selected. In addition, the RMP is piloting an effort and exploring the use of alternative un-manned "remote" suspended sediment samplers. During WY 2015, samples were collected from 20 watersheds. At three of these locations, data were also collected using two remote suspended sediment samplers. The UCMR summarizes the WY 2015 findings and provides a preliminary interpretation of data collected during WY 2015 (the detailed report is included as **Appendix 5**). The POC report is designed to be updated in subsequent years as more data are collected.

As part of the Alternative Approach (**Appendix 6**) CCCWP and Permittee staff have been conducting source area screening to delineate High, Moderate, and Low/No Opportunity parcels for consideration in focused implementation planning for PCBs and mercury load reduction. To date, 57 sites have been sampled in an attempt to locate high opportunity areas for PCBs abatement. Four PCBs samples and four mercury samples exceeded the action levels (PCBs action level = 500 ppb; Mercury action level = 750 ppb), while only one sample exceeded the action level for both PCBs and mercury. A summary report of this data is presented in the Pollutants of Concern Sediment Screening 2015 Annual Sampling and Analysis Report (**Appendix 7**).

CCCWP began implementation of a Methylmercury Control Study in 2012 to fulfill requirements of the Central Valley Permit (C.11.l). A Methylmercury Control Study Work Plan was prepared to 1) evaluate the effectiveness of existing Best Management Practices (BMPs) for the control of methylmercury; 2) evaluate additional or enhanced BMPs, as needed, to reduce mercury and methylmercury discharges to the Delta; and 3) determine the feasibility of meeting methylmercury waste load allocations. The progress report submitted to the CVRWQB on October 30, 2015, presents preliminary findings of the Methylmercury Control Study Work Plan monitoring efforts from Spring 2012 through Spring 2015.

Provision C.12.f of MRP 1.0 required permittees to evaluate diversion of dry weather and wet weather urban runoff into sanitary sewage conveyance and treatment systems to determine if diversion to sanitary treatment is a useful tool for reducing PCBs loads from urban runoff. The North Richmond stormwater pump station project (**Appendix 8**) achieved the objective of installing and pilot testing urban runoff diversion infrastructure. Diversion of dry and wet weather urban runoff into the nearest water reclamation facility offers only incremental PCBs load reduction benefits. Diversion is not a “silver bullet” that will make a significant difference to PCBs loads; however, consideration of multiple water quality benefits, such as trash controls, water resource development, and reduction of bacteria, oil and grease, and other urban pollutants discharged to Wildcat Marsh and the Bay may motivate additional, expanded stormwater harvest and use projects in this watershed.

Finally, the cleanup of the Mount Diablo Mercury Mine is one of the County’s priority Projects included as **Appendix 9**. The mine represents an ongoing point source of mercury in the watershed and must be cleaned up. At this time, it is still unknown if the identified responsible parties will be required to remediate the entire mine site or a portion of the site.

### Pesticides and Toxicity Monitoring (C.8.g)

Pesticides and Toxicity Monitoring are separated into their own section in MRP 2.0. Because the monitoring took place during WY 2015, under MRP 1.0 guidelines, they have been reported in section C.8.d (Creek Status Monitoring).

# 1.0 Introduction

This *Urban Creeks Monitoring Report* was prepared by the Contra Costa Clean Water Program (CCCWP) per the Municipal Regional Permit (MRP) for urban stormwater issued by the San Francisco Bay Regional Water Quality Control Board (SFRWQCB; Order No. R2-2015-0049; "MRP 2.0") and the East Contra Costa County Municipal NPDES Permit (Central Valley Permit) issued by the Central Valley Regional Water Quality Control Board (CVRWQCB; Order No. R5-2010-0102). Much of the information reported within is based on requirements found in the previous Municipal Regional Permit (R2-2009-0074; "MPR 1.0"). This report (including all appendices and attachments) fulfills the requirements of MRP 2.0 (Provision C.8.h.iii) and the Central Valley Permit (Provision C.8.g.iii) for interpreting and reporting monitoring data collected during Water Year (WY) 2015 (October 1, 2014 - September 30, 2015), the fourth year of water quality monitoring conducted under MRP 1.0 and the Central Valley Permit. All monitoring data presented in this report were submitted electronically to the Water Boards by the CCCWP and may be obtained via the San Francisco Bay Area Regional Data Center (http://www.sfei.org/sfeidata.htm).

This report is organized into two main parts – the main body and appendices. The main body provides brief summaries of accomplishments made in WY 2015 in compliance with MRP and Central Valley Permit provision C.8. Summaries are organized by sub-provisions of MRP 2.0 and the Central Valley Permit and grouped into the following sections:

1. Introduction (C.8.a)
2. Monitoring Protocols and Data Quality (C.8.b)
3. San Francisco Estuary Receiving Water Monitoring (C.8.c)
4. Creek Status Monitoring (C.8.d)
5. Stressor/Source Identification (SSID) Projects (C.8.e)
6. Pollutants of Concern Monitoring (C.8.f)
7. Pesticides and Toxicity Monitoring (C.8.g)

Appendices to this report include interpretive reports focused on specific types of water quality monitoring required by the MRP and Central Valley Permit and are referenced within the applicable sections of the main body of this report.

Provision C.8.a of the MRP and Central Valley Permit allows Permittees to address monitoring requirements either through Regional Collaboration, through their Area-wide Stormwater Programs, or Third-party Monitoring. In June 2010, Permittees notified the SFBRWQCB and CVRWQCB in writing of their agreement to participate in a regional monitoring collaboration to address requirements in Provision C.8. The collaboration is known as the Bay Area Stormwater Management Agencies Association (BASMAA) Regional Monitoring Coalition (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 and Central Valley Permit 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). 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 and Central Valley Permit.

Regionally-implemented activities in the RMC Work Plan are conducted under the auspices of the 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 Board of Directors. MRP Permittees, through their stormwater program representatives on the Board of Directors and its subcommittees, collaboratively authorize and participate in BASMAA regional projects and 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[1].

The following MRP and Central Valley Permit reporting requirements are addressed within this report and the associated appendices:

- Water Year Summary Table
- SSID Status Report
- Statement of Data Quality
- Analysis of data

[1] The BASMAA programs supporting MRP Regional Projects include all MRP Permittees as well as the cities of Antioch, Brentwood, and Oakley which are not named as Permittees under the MRP but have voluntarily elected to participate in MRP-related regional activities.

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

The MRP requires Permittees to report annually on water quality data collected in compliance with the MRP and Central Valley Permit. Annual reporting requirements include:

1. Water quality standard exceedances;
2. Creek status monitoring electronic reporting; and
3. Urban creeks monitoring reporting.

For RMC participants, annual reporting requirements began with the initial creek status monitoring electronic data submittal to the SFBRWQCB and CVRWQCB that occurred on January 15, 2013. 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 Urban Creeks Monitoring Report and associated appendices.

Provision C.8.b requires that water quality data collected by Permittees in compliance with the MRP and Central Valley Permit 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 made significant progress on the following regional projects during the period of this report:

- Standard Operating and Data Quality Assurance Procedures
  - For creek status monitoring, the RMC adapted existing Standard Operating Protocols (SOPs) and QAPP developed by SWAMP to document the field procedures necessary to maintain comparable, high quality data among RMC participants. The RMC Creek Status Monitoring Program QAPP was finalized in January 2014 (BASMAA 2014).
  - For POC loads monitoring, a draft field manual and QAPP were developed through the STLS Workgroup and described in the STLS 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 System Development/Adaptation
  - For creek status monitoring, the RMC participants developed an Information Management System (IMS) to provide SWAMP-compatible storage and import/export of data for all RMC programs. A data management subgroup of the RMC met periodically for training and review of data management issues, and suggested enhancements for data checking and to increase efficiency. These enhancements 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 management system and performed quality assurance review of the data collected by RMC programs, consistent with the QAPP for data collected through the RMP. The IMS provides standardized data storage formats that allow RMC participants to share data among themselves and to submit data electronically to the SFBRWQCB and CVRWQCB.

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

As described in MRP provision C.8.c, Permittees are required to contribute their fair-share financially on an annual basis towards implementing an estuary receiving water monitoring program that at a minimum is equivalent to the Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP). Since the adoption of the MRP, all Permittees have complied with this provision by making financial contributions to the RMP. Additionally, Permittees actively participate in RMP committees and work groups through Permittee and/or stormwater program representatives.

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. 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?

The CCCWP contributes annually to the RMP. In WY 2015 the CCCWP contributed $148,445. The RMP budget is generally broken into two major program elements: Status and Trends, and Pilot/Special Studies. The RMP publishes reports and study results on their website at www.sfei.org/rmp.

# 4.0 Creek Status Monitoring (C.8.d)

MRP 2.0 Provision C.8.d (formerly 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, rivers, and tributaries?
2. Are conditions in local receiving waters supportive of or likely supportive of beneficial uses?

Creek status monitoring parameters, methods, occurrences, duration, and minimum number of sampling sites for each stormwater program are described in Provision C.8.d of MRP 2.0 and in the Central Valley Permit. Based on the implementation schedule described in MRP 1.0 Provision C.8.a.ii, creek status monitoring coordinated through the RMC began in October 2011.

## 4.1 Regional and Local Monitoring Designs

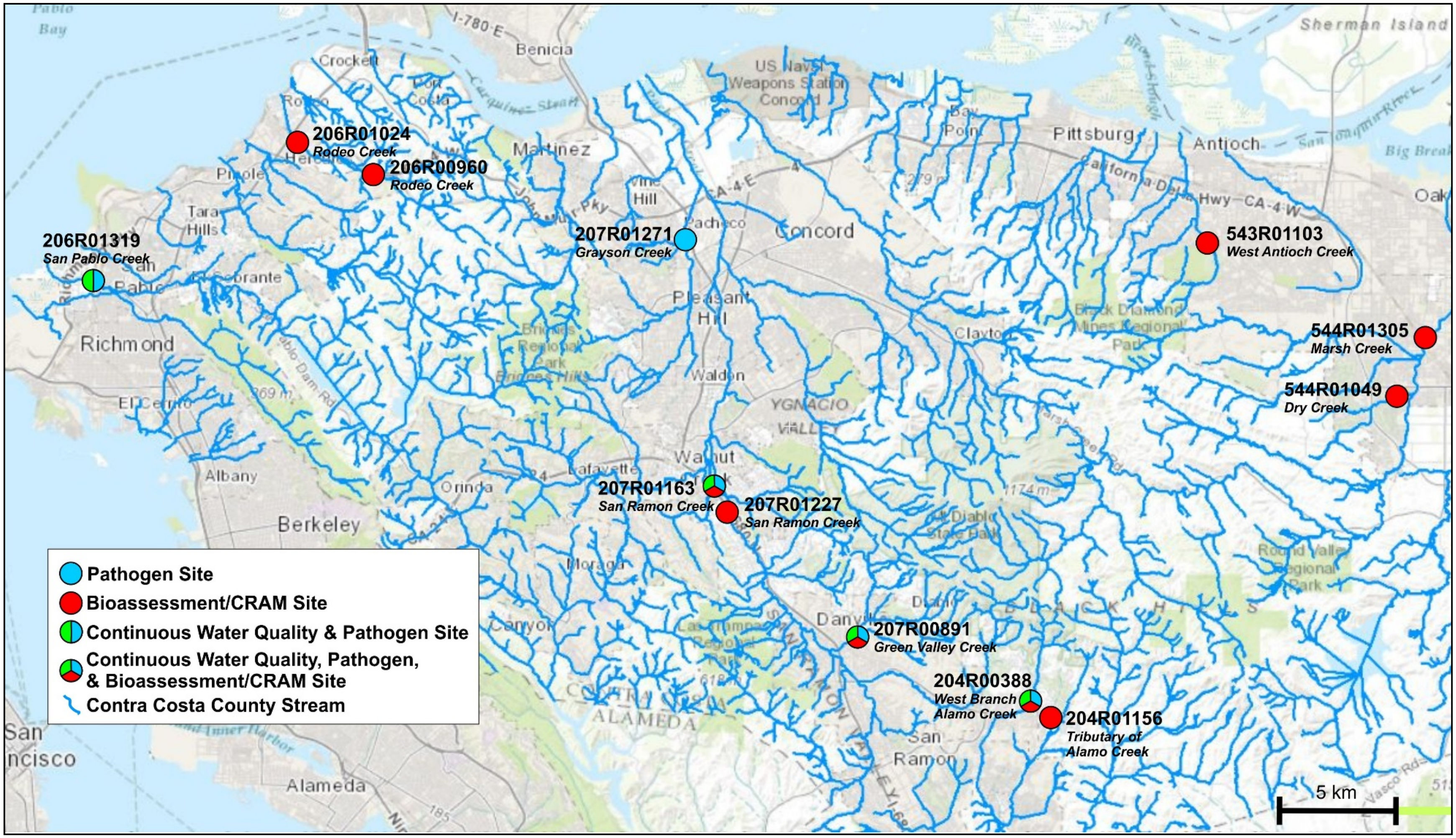
The RMC's regional monitoring strategy for complying with the MRP and Central Valley Permit creek status monitoring, is described in *Creek Status and Long-Term Trends Monitoring Plan* (BASMAA 2011) and follows the January 2014 *Regional Monitoring Coalition Creek Status Monitoring Program Quality Assurance Project Plan* (BASMAA 2014). 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).

Creek status monitoring data were submitted by the CCCWP to the SFBRWQCB and CVRWQCB by March 31, 2016. The analysis of results from creek status monitoring conducted in WY 2015 is presented in **Appendix 1** (Regional/Probabilistic Creek Status Monitoring Report Water Year 2015) and **Appendix 2** (Local/Targeted Creek Status Monitoring Report Water Year 2015). **Table 4-1** provides a list of which parameters are included in regional and local reports and the following sections provide a brief summary of each report.

**Table 4-1. Location of monitoring results and analysis for each required parameter**

| Biological Response and Stressor Indicators | Interpretative Report | |
|---|---|---|
| | **Appendix 1** Regional/Probabilistic Creek Status Monitoring Report WY 2015 | **Appendix 2** Local/Targeted Creek Status Monitoring Report WY 2015 |
| 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 |
| Bacteria | | X |
| Stream Survey (CRAM) | | X |

**Figure 4-1. Contra Costa County Sites Monitored in Water Year 2015**




Note: Bioassessment Sites Are Those Selected From the RMC Probabilistic Monitoring Design

### 4.1.1 Regional/Probabilistic Monitoring

The Regional/Probabilistic Creek Status Monitoring Report (**Appendix 1**) documents the results of monitoring performed by CCCWP during WY 2015 under the regional/probabilistic monitoring design developed by the RMC. During WY 2015, 10 sites were monitored by the CCCWP under the regional/probabilistic design for bioassessment, physical habitat, and related water chemistry parameters. Two of the 10 sites were also monitored for water and sediment toxicity and sediment chemistry.

The bioassessment and related data are used 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 water and sediment chemistry and toxicity data are used to evaluate potential stressors that may affect aquatic habitat quality and beneficial uses. The probabilistic design requires several 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 initial years of data collection are necessarily limited.

Based upon the bioassessment results (principally B-IBI scores from benthic macroinvertebrate taxonomy), the preliminary condition analysis indicates that many sites monitored in WY 2015 and prior years may be impacted from the standpoint of aquatic life beneficial uses. The stressor analysis is summarized as follows, based on an analysis of the regional/probabilistic data collected by CCCWP during WY 2015:

- Physical Habitat Conditions – the lack of correlation between physical habitat parameters (PHab scores, CRAM scores) and biological condition indices (SoCal and Contra Costa B-IBI scores) minimizes the usefulness of these parameters in evaluating biological conditions in the urban creeks monitored in Contra Costa County during WY 2015. Additional, more comprehensive, regional investigation of these factors is warranted.

- Water Quality – Of 11 water quality parameters required in association with bioassessment monitoring, applicable water quality standards were only identified for ammonia, chloride, and nitrate + nitrite (for sites with MUN beneficial use only). None of the results generated at the 10 sites monitored by CCCWP for those three parameters during WY 2015 exceeded the applicable water quality standard or threshold. The MRP 1.0 Table 8.1 trigger threshold for “Nutrients” (i.e., 20% of results in one water body exceed one or more water quality standards or applicable thresholds) was therefore not exceeded at any of the monitored sites.

- Water Toxicity – Toxicity testing was performed for four test species in water samples collected by CCCWP from two sites, during one wet weather event and one dry season event in WY 2015. Samples collected during the wet weather monitoring event (2/6/2015) from both the Rodeo Creek [206R01024] and Green Valley Creek [207R00891] sites exhibited significant acute toxicity (reduction in survival) to *H. azteca*. Both of those toxicity test results met the MRP 1.0 Table 8.1 threshold (<50% of the Control value) for follow-up action, and an additional set of samples was collected during a subsequent rain event on 4/7/2015. Again, both samples were acutely toxic to *H. azteca*, but in the April tests only the Green Valley Creek sample met the 50% MRP 1.0 Table 8.1 threshold. During the summer aquatic toxicity tests, the Rodeo Creek sample was determined to be statistically different from the Control for the acute *H. azteca* test. That sample, at 94% survival for *H. azteca*, did not trigger the MRP 1.0 Table 8.1 threshold.

- Sediment Toxicity – Bedded sediment samples collected from the same two sites on Rodeo Creek and Green Valley Creek on 7/7/2015 were tested for acute and chronic toxicity. The Rodeo Creek sample was not toxic to the test species (*H. azteca*), but the Green Valley Creek sample was toxic to *H. azteca* for both the acute and chronic endpoints. Only the chronic test result (growth as measured by organism biomass) met the MRP 1.0 Table H-1 (Central Valley Permit Table D-1) criterion (more than 20% less than the Control).

- Sediment Chemistry – Bedded sediment samples were collected from the same two sites on Rodeo Creek and Green Valley Creek on 7/7/2015 and analyzed for a suite of sediment chemistry constituents. Analytical results produced similar evidence of potential stressors as did samples analyzed in WY 2012 and 2013, based on the criteria from MRP Table H-1 (Central Valley Permit Table D-1). The Green Valley Creek sediment sample resulted in three constituents with TEC quotients greater than 1.0 (nickel, DDEs, and sum of DDTs), and a sum of TU equivalents for measured pyrethroids greater than 1.0 (1.11). The pyrethroid pesticide bifenthrin was found in both creek sediment samples, but not at levels expected to cause toxicity to test organisms. The Rodeo Creek site did not trigger any of the sediment chemistry criteria.

- Sediment Triad Analyses – Bioassessment, sediment toxicity, and sediment chemistry results were evaluated as the three lines of evidence used in the triad approach for assessing overall stream condition. For the Green Valley Creek site, follow-up action is required based on the triad analysis: low bioassessment score, evidence of sediment toxicity to *H. azteca*, and sediment chemistry analysis pertaining to TEC equivalents and pyrethroid pesticide toxic unit equivalents.

The recurring findings of aquatic and sediment toxicity indicate that chemical stressors may be present that are impacting stream water quality for the monitored locations. The sediment triad analyses from WY 2012-2015 indicate that pyrethroid pesticides may be causing sediment toxicity; in samples exhibiting significant sediment toxicity, other pollutants are present at elevated concentrations as well. The chemical stressors may in turn be contributing to the degraded biological conditions indicated by the low B-IBI scores in many of the monitored streams.

Additional creek status monitoring will be undertaken in WY 2016 to further add to the data applicable to the regional/probabilistic design, along with further work regarding stressor/source investigations.

### 4.1.2 Local/Targeted Monitoring

The Local/Targeted Creek Status Monitoring Report (**Appendix 2**) documents the results of targeted monitoring performed by CCCWP during WY 2015. Within Contra Costa County, targeted monitoring was conducted at:

- Four continuous water temperature monitoring locations
- Two general water quality monitoring locations
- Five pathogen indicator monitoring locations
- Ten riparian assessment monitoring locations

Site locations were identified using a targeted monitoring design based on the directed principle to address the following management questions:

1. What is the range of general water quality measurements at targeted sites of interest?
2. Do general water quality measurements indicate potential impacts to aquatic life?
3. What are the pathogen indicator concentrations at creek sites where water contact recreation may occur?
4. What are the overall physical and/or ecological conditions of creek reaches and specific point impacts within each reach?

During the four years studied thus far, winter seasons have been very dry relative to average annual conditions. Targeted monitoring data, with the exception of California Rapid Assessment Method (CRAM) results and specific conductivity, were evaluated against numeric Water Quality Objectives (WQOs) or other applicable criteria, as described in the MRP and Central Valley Permit. The results are summarized below:

- Temperature – A weekly running average maximum daily temperature (MWAT) of 20.5°C was used as the applicable criterion to evaluate temperature data. At the four stations with continuously recorded temperature from April until October, two stations (Green Valley Creek [207R00891] and San Ramon Creek [207R01163]) had results that exceeded the MWAT threshold. At both of the other two sites in the spring and summer index periods no results were above the WAMT threshold.

- Dissolved Oxygen (DO) – WQOs for dissolved oxygen (DO) in non-tidal waters are applied as follows: 7.0 mg/L minimum for waters designated as cold habitat (COLD) and 5.0 mg/L minimum for waters designated as warm water habitat (WARM). The threshold for evaluating dissolved oxygen data for the West Branch of Alamo Creek [204R00388] and San Ramon Creek [207R01163] was 5.0 mg/L as both creeks are classified as WARM. In the West Branch of Alamo Creek, 30 percent of dissolved oxygen concentrations were measured below the WARM threshold during the September deployment, exceeding the MRP Table 8.1 threshold. At San Ramon Creek [207R01163] during both deployments, there were no results that measured lower than the WARM threshold.

- pH – WQOs for pH are 6.5 – 8.5. In the April-May monitoring period at San Ramon Creek [207R01163], 30 percent of pH measurements were above this WQO. pH measurements at the West Branch of Alamo Creek [204R00388] did not exceed this WQO during the monitoring period.

- Pathogen Indicator Bacteria – Single sample maximum concentrations of 400 MPN/100 ml fecal coliform (SFBRWQCB 2011) and 410 MPN/100 ml *E. coli* (USEPA 2012) were used as Water Contact Recreation evaluation criteria for the purposes of this evaluation. Samples for fecal coliform and E.coli at two of the five stations (Walnut Creek [207R01271] and San Pablo Creek [206R01319]) exceeded the maximum single sample concentrations.

Applicable criteria have not been developed for CRAM. The application of CRAM in urban creeks of the San Francisco Bay Region is relatively recent and results should be considered preliminary. Further analysis of existing data and additional information are needed to comprehensively evaluate the utility of CRAM data for assessing stream ecosystem health and aquatic life uses.

# 5.0 Stressor/Source Identification Studies (C.8.e)

The CCCWP is responsible for performing related follow-up studies triggered by the creek status monitoring. In WY 2012 and WY 2013, the CCCWP's Creek Status Monitoring triggered exceedances for water and sediment toxicity parameters. Both Dry Creek (site 544R00025; Central Valley Region) and Grayson Creek (site 207R00011; San Francisco Bay Region) exhibited water toxicity to *H. azteca* in creek samples collected during wet weather in WY 2012, and retests in WY 2013 confirmed the findings. In July 2012, sediment toxicity testing also revealed toxicity to *H. azteca* in sediment samples from both creeks. Though no other test species were adversely affected by the water toxicity testing, sediment chemistry testing indicated elevated levels of sediment contaminants, and bioassessment monitoring of both creeks reported "Very Low" scores for the B-IBI. The combination of these results triggered the current Stressor/Source Identification (SSID) Studies, which fulfill CCCWP's obligation for follow up actions under MRP 1.0 and Central Valley Permit.

As follow up actions to WY 2012 and WY 2013 creek status monitoring, the CCCWP developed a Stressor/Source ID Study Concept Plan (CCCWP 2014a). The Concept Plan includes four parts, corresponding to the four steps required for SSID Studies.

- Part A: Evaluate and investigate the causes and extent of the observed creek toxicity to *H. azteca* in Dry Creek and Grayson Creek watershed (WY 2014.)
- Part B: Identification of potential sources of the pollutant(s) or stressor(s) (WY 2015)
- Part C: Identification and evaluation of potential abatement measures (WY 2016)
- Part D: Evaluate effectiveness of implemented control measures (WY 2019)

Part A results were reported in the WY 2014 UCMR, and confirmed that current use pesticides, namely pyrethroids were the cause of the toxicity measured in Dry Creek and Grayson Creek. SSID Study Part B efforts to identify potential sources of the pyrethroid pesticides, and therefore potential source controls, are described herein, with a full report included as **Appendix 3**.

The Concept Plan includes the following description of the activities planned for Part B of the SSID studies:

> "After confirming the stressors, sources need to be identified. Presuming that pesticide applications are determined to be the source(s) for the pesticides identified as stressors in Part A, the assessment would attempt to characterize the relative magnitudes of sources attributable to the following: Contra Costa County professional Pest Control Operators vs. homeowners, spatial and temporal characteristics of pesticide applications, the role of impervious surfaces, and any potential contribution from different land uses such as agriculture or golf courses. These activities are anticipated for FY 2014 - 2015."

To complete Part B, available information on urban sources of pyrethroid pesticides was summarized as applicable to the two SSID studies being performed in Contra Costa County. The purpose of this summary was to characterize or estimate the sources of those pesticides, including the relative magnitudes of sources attributable to Contra Costa County Professional Pest Control Operators versus homeowners, spatial and temporal characteristics of pesticide applications, the role of impervious surfaces, and any potential contribution from non-urban land uses such as agriculture or golf courses,

Based on the analysis of pyrethroid concentrations and their relative toxicity, bifenthrin was found to be the leading cause of toxicity in Dry Creek and Grayson Creek. However, all six detected pyrethroids (bifenthrin, cyfluthrin, cypermethrin, deltamethrin, lambda-cyhalothrin, permethrin) were included in the Part B analysis. Pesticide use reporting and sales data were obtained from the California Department of Pesticide Regulations (DPR) database. The most recent data available is for sales and use in 2013. DPR compiles data on pesticide sales by product and active ingredient, but on a statewide basis only. The pesticide sales records document the first sale of the product within California, including wholesale purchases by retail outlets, so the sales data include both pesticides purchased by professionals (PCOs) and amounts purchased by non-professionals (e.g., residents and businesses). The difference between pesticide sales data and reported use data (by PCOs) then represents an estimate of sales to non-professionals.

Based on data from 2009-2013, it appears that use of the most toxic and impactful pyrethroids (bifenthrin and cyfluthrin) has increased in urban areas in Contra Costa County in recent years. This is surprising, given the restrictions placed on bifenthrin uses by DPR in its recently adopted Surface Water Quality Regulations. The reported uses should be further investigated via DPR and the County Agricultural Commissioner's office to verify whether the reported use and sales figures are correct, and if so, whether PCOs are implementing the various mitigation measures included within DPR's regulation.

Similarly, the highest reported individual applications of bifenthrin and cyfluthrin in 2013 should be further investigated via DPR and the County Agricultural Commissioner's office to determine whether the figures are accurate, and if so, whether steps could be taken to reduce the volumes of pesticides applied in those instances, especially to impervious surfaces during the rainy season.

The monthly non-agriculture (urban) use patterns for bifenthrin and cyfluthrin during 2013 in Contra Costa County are apparently dominated by several high values. If the high values prove to be legitimate data points, the monthly/seasonal patterns that coincide with those values could be useful in determining associated mitigation measures.

All efforts to effectively control water quality impacts from urban pesticide applications must account for the heightened water quality impacts that are attributable to applications to impervious surfaces. Additional work should be done in the two study watersheds to identify impervious surfaces, especially those that are directly coupled to constructed storm drain systems, and determine whether pesticides are typically applied to those impervious surfaces. Lessons learned from this additional research then can be used to support public education and outreach efforts aimed at business owners, residents, and PCOs that will be designed to minimize pesticide runoff from urban areas.

A summary of the BASMAA Regional Monitoring Coalition SSID project locations, rationales and status from 2010 – 2016 are provided in **Appendix 4**.

# 6.0 Pollutants of Concern Monitoring (C.8.f)

Pollutants of Concern (POC) load monitoring is required by the MRP and Central Valley Permit. 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 total maximum daily loads (TMDLs), and help resolve uncertainties associated with loading estimates for these pollutants. In particular, there are five priority POC management information needs that must be addressed though POC loads monitoring:

1. Source Identification
2. Contributions to Bay Impairment
3. Management Action Effectiveness
4. Loads and Status
5. Trends

To assist Permittees in effectively and efficiently conducting POC loads monitoring required by the MRP and Central Valley Permit, 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 was to develop a comprehensive planning framework to coordinate POC loads monitoring/modeling between the RMP and RMC participants.

Based on the consensus of the STLS Team, RMC representatives in coordination with SFEI staff created a STLS Multi-Year Plan intended to assist Permittees in complying with provision C.8.e (POC Monitoring) through an alternative POC monitoring program other than the one described in the MRP. The alternative STLS Multi-year Plan is designed to address the four core POC loads monitoring management questions, while integrating activities funded by BASMAA via the RMC with those funded by the RMP. The STLS Multi-year Plan provides a comprehensive description of activities that will be implemented over the next 5-10 years to provide information and comply with the MRP. The STLS Multi-year Plan provides rationale for the methods and locations of proposed activities to answer the four management questions listed above. Activities include modeling using the regional watershed spreadsheet model (RWSM) to estimate regional scale loads, and pollutant characterization and loads monitoring in local tributaries beginning WY 2011, continuing in WY 2012 and WY 2013, and largely completed in WY 2014.

The framework and a summary of activities and products to date are provided in the STLS Multi-Year Plan (SFEI 2013). With concurrence of participating Water Board Staff, the STLS Multi-Year Plan presents an alternative approach to the POC loads monitoring requirements described in MRP 1.0 Provision C.8.e.i, as allowed by Provision C.8.e.

MRP 1.0 contained provisions aimed at improving information on stormwater loads in selected watersheds (Provision C.8.) and piloting a number of management techniques to reduce PCB and Hg loading entering the Bay from smaller urbanized tributaries (Provisions C.11. and C.12.). MRP 2.0 places an increased focus on finding watersheds, sources areas, and source properties that are potentially more polluted and upstream from sensitive Bay margin areas (high leverage).

To support this focus, a stormwater characterization monitoring program was developed and implemented beginning in WY 2015 (**Appendix 5**). This same design is being implemented in the winter of WY 2016 by the RMP and the Santa Clara and San Mateo countywide stormwater programs. This design will also be implemented for Contra Costa when appropriate sites are identified. In addition, the RMP is piloting an effort and exploring the use of alternative un-manned "remote" suspended sediment samplers. During WY 2015, samples were collected from 20 watersheds. At three of these locations, data were also collected using two remote suspended sediment samplers.

Total PCBs concentrations measured in the composite water samples varied by 27-fold between 2,033-55,503 pg/L. When normalized by suspended sediment concentrations (SSC) to generate particle ratios, the three highest ranking sites were the Outfall to Lower Silver Creek in San Jose (783 ng/g), Ritter Park Drive Storm Drain in San Jose (488 ng/g) and Alameda County (AC)-Line-3A-M at 3A-D in Union City (337 ng/g). Particle ratios of this magnitude are relatively elevated but lower than some of the previous highest observations (Santa Fe Channel (1,403 ng/g), Pulgas Creek – North (1,050 ng/g), Pulgas Creek – South (906 ng/g), Ettie St. Pump Station (745 ng/g)).

Total Hg (HgT) concentrations in composite water samples ranged 6-fold between sites from 13.7-85.9 ng/L. The greatest HgT concentrations were observed in AC-Line-3A-M at 3A-D in Union City, East Gish Rd Storm Drain in San Jose, and Meeker Slough in Richmond. When the data were normalized by SSC, the three most highly ranked sites were Meeker Slough in Richmond (1.3 µg/g), AC-Line-3A-M at 3A-D in Union City (1.2 µg/g), and Rock Springs Drive Storm Drain in San Jose (0.93 µg/g). Particle ratios of this magnitude are similar to the upper range of those observed previously. The six highest ranking sites for PCBs based on particle ratios only ranked 12th, 16th, 2nd, 7th, 14th, and 8th respectively in relation to HgT.

Both of the remote suspended sediment sampler types appear to generally characterize sites similarly to the composite stormwater sampling methods (higher concentrations matching higher and lower matching lower), but further testing is needed to determine the overall reliability and practicality of deploying these instruments instead of or to augment manual sampling.

PCBs particle ratios appear to positively correlate with impervious cover, old industrial land use, and HgT. PCBs appear to inversely correlate with watershed area and the other trace metals analyzed (As, Cu, Cd, Pb, and Zn). Total mercury does not appear to correlate with any of the other trace metals and showed similar but weaker relationships to impervious cover, old industrial land use, and watershed area than did PCBs. In contrast, the trace metals all appear to correlate with each other more generally. Overall, the WY 2015 data do not support the use of any of the trace metals analyzed as a tracer for either PCBs or HgT pollution sources.

A total of 45 sites have been sampled for PCBs and HgT during various field sampling efforts since WY 2003. About 19.2% of the old industrial land use in the region has been sampled to date. Of the remaining older industrial land use yet to be sampled, 48% of it lies within 1 km of the Bay and 65% of it is within 2 km of the Bay. These areas are more likely to be tidal, likely to include heavy industrial areas that were historically serviced by rail and ship based transport, and are often very difficult to sample due to a lack of public right of ways. A different sampling strategy is needed to effectively determine what pollution might be associated with these areas.
Based on the WY 2015 results SFEI recommends:

- Continuing to select sites based on the four main selection rationales:
  - Identifying high leverage watersheds and subwatersheds
  - Sampling strategic large watersheds with USGS gauges to provide first order loading estimates and to support calibration of the RWSM
  - Validating unexpected low (potential false negative) concentrations (to address the possibility of a single storm composite poorly characterizing a sampling location)
  - Filling gaps along environmental gradients or source areas (to support the RWSM)

- The majority of the samples should be devoted to identifying areas of high leverage (indicated by high unit areas loads or particle ratios/ concentrations relative to other sites) with a small number of sites allocated to sampling potentially cleaner and variably-sized watersheds to help broaden the dataset for regional model calibration and to inform consideration of cleanup potential. The method of selection of sites of potentially higher leverage focusing on older industrial and highly impervious landscapes should continue.
- Continuing to use the composite water sampling design as developed and applied during WY 2015 with no further modifications. In the event of a higher rainfall wet season, greater success may even occur at sites influenced by tidal processes since, with more storms to choose from, there will be a greater likelihood that more storm events will fall within the needed tidal windows.
- Continuing to trial both the Hamlin and Walling remote suspended sediment samplers with the objective of amassing a full dataset of 12 side-by-side sample pairs for comparison to the composite water column sampling design with the objective of evaluating usefulness and comparability of the data obtained in relation to the management questions.

## 6.1 Sampling and Analysis Plan & Quality Assurance Project Plan

A Sampling and Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), and Standard Operating Procedures (SOP) are being developed to implement the new requirements of MRP 2.0. The SAP is a living document that will be updated on an annual basis. Its primary intention is to memorialize field sampling (procedures, documentation and methods) and analytical methods that will be used to conduct analyses and testing in accordance with the MRP 2.0 Provision C.8.f and C.8.g requirements. The QAPP and SOPs will be updated as necessary to remain accurate with the SAP.

## 6.2 Alternative Monitoring

In July 2014, the CCCWP submitted a request and rationale for an additional Alternative Approach to POC and Long-Term Trends Monitoring (**Appendix 6**), which was accepted by both Regional Water Boards. The CCCWP proposed to:

1. Sample no more than two storms at the existing March Creek POC loads station for mercury, methylmercury, and suspended sediment concentrations. The sampling would be timed to capture upper watershed flow (i.e., flow from the March Creek Reservoir).
2. Conduct PCB source identification studies, following the approach proposed in the Integrated Monitoring Report, Part C, submitted in March 2014 (CCCWP 2014c).
3. Increase the number of Low-Impact Development (LID) effectiveness evaluation samples collected and analyzed as part of the approved methylmercury control study plan.

Updates on the methylmercury and PCB efforts are summarized in the following paragraphs.

**Methylmercury Control Study**
CCCWP began implementation of a Methylmercury Control Study in 2012 to fulfill requirements of the Central Valley Permit. A Methylmercury Control Study Work Plan (Amec, 2013) was prepared to 1) evaluate the effectiveness of existing Best Management Practices (BMPs) for the control of methylmercury; 2) evaluate additional or enhanced BMPs, as needed, to reduce mercury and methylmercury discharges to the Delta; and 3) determine the feasibility of meeting methylmercury waste load allocations.

The CVRWQCB has established a water column concentration goal of 0.06 ng/L total methylmercury. If the average total methylmercury concentration in a water body exceeds 0.06 ng/L, follow-up actions are required by the CVRWQCB to investigate causes within a water source, and to determine reasonable and foreseeable means of attaining 0.06 ng/L.

The progress report, submitted to the CVRWQCB on October 30, 2015, presents preliminary findings of the Methylmercury Control Study Work Plan from Spring 2012 through Spring 2015. Watershed characterization of methylmercury concentrations in eastern portions of the County is referred to as Phase 1 (Watershed Characterization); evaluation of potential control measures (e.g., structural BMPs) is referred to as Phase 2 (BMP Evaluation). A final report to the CVRWQCB is required by October 2018 and a brief summary of results to date are provided below.

*Phase 1 – Watershed Characterization Summary Findings*

- The watershed survey did not reveal significant watershed sources of elevated methylmercury during the wet and dry events sampled.
- The lowest methylmercury concentrations measured were in lower Marsh Creek, where flow is primarily highly treated effluent from the Brentwood Wastewater Treatment Plant.

*Phase 1 – Watershed Characterization Data Gaps and Next Steps*

- Future watershed monitoring for mercury will be limited to characterizing upper watershed flows from Marsh Creek where only a single sample has been collected thus far, owing to low rainfall amounts during much of the study period.
- As rainfalls allow, collect up to two additional sample sets at Site M2 (Lower Marsh Creek) during upper-watershed discharge (when the Marsh Creek reservoir is discharging to Lower Marsh Creek).

*Phase 2 – BMP Evaluation Summary Findings*

- Treating stormwater by low impact development (LID) to promote infiltration and reduce suspended sediments in discharged stormwater is the most reasonable and foreseeable means of reducing methylmercury loads from urban stormwater.
- The non-traditional LID application in Richmond that was assessed in this study is not designed for infiltration – it only passes water through the root zones of plants to reduce suspended sediment concentrations and may not provide as much treatment as traditional LID applications (i.e., detention and infiltration structures).
- Some features of the Richmond biofiltration cells assessed in this study increased methylmercury; currently evaluating why.
- No matter how much progress is made over the next two years, there will likely be additional uncertainties and unanswered questions about optimizing LID designs and upper Marsh Creek watershed processes.

*Phase 2 – BMP Evaluation Data Gaps and Next Steps*

- The remainder of the Phase 2 study will focus on evaluation of more traditional LID applications, as described in the Contra Costa County C.3 Design Guidance, that promote detention and infiltration. These types of BMPs have not yet been assessed in this study.
- The goal of the remaining Phase 2 Best Management Practice effectiveness evaluation effort is to characterize the methylmercury concentration in discharges from traditional LID devices.
- The final study report will also describe methylmercury load reduction benefits resulting from infiltration.

**Pollutants of Concern Sediment Screening**

In 2015, CCCWP and Permittee staff conducted source area screening to delineate High, Moderate, and Low/No Opportunity parcels for consideration in focused implementation planning. CCCWP prepared a guidance document and map files to assist the Permittees in identifying potential PCBs source properties through the refinement of the draft source area maps contained in the IMR and a preliminary source property database. Using multiple lines of evidence (e.g., institutional knowledge, records review, windshield surveys, facility inspections, and sampling results), the properties in the database were categorized as High, Moderate, or Low/No Opportunity for consideration of control measure implementation.

Sampling locations were selected in public right-of-ways, or on private property adjacent to public right of ways, known or suspected of having high opportunity for PCBs and/or mercury control. CCCWP permittees provided information on historic and present day land use, prior monitoring results, and other information to assist CCCWP in developing target sampling locations. Prior to sample collection, desktop reconnaissance and windshield surveys were conducted to inform the monitoring approach and assist in sampling logistics. Much of the sampling and analysis procedures of this present work originated from the BASMAA Clean Watersheds for a Clean Bay Task 3 study (AMS, 2012). Samples were screened for 1) total PCBs congeners using EPA Method 8082A; 2) total mercury; 3) total organic carbon; and 4) particle size distribution. For quality control/quality assurance purposes, blind field duplicate samples were collected and analyzed, and a selection of samples with PCBs congener results above 100 ppb were reanalyzed with a more rigorous test method (EPA Method 1668C).

Fifty-seven (57) sampling locations throughout Contra Costa County were sampled between April and September 2015 (**Appendix 7**). Action levels were set at total PCBs results exceeding 500 parts per billion (ppb) and/or total mercury results exceeding 750 ppb. Exceedances of these action levels indicates that a sampling location meets the concentration criterion of a high opportunity area for PCBs or mercury controls. Four PCBs samples and four mercury samples exceeded the action levels, while only one sample, exceeded the action level for both PCBs and mercury.

**Pilot Stormwater Diversion Project: North Richmond Stormwater Pump Station**

Provision C.12.f of MRP 1.0 required permittees to evaluate diversion of dry weather and wet weather urban runoff into sanitary sewage conveyance and treatment systems to determine if diversion to sanitary treatment is a useful tool for reducing PCBs loads from urban runoff. The North Richmond stormwater pump station project (**Appendix 8**) achieved the objective of installing and pilot testing urban runoff diversion infrastructure. Diversion of dry and wet weather urban runoff into the nearest water reclamation facility offers only incremental PCB load reduction benefits. Diversion is not a “silver bullet” that will make a significant difference to PCB loads; however, consideration of multiple water quality benefits, such as trash controls, water resource development, and reduction of bacteria, oil and grease, and other urban pollutants discharged to Wildcat Marsh and the Bay may motivate additional, expanded stormwater harvest and use projects in this watershed. Water resource needs may be the overall driver. The newly installed diversion infrastructure installed can harvest and re-use up to 50 million gallons per year of urban runoff, primarily as dry weather urban runoff, should WCWD choose to implement longer term diversions. Overall, the immediate benefit of extending the useful life of the NRSPS and having diversion capabilities, opens longer term planning opportunities that makes this project a success.

The results of the pilot project include both positive and negative findings.

Positive Findings:

- CCCWP permittees complied with provision C.12.f of MRP 1.0 by collaborating with several partners to complete a pump station stormwater diversion pilot with a permanent, "hard-piped" diversion system installed at the NRSPS.
- WCWD experienced no overflows, sewage treatment system upsets, or other disruptions to operations as a result of the pilot diversion project.
- In addition to rehabilitating existing infrastructure, the NRSPS diversion project offers new operational flexibility to the Pump Station owners.
- Project partners gained a new understanding of the incentives and opportunities that can potentially support co-management of urban runoff with water reclamation systems originally designed for sanitary sewage.
- There is now an established partnership and relationship between the County and WCWD, and with new infrastructure now in place and the pilot successfully completed, there is an opportunity to pursue grant funding to support stormwater harvest and use projects in the future.

Negative Findings:

- The wet and dry diversion pilot tests accomplished miniscule load reductions: e.g., about one milligram (0.001 grams) of PCBs, against a required Baywide PCB load reduction of 18,000 grams by the year 2028.
- Conveyance limitations of the sanitary sewage system prohibit substantial scale-up of the pilot to larger diversion flows. The diversion pump installed pumps 200 to 250 gallons per minute into the WCWD collection system. Larger flow rates risk sanitary sewer overflows. The design of the pump station provides 135,000 gallons per minute of stormwater pumping capacity, about 600 times more volume than the diversion. That might be comparable to a person sipping water from a gushing fire hydrant.
- Even if all of the stormwater from the 339 acre catchment served by the NRSPS could be captured and treated – which would require a substantial capital project - the total PCB load reduction possible is on the order of one to ten grams at best, still a tiny fraction of the overall load reduction mandate for the Bay.
- The total project cost was over $1.4 million which included some necessary upgrades to the existing Pump Station infrastructure. The cost for a "stand-alone" stormwater diversion project would be approximately $1 million.
- This is an example of opportunistically combining stormwater quality enhancement and municipal infrastructure restoration into one project. The project evolved and changed from its inception five years ago. Initially the project included substantial improvements to the Pump Station until the estimated costs approached $2 million. Then the project was changed to only include improvements to the extent needed to complete the stormwater diversion.

On February 25, 2016, the NRSPS Stormwater Diversion Project was awarded the honor of Environmental Project of the Year by the Northern California Chapter of the American Public Works Association. The award named CCCWP as "an essential partner in the development and construction of this innovative project."

**Mt. Diablo Mercury Mine Project**

The cleanup of the Mount Diablo Mercury Mine is one of the County's priority Projects (**Appendix 9**). On December 4, 2012, the Board of Supervisors accepted a comprehensive status report on the Army Corps of Engineers (Corps) planning process to clean up the mercury mine through their Remediation of Abandoned Mine Sites program.

The Central Valley Regional Water Quality Control Board (CVRWQCB) issued a Cleanup and Abatement Order to Sunoco to clean up the mercury mine. Sunoco, however, claims to not have performed active mining on the site but only conducted exploratory excavation for a short period of time and only at an isolated location within the mining complex. It will be a couple of years before this process is concluded and it becomes clear how much of the mine site will be cleaned up by Sunoco.

On October 20, 2011, the CVRWQCB approved a Total Maximum Daily Load (TMDL) allocation to control methylmercury and total mercury in the watershed and amended the Water Quality Control Plan for the Sacramento-San Joaquin River Delta. Marsh Creek drains into the Delta and is subject to this TMDL requirement. The Response Plan for the TMDL recognizes the Mount Diablo Mercury Mine as a point source of mercury contamination and its cleanup now takes on an additional degree of importance. Contra Costa County helps fund the Delta Mercury Exposure Reduction Program, through the County Clean Water Program, which works to reduce exposure to mercury among people who eat fish from the Delta. CCCWP is also implementing a Methylmercury Control Study to meet TMDL requirements and taking water quality samples for mercury below the Marsh Creek Reservoir. The CVRWQCB is currently working on a TMDL for both Marsh Creek and Dunn Creek. The information being gathered should help with the Corps planning work.

The mine represents an ongoing point source of Mercury in the watershed and must be cleaned up. At this time, it is still unknown if the identified responsible parties will be required to remediate the entire mine site or a portion of the site. The outcome of the State Water Resources Control Board enforcement action will be a key determinant of what the cleanup project will be. In correspondence to the CVRWQCB and others on the enforcement action, CCCWP has requested the responsible parties also contribute to mitigating impacts downstream of the mine site, including the Marsh Creek Reservoir. However, it appears the enforcement action is focusing solely on cleaning up the mine site.

# 7.0 Pesticides and Toxicity Monitoring (C.8.g)

Pesticides and Toxicity Monitoring is a new section in MRP 2.0. Therefore, the pesticides and toxicity monitoring conducted in WY 2015 has been included in the Creek Status Monitoring reports – Section 4.0 (and **Appendices 1 and 2**).

A Sampling and Analysis Plan, Quality Assurance Project Plan, and Standard Operating Procedures are being developed or updated to implement the new requirements of MRP 2.0 Provision C.8.g.

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# Appendix 1

Regional/Probabilistic Creek Status Monitoring Report, Water Year 2015

# *Regional/Probabilistic Creek Status Monitoring Report Water Year 2015*

***(October 1, 2014 – September 30, 2015)***

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This report was prepared by Armand Ruby Consulting (ARC) in association with ADH Environmental, under contract to and under the supervision of the Contra Costa Clean Water Program (CCCWP). The report format and organization are in large part derived from the original, region-wide Regional Monitoring Coalition (RMC) 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 general from the methods, results and formats presented within the WY 2012 Regional UCMR.

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.

Staff of the Contra Costa Clean Water Program, specifically Lucile Paquette and Tom Dalziel, provided project supervision and review of draft documents. Alessandro Hnatt served as project manager for ADH Environmental, lead consultant to CCCWP. Staff of ADH Environmental also contributed to both the content and production of this report, in particular with respect to data compilation and extraction, organization of meta-data, graphics production, and original analysis of the CRAM vs. B-IBI scores.

# Preface

The Bay Area Stormwater Management Agencies Association (BASMAA) Regional Monitoring Coalition (RMC) developed a probabilistic design for regional characterization of selected creek status monitoring parameters. The following program participants make up the RMC:

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

This report fulfills reporting requirements for the portion of the regional/probabilistic Creek Status monitoring data generated within Contra Costa County during Water Year 2015 (October 1, 2014, through September 30, 2015) through the RMC's probabilistic design for certain parameters monitored according to Provision C.8.c. This report is an Appendix to the full Urban Creeks Monitoring Report (UCMR) submitted by each of the participating RMC programs on behalf of their respective Permittees.

This report is submitted by the participating agencies of the

CONTRA COSTA CLEAN WATER PROGRAM

**CCCWP Participants:**

- Cities/Towns of: Antioch, Brentwood, Clayton, Concord, Danville, El Cerrito, Hercules, Lafayette, Martinez, Moraga, Oakley, Orinda, Pinole, Pittsburg, Pleasant Hill, Richmond, San Pablo, San Ramon and Walnut Creek
- Contra Costa County
- Contra Costa County Flood Control & Water Conservation District

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Website: www.cccleanwater.org

# List of Acronyms

| | |
|---|---|
| ACCWP | Alameda Countywide Clean Water Program |
| AFDM | ash-free dry mass |
| BASMAA | Bay Area Stormwater Management Agencies Association |
| B-IBI | Benthic Index of Biological Integrity |
| BMI | Benthic Macroinvertebrate |
| CCCWP | Contra Costa Clean Water Program |
| CDFW | California Department of Fish and Wildlife |
| CMC | Criteria Maximum Concentration |
| CTR | California Toxics Rule |
| DW | Dry Weight |
| DQO | Data Quality Objective |
| 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 |
| 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 |
| 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 |
| SFBRWQCB | San Francisco Bay Regional Water Quality Control Board |
| SMC | Southern California Stormwater Monitoring Coalition |

| | |
|---|---|
| SMCWPPP | San Mateo Countywide Water Pollution Prevention Program |
| SoCal B-IBI | Southern California Benthic Index of Biological Integrity |
| SOP | Standard Operating Procedure |
| STLS | Small Tributaries Loading Strategy |
| SWAMP | Surface Water Ambient Monitoring Program |
| TEC | Threshold Effect Concentration |
| TKN | Total Kjeldahl Nitrogen |
| TNS | Target Not Sampled |
| TOC | Total Organic Carbon |
| TS | Target Sampled |
| U | Unknown |
| USEPA | U.S. Environmental Protection Agency |
| TU | Toxicity Unit |
| WQ | Water Quality |
| WY | Water Year |

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# Executive Summary

This Regional/Probabilistic Creek Status Monitoring Report documents the results of monitoring performed by the Contra Costa Clean Water Program (CCCWP) during Water Year 2015 (WY 2015) under the regional/probabilistic monitoring design developed by the Regional Monitoring Coalition (RMC). This report is a component of the Urban Creeks Monitoring Report (UCMR) for WY 2015. Together with the creek status monitoring data reported in the Local/Targeted Creek Status Monitoring Report, this submittal fulfills reporting requirements for status monitoring specified in Table 8.1 under Provision C.8.c[1] of both the Municipal Regional Permit (MRP) for urban stormwater issued by the San Francisco Bay Regional Water Quality Control Board (SFRWQCB; Order No. R2-2009-0074) and the East Contra Costa County Municipal NPDES Permit (Central Valley Permit) issued by the Central Valley Regional Water Quality Control Board (CVRWQCB; Order No. R5-2010-0102). Reporting requirements for Table 8.1 constituents are established in provision C.8.g.iii of both permits.

Other creek status monitoring parameters were addressed using a targeted design, with regional coordination and common methodologies. The local/targeted parameters are reported in a separate appendix to the UCMR (ADH, 2016).

During Water Year 2015, 10 sites were monitored by CCCWP under the regional/probabilistic design for bioassessment, physical habitat, and related water chemistry parameters. Two of the 10 sites were also monitored for water and sediment toxicity and sediment chemistry.

The bioassessment and related data are used 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 water and sediment chemistry and toxicity data are used to evaluate potential stressors that may affect aquatic habitat quality and beneficial uses. The probabilistic design requires several 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 initial years of data collection are necessarily limited.

Based upon the bioassessment results (principally B-IBI scores from benthic macroinvertebrate taxonomy), the preliminary condition analysis indicates that many sites monitored in WY 2015 and prior years may be impacted from the standpoint of aquatic life beneficial uses. The stressor analysis is summarized as follows, based on an analysis of the regional/probabilistic data collected by CCCWP during WY 2015:

- **Physical Habitat Conditions –** the lack of correlation between physical habitat parameters (PHab scores, CRAM scores) and biological condition indices (SoCal and Contra Costa B-IBI scores) minimizes the usefulness of these parameters in evaluating biological conditions in the urban creeks monitored in Contra Costa County during WY 2015. Additional, more comprehensive, regional investigation of these factors is warranted.

- **Water Quality –** Of 11 water quality parameters required in association with bioassessment monitoring, applicable water quality standards were only identified for ammonia, chloride, and nitrate + nitrite (for sites with MUN beneficial use only). None of the results generated at the 10

[1] The MRP (Order No. R2-2009-0074) was superseded by Order No. R2-2015-0049 (known as MRP 2), effective January 1, 2016. Table 8.1 was eliminated, and the creek status monitoring requirements are now specified in MRP 2 provision C.8.d. The Central Valley Permit has not yet been updated.

sites monitored by CCCWP for those three parameters during WY 2015 exceeded the applicable water quality standard or threshold. The MRP Table 8.1 trigger threshold for “Nutrients” (i.e., 20% of results in one water body exceed one or more water quality standards or applicable thresholds) was therefore not exceeded at any of the monitored sites.

- **Water Toxicity –** Toxicity testing was performed for four test species in water samples collected by CCCWP from two sites, during one wet weather event and one dry season event in WY 2015. Samples collected during the wet weather monitoring event (2/6/2015) from both the Rodeo Creek (site code 206R01024) and Green Valley Creek (site code 207R00891) sites exhibited significant acute toxicity (reduction in survival) to *H. azteca*. Both of those toxicity test results met the Permit Table 8.1 threshold (<50% of the Control value) for follow-up action, and an additional set of samples was collected during a subsequent rain event on 4/7/2015. Again, both samples were acutely toxic to *H. azteca*, but in the April tests only the Green Valley Creek sample met the 50% Permit Table 8.1 threshold. During the summer aquatic toxicity tests, the Rodeo Creek sample was determined to be statistically different from the Control for the acute *H. azteca* test. That sample, at 94% survival for *H. azteca*, did not trigger the Permit Table 8.1 threshold.

- **Sediment Toxicity –** Bedded sediment samples collected from the same two sites on Rodeo Creek and Green Valley Creek on 7/7/2015 were tested for acute and chronic toxicity. The Rodeo Creek sample was not toxic to the test species (*H. azteca*), but the Green Valley Creek sample was toxic to *H. azteca* for both the acute and chronic endpoints. Only the chronic test result (growth as measured by organism biomass) met the MRP Table H-1 (Central Valley Permit Table D-1) criterion (more than 20% less than the Control).

- **Sediment Chemistry –** Bedded sediment samples were collected from the same two sites on Rodeo Creek and Green Valley Creek on 7/7/2015 and analyzed for a suite of sediment chemistry constituents. Analytical results produced similar evidence of potential stressors as did samples analyzed in WY 2012 and 2013, based on the criteria from MRP Table H-1 (Central Valley Permit Table D-1). The Green Valley Creek sediment sample resulted in three constituents with TEC quotients greater than 1.0 (nickel[2], DDEs, and sum of DDTs), and a sum of TU equivalents for measured pyrethroids greater than 1.0 (1.11). The pyrethroid pesticide bifenthrin was found in both creek sediment samples, but not at levels expected to cause toxicity to test organisms. The Rodeo Creek site did not trigger any of the sediment chemistry criteria.

- **Sediment Triad Analyses –** bioassessment, sediment toxicity, and sediment chemistry results were evaluated as the three lines of evidence used in the triad approach for assessing overall stream condition. For the Green Valley Creek site, follow-up action is required based on the triad analysis: low bioassessment score, evidence of sediment toxicity to *H. azteca*, and sediment chemistry analysis pertaining to TEC equivalents and pyrethroid pesticide toxic unit equivalents.

The recurring findings of aquatic and sediment toxicity indicate that chemical stressors may be present that are impacting stream water quality for the monitored locations. The sediment triad analyses from WY 2012-2015 indicate pyrethroid pesticides may be causing sediment toxicity; in samples exhibiting significant sediment toxicity, other pollutants are present at elevated concentrations as well. The chemical

[2] During WY 2012-2014 most sites also exceeded the TEC value for nickel in sediment, and some chromium concentrations in sediment also exceeded TEC values. Considering that both metals are naturally occurring at relatively high levels in Bay Area soils, and concentrations generally also exceed TEC values in reference or non-urban sites, TEC values presented in MacDonald et al. (2000) for those metals may not be appropriate for Bay Area creeks. These observations should be considered in future evaluations of sediment chemistry data collected by RMC participants in Bay Area creeks.

stressors may in turn be contributing to the degraded biological conditions indicated by the low B-IBI scores in many of the monitored streams.

Additional creek status monitoring will be undertaken in WY 2016 to further add to the data applicable to the regional/probabilistic design, along with further work regarding stressor/source investigations.

# 1. Introduction

Contra Costa County lies within the jurisdictions of both the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB; Region 2) and the Central Valley Regional Water Quality Control Board (CVRWQCB; Region 5). Municipal stormwater discharges in Contra Costa County are regulated by the requirements of two National Pollutant Discharge Elimination System (NPDES) stormwater permits: the Municipal Regional Permit (MRP) for urban stormwater in Region 2 (Order No. R2-2009-0074, superseded as of January 1, 2016 by Order No. R2-2015-0049[3]), and the East Contra Costa County Municipal NPDES Permit (Central Valley Permit) in Region 5 (Order No. R5-2010-0102[4]).

This report is a component of the Urban Creeks Monitoring Report (UCMR) for Water Year 2015 (October 1, 2014-September 30, 2015), covering creek status monitoring conducted under a regional probabilistic design. Together with the creek status monitoring data reported in the Local/Targeted Creek Status Monitoring Report, this submittal fulfills reporting requirements for status monitoring performed per the requirements of Provision C.8.c and Table 8.1 of both Municipal NPDES permits.

The regional probabilistic design was developed and implemented by the Regional Monitoring Coalition (RMC) of the Bay Area Stormwater Management Agencies Association (BASMAA). This monitoring design allows each 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 conditions in San Francisco Bay Area creeks.

The RMC was formed in early 2010 as a collaborative among several BASMAA members and all MRP Permittees (see Table 1-1) to collaboratively implement the monitoring requirements found in Provision C.8 of the MRP through a regionally-coordinated effort. Participation in the RMC is coordinated by county stormwater programs and/or Permittee representatives, 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 SFBRWQCB 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). Through the RMC Work Group, the BASMAA RMC developed a Quality Assurance Program Plan (QAPP; BASMAA, 2014a), Standard Operating Procedures (SOPs; BASMAA, 2014b), data management tools, and reporting templates and guidelines. Costs for these activities are shared among RMC members.

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[3] The San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) issued the five-year Municipal Regional Permit for Urban Stormwater (MRP, Order No. R2-2011-0083) to 76 cities, counties and flood control districts (i.e., Permittees) in the Bay Area on October 14, 2009 (SFBRWQCB 2009). The BASMAA programs supporting MRP Regional Projects include all MRP Permittees as well as the cities of Antioch, Brentwood, and Oakley which are not named as Permittees under the MRP but have voluntarily elected to participate in MRP-related regional activities. The RMC regional monitoring design was expanded to include the portion of eastern Contra Costa County that drains to the San Francisco Bay, to assist CCCWP in fulfilling parallel provisions in their Central Valley (Region 5) NPDES permit. The MRP was revised and reissued as Order No. R2-2015-0049, effective January 1, 2016.

[4] The Central Valley Regional Water Quality Control Board (CVRWQCB) issued the East Contra Costa County Municipal NPDES Permit (Central Valley Permit, Order No. R5-2010-0102) on September 23, 2010 (CVRWQCB 2010).

**Table 1-1. Regional Monitoring Coalition 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/Towns 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:

- Assist RMC Permittees in complying with requirements in MRP Provision C.8 (Water Quality Monitoring);
- Develop and implement regionally consistent creek monitoring approaches and designs in the San Francisco Bay Area, through improved coordination among RMC participants and other agencies that share common goals, e.g., Regional Water Quality Control Boards, Regions 2 and 5, and the State Water Resources Control Water Board's Surface Water Ambient Monitoring Program (SWAMP); and
- Stabilize the costs of creek monitoring by reducing duplication of effort and streamlining monitoring and reporting.

The RMC divided the creek status monitoring requirements specified in Permit Table 8.1 into those parameters that reasonably could be included within a regional/probabilistic design, and those that, for logistical and jurisdictional reasons, should be implemented locally using a targeted (non-probabilistic) design. The monitoring elements included in each category are specified in Table 1-2. Provision C.8.c monitoring data collected by CCCWP at local/targeted sites (not included in the regional probabilistic design) are reported separately in the UCMR.

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 1-3. Additional information on other aspects of Permit-required monitoring is found in other Appendices and the main UCMR.

**Table 1-2. Creek Status Monitoring Parameters Sampled in Compliance with MRP Provision C.8.c. as Either Regional/Probabilistic or Local/Targeted Parameters**

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

**Table 1-3. 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 UCMR, Main Body [5] | 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] Data collected by the SFBRWQCB are not included in this report.

# 2. Study Area and 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). 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 RMC participating counties that fall within the SFBRWQCB boundary, and the eastern portion of Contra Costa County that drains to the Central Valley Regional Board. A map of the BASMAA RMC area, equivalent to the area covered by the regional probabilistic design "sample frame", is shown in Figure 2-1.

## 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. 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 (SMC, 2007). For the purpose of developing the RMC's probabilistic design, the RMC area is considered to define the sample frame and represent the "sample universe."

### 2.2.1 Management Questions

The RMC regional monitoring probabilistic design was developed to address the management questions listed below:

1. What is the condition of aquatic life in creeks in the RMC area; are water quality objectives met and are beneficial uses supported?

    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?

To the extent feasible, these questions are addressed in a preliminary manner in this report for Contra Costa County, based only on an evaluation of WY 2015 data. These questions can be more fully answered on both a regional and county-specific basis in future years, once sample sizes increase, and upon implementation of a region-wide approach to data analysis.

**Figure 2-1. BASMAA RMC Area, County Boundaries and Major Creeks**

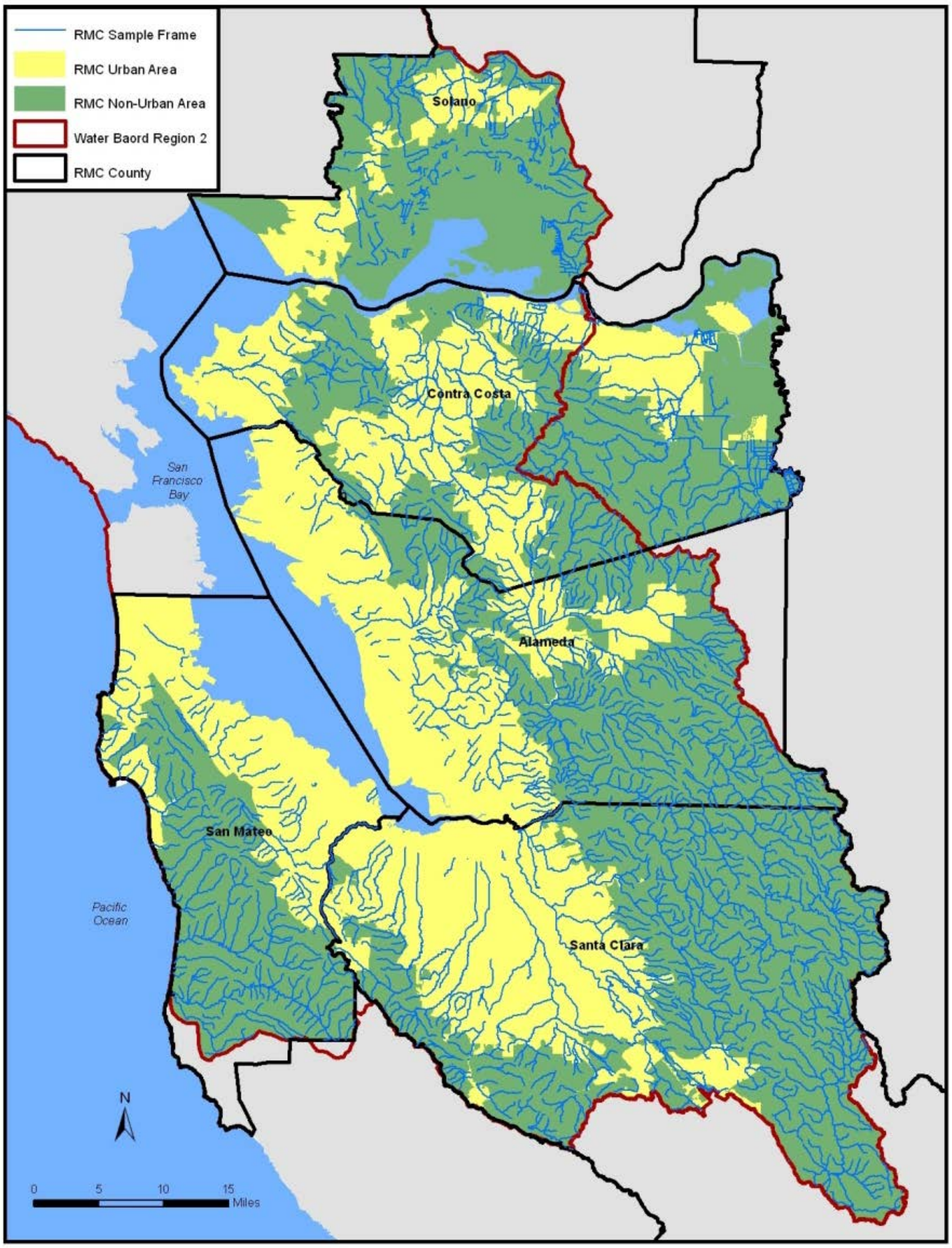


Table 2-1 shows the expected, cumulative progress towards establishing statistically representative sample sizes (estimated to be achieved at approximately n≥30) for each of the classified strata in the regional monitoring design. The cumulative sample numbers are estimated yearly over a five year period, assuming continuation of the present/planned rate of annual bioassessment sampling.

**Table 2-1. Cumulative Numbers of Planned Bioassessment Samples Per Monitoring Year**

| Monitoring Year | Totals for RMC Area (Region-wide) | | Santa Clara County | | Alameda County | | Contra Costa County | | San Mateo County | | Fairfield, Suisun City, and Vallejo [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 |

Shaded cells indicate when a minimum sample size (estimated to be n≥30) may be available to develop a statistically representative data set to address management questions related to condition of aquatic life for the strata included within the regional probabilistic design.
[a] Assumes SFBRWQCB will continue monitoring 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 initial MRP 5-Year Permit.

### 2.2.2 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[6] (BASMAA, 2011). This approach was agreed to by SFBRWQCB 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 (SFBRWQCB, 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

[6] Based on discussion during RMC meetings, with SFBRWQCB 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.

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 SFBRWQCB staff present, RMC participants weight their sampling so that annually approximately 80% of monitored sites are in urban areas and 20% in non-urban areas. RMC participants coordinated with the SFBRWQCB by identifying additional non-urban sites from their respective counties for SWAMP sampling.

## 2.3 Monitoring Design Implementation

Monitoring was conducted in accordance with the RMC Multi-year Monitoring Plan (BASMAA, 2011). The Monitoring Plan illustrates the total number of sites that each RMC Program plans to monitor within the MRP term (SFBRWQCB, 2009), as shown in Table 2-1 above. Table 2-1 also illustrates the number of 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. Per the RMC Monitoring Plan and the requirements of MRP Provision C.8.c, the RMC creek status monitoring emphasizes monitoring of urban land use sites. RMC participants have set a target of at least 80% of the sites sampled annually to be in urban 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. Some sites classified as urban, using data in a geographic information system, may be considered for reclassification as non-urban based on actual land uses of the drainage area, despite their location inside municipal jurisdictional boundaries. Such outcomes can be addressed in subsequent years by adjusting the relative proportion of urban and non-urban sites in regional statistical analyses.

The numbers of probabilistic sites monitored annually in Water Years 2012-2015 by CCCWP are shown by land use category in Table 2-2.

**Table 2-2. Number of Urban and Non-Urban Bioassessment Sites Sampled By CCCWP in Water Years 2012-2015**

| | Contra Costa County | |
|---|---|---|
| | Land Use | |
| Monitoring Year | Urban Sites | Non-Urban Sites |
| WY 2012 | 8 | 2 |
| WY 2013 | 10 | 0 |
| WY 2014 | 10 | 0 |
| WY 2015 | 10 | 0 |
| Total | 38 | 2 |

# 3. 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[7] (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 wadeable during the sampling index period.
4. Site has sufficient flow during the sampling index period to support standard operation procedures for biological and nutrient sampling.
5. Site is physically accessible and can be entered safely at the time of sampling.
6. Site may be physically accessed and sampled within a single day.
7. Landowner(s) grant permission to access the site.[8]

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 four categories:

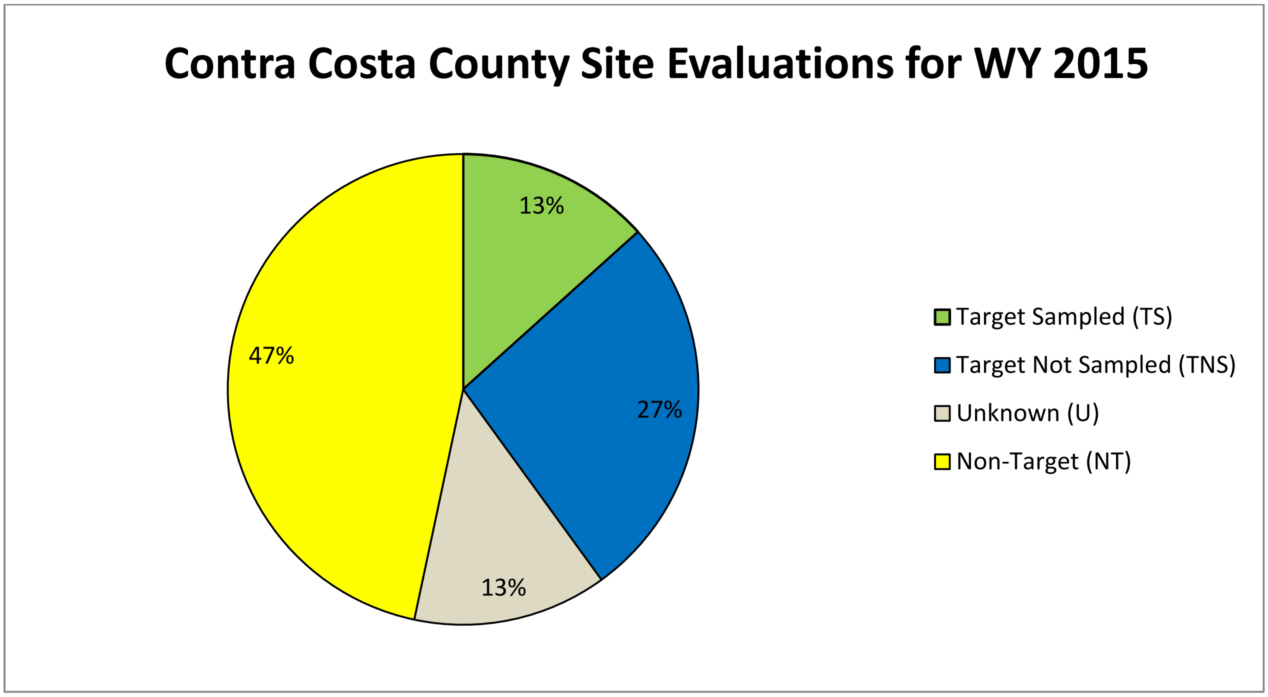
- **Target** – Sites that met all seven criteria above were classified as **target sampleable** status **(TS),** and sites that met criteria 1 through 4, but did not meet at least one of criteria 5 through 7 were classified as **target non-sampleable (TNS)**.
- **Non-Target (NT)** – Sites that did not meet at least one of criteria 1 through 4 were classified as non-target status and were not sampled.
- **Unknown (U)** – Sites were classified with unknown status and not sampled 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.

[7] Communication with managers for the SMC and the PSA are ongoing to ensure the consistency of site evaluation protocols.

[8] 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.

The outcomes of these site evaluations for CCCWP sites are illustrated in Figure 3-1 for WY 2015. A relatively small fraction of sites evaluated each year are classified as “target sampleable” sites.

**Figure 3-1. Results of CCCWP Site Evaluations for WY 2015**




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

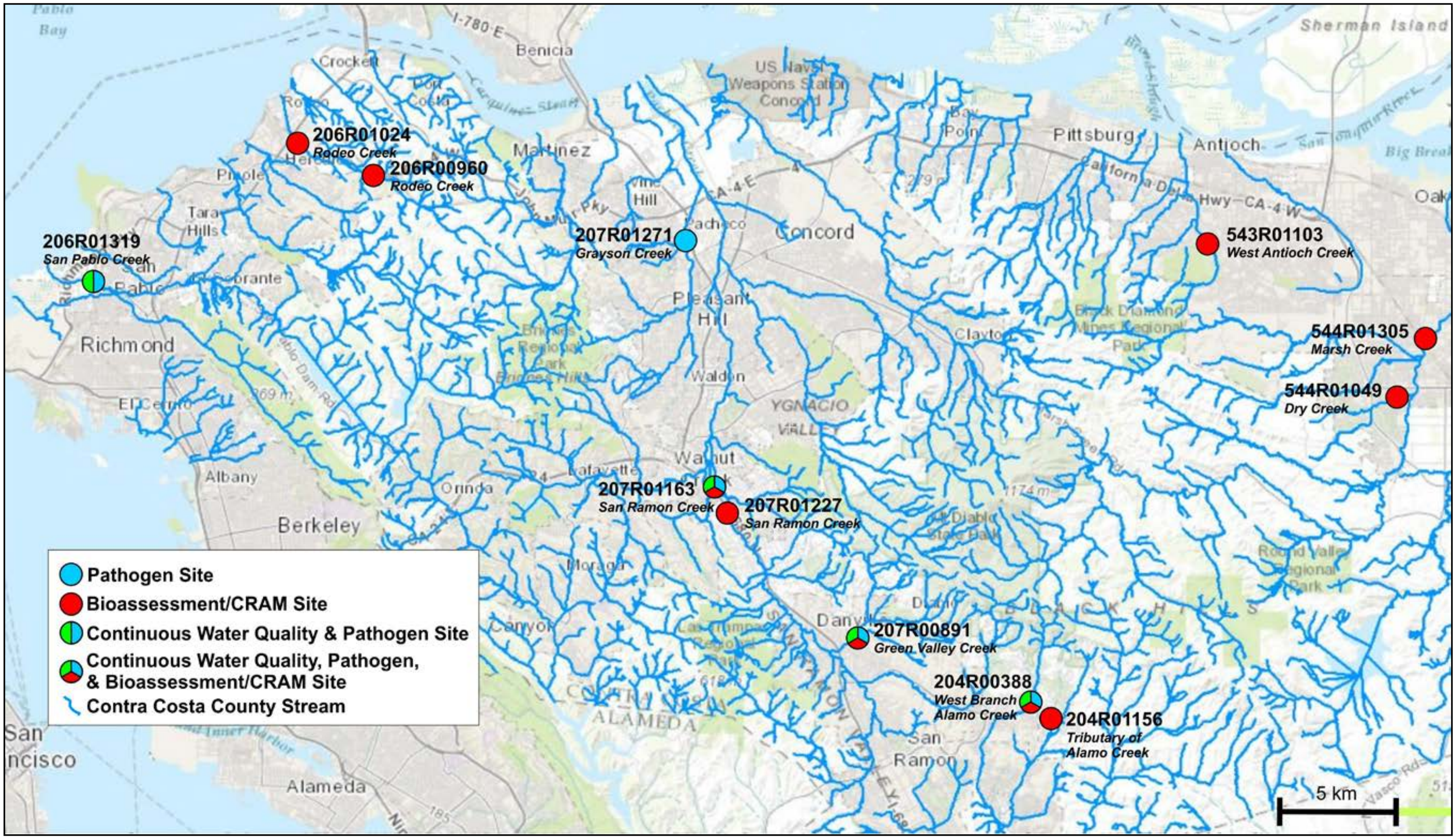
- Wet Flowing (continuously wet or nearly so, flowing water)
- Wet Trickle (continuously wet or nearly so, very low flow (trickle, less than 0.1 L/second)
- Majority Wet (discontinuously wet, greater than 25% by length of stream bed covered with water (isolated pools)
- Minority Wet (discontinuously wet, less than 25% of stream bed by length covered with water (isolated pools)
- 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 nonperennial as follows:

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

The regional/probabilistic sites monitored in WY 2015 are shown graphically in Figure 3-2 as the “Bioassessment/CRAM” sites, and are listed also with additional site information in Table 3-1.

**Figure 3-2. Contra Costa County Sites Monitored in WY 2015**




Note: "Bioassessment" Sites Are Those Selected From the RMC Probabilistic Monitoring Design

**Table 3-1. Site Locations, Monitoring Parameters and Dates Sampled at CCCWP Sites from the RMC Probabilistic Monitoring Design in WY 2015**

| Site ID | Creek Name | Land Use | Latitude | Longitude | Bioassessment, PHab, Chlorine, Nutrients | Water Toxicity (Wet Weather) | Water & Sediment Toxicity, Sediment Chemistry (Dry Weather) |
|---|---|---|---|---|---|---|---|
| 204R00388 | W Branch Alamo Creek | Urban | 37.80352 | -121.89936 | 05/06/15 | | |
| 204R01156 | Trib. of Alamo Creek | Urban | 37.79739 | -121.88988 | 05/06/15 | | |
| 206R00960 | Rodeo Creek | Urban | 38.00768 | -122.22185 | 04/22/15 | | |
| 206R01024 | Rodeo Creek | Urban | 38.01993 | -122.25920 | 05/05/15 | 02/06/15<br>04/07/15 | 07/07/15 |
| 207R00891 | Green Valley Creek | Urban | 37.82838 | -121.98444 | 04/22/15 | 02/06/15<br>04/07/15 | 07/07/15 |
| 207R01163 | San Ramon Creek | Urban | 37.88713 | -122.05534 | 05/04/15 | | |
| 207R01227 | San Ramon Creek | Urban | 37.87703 | -122.04847 | 05/04/15 | | |
| 543R01103 | W Antioch Creek | Urban | 37.98026 | -121.81226 | 04/21/15 | | |
| 544R01049 | Dry Creek | Urban | 37.92213 | -121.71938 | 04/20/15 | | |
| 544R01305 | Marsh Creek | Urban | 37.94454 | -121.70527 | 04/23/15 | | |

## 3.2 Field Sampling and 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 (BASMAA, 2014b). 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 3-2.

Procedures for sample container size and type, preservative type and associated holding times for each regional/probabilistic analyte are described in RMC SOP FS-9 (BASMAA, 2014b). Procedures for completion of field data sheets are provided in RMC SOP FS-10, and procedures for sample bottle labeling are described in RMC SOP FS-11 (BASMAA, 2014b).

As indicated in Table 3-1, of the ten bioassessment monitoring sites in WY 2015, the selected sites for wet weather toxicity testing, and dry weather water toxicity, sediment toxicity, and sediment chemistry testing in WY 2015 were Rodeo Creek (site code 206R01024) and Green Valley Creek (site code 207R00891).

**Table 3-2. RMC Standard Operating Procedures (SOPs) Pertaining to Regional Creek Status Monitoring**

| SOP # | Procedure |
|---|---|
| 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 |

### 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 of rainfall within a 24-hour period).

Each bioassessment monitoring site consisted of an approximately 150 meter (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).

#### 3.2.1.1 Benthic Macroinvertebrates

BMIs were collected via kick-net sampling using the Reach-wide Benthos (RWB) method described in RMC SOP FS-1 (BASMAA, 2014b) ), based on the SWAMP Bioassessment Wadeable Streams Protocol (Ode et al. 2007). Samples were collected from a 1-square-foot area approximately 1m 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 (per 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.

#### 3.2.1.2 Algae

Filamentous algae and diatoms also were collected using the RWB method described in SOP FS-1 (BASMAA, 2014b), based on the SWAMP Bioassessment Wadeable Streams Protocol (Ode et al., 2007). 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 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 taken from the algae composite sample and combined with 10 mL of 10% formalin into a 50 mL sample tube for taxonomic identification of diatoms.

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.

#### 3.2.1.3 Physical Habitat

Physical habitat assessments (PHab) were conducted during each BMI bioassessment monitoring 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 PHab 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).

Riparian assessments also were conducted at the 10 bioassessment sites between September 14 and September 21 using the California Rapid Assessment Method (CRAM), to fulfill the “Stream Survey” requirement of the Permit. Although the Stream Survey has been implemented by the RMC as a local/targeted parameter, the CRAM assessments were conducted during WY 2015 at the same locations that were monitored for bioassessment and other parameters under the RMC probabilistic design. CRAM includes an assessment of the following four attributes within a defined riparian assessment area: 1) buffer and landscape context; 2) hydrology; 3) physical structure; and 4) biotic structure. Procedures describing methods for scoring riparian attributes are described in Collins et al. (2008). The CRAM data are also used in this report to help interpret the biological data as part of the Stressor Assessment.

### 3.2.2 Physicochemical Measurements

Dissolved oxygen, temperature, conductivity, and pH were measured during bioassessment monitoring 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, or by collection and immediate analysis of grab sample in the field. Water quality measurements were taken approximately 0.1 m below the water surface at locations of the stream that appears to be completely mixed, ideally at the centroid of the stream. Measurements should occur upstream of sampling personnel and equipment and upstream of areas where bed sediments have been disturbed, or prior to such bed disturbance.

### 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 bioassessment monitoring and again during dry season monitoring for sediment chemistry, sediment toxicity, and water toxicity.

### 3.2.4 Nutrients and Conventional Analytes (Water Chemistry)

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. 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. The laboratory was notified of the impending sample delivery to help ensure meeting the 24-hour sample delivery time requirement. Procedures used for sample collection and transport 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 the WY 2012 UCMR BASMAA (2012a). The following analytical laboratory contractors were used for chemical and toxicological analysis:

- BioAssessment Services, Inc. – BMI taxonomic identification. The laboratory 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, with additional identification of Chironomids to subfamily/tribe level (corresponding to a Level 1a STE).

- EcoAnalysts, Inc. – algae taxonomic identification. Samples were processed in the laboratory following draft SWAMP protocols to provide count (diatom and soft algae), biovolume (soft algae), and "presence" (diatom and soft algae) data. Diatom and soft algae identifications were harmonized with the California Algae and Diatom Taxonomic Working Group's Master Taxa List. Laboratory processing included identification and enumeration of 300 natural units of soft algae and 600 diatom valves to the lowest practical taxonomic level.

- Caltest Analytical Laboratory, Inc. – water chemistry (nutrients etc.), sediment chemistry, chlorophyll-a, AFDM. Upon receipt at the laboratory, samples were immediately logged and preserved as necessary. USEPA-approved testing protocols were then applied for analysis of water and sediment samples.

- Pacific EcoRisk, Inc. – water and sediment toxicity. Testing of water and sediment samples was performed according to species-specific protocols published by USEPA.

## 3.4 Data Analysis

In this report only the data collected by CCCWP during WY 2015 for regional/probabilistic parameters are presented and analyzed. This includes data collected during bioassessment monitoring, which includes BMI and algae taxonomy, water chemistry and physical habitat evaluations at ten sites, as well as water and sediment toxicity and sediment chemistry data from two of those ten sites. 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 for the RMC region to address management questions related to condition of aquatic life, and report on these per MRP Provision C.8.g.iii.

Analysis of Provision C.8.c monitoring data generated by CCCWP at local/targeted sites (not included in the probabilistic design) is reported in the Local/Targeted Creek Status Monitoring Report (ADH, 2015).

### 3.4.1 Biological Data

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 CCCWP in WY 2015 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.

#### 3.4.1.1 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).

In the initial (WY 2012) Urban Creeks Monitoring Report (BASMAA, 2013), an array of such BMI metrics were computed using methods developed and tested extensively for both Southern California (Ode et al., 2005) and Northern California (Rehn et al., 2005), including benthic IBI scores using methods developed using selected BMI metrics for Southern California (SoCal B-IBI; Ode et al., 2005) and Northern California (NorCal B-IBI; Rehn et al., 2005). The B-IBI scores calculated using those two tools were well correlated based on the WY 2012 data for the RMC region. Because the ecoregions represented by the SoCal B-IBI are more similar to those in the majority of the RMC area than the NorCal ecoregions (with the exception of coastal streams in San Mateo County), the SoCal B-IBI was selected as the primary index used to evaluate biological condition. The SoCal and NorCal B-IBIs were developed in perennial streams in their respective regions. The majority of sites sampled by the RMC are classified as perennial steams. For consistency and comparison with the 2012 UCMR and other RMC programs, the SoCal B-IBI score is still computed for condition assessment in this report.

Prior to the adoption of the first MRP, work was initiated on a San Francisco Bay Region B-IBI in a collaborative effort by BASMAA participants and others, and the results were provisionally tested previously in Contra Costa (CCCWP, 2007) and Santa Clara (SCVURPPP, 2007) Counties. The Contra Costa County version of the Bay Area B-IBI was subsequently used in analysis and reporting of BMI data over the course of several years for the annual Contra Costa Monitoring and Assessment Program (CCMAP) bioassessment monitoring (see summary, Ruby, 2012). Calculation of the preliminary Contra Costa B-IBI is also presented for CCCWP’s BMI data in this report, to allow for comparisons with the historical CCMAP data set. The preliminary Contra Costa B-IBI is used as the principal metric for condition assessment in this report.

Support for aquatic life beneficial uses at CCCWP regional/probabilistic sites monitored in WY 2015 was evaluated by comparing the SoCal and preliminary Contra Costa B-IBI scores and associated condition categories to warm water (WARM) and cold water (COLD) aquatic life uses as designated by the SF Bay Regional Water Quality Control Board (2013).

The scores calculated using the SoCal B-IBI are classified according to condition categories established for the SoCal B-IBI (Table 3-3).

**Table 3-3. Condition Categories for Southern California B-IBI Scores Derived from BMI Taxonomy Data**

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

The scores calculated using the preliminary Contra Costa B-IBI are classified according to condition categories as shown in Table 3-4.

**Table 3-4. Condition Categories for Preliminary Contra Costa B-IBI Scores Derived from BMI Taxonomy Data**

| Condition Category | Contra Costa B-IBI Scores |
|---|---|
| Very Good | 43–50 |
| Good | 35–41 |
| Fair | 23–34 |
| Marginal | 11–22 |
| Poor | 0–10 |

#### 3.4.1.2 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 (Marco Sigala, pers. comm.), 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.

Soft algae and diatom taxonomy samples were collected at 10 sites in Contra Costa County during April and May of 2015, following the SWAMP Bioassessment Wadeable Streams Protocol (Ode et al. 2007). Samples were processed in the laboratory following draft SWAMP protocols to provide count (diatom and soft algae), biovolume (soft algae), and “presence” (diatom and soft algae) data. Diatom and soft algae identifications were not fully harmonized with the California Algae and Diatom Taxonomic Working Group's Master Taxa List and 15 Final IDs were not included in the analyses.

Eleven diatom metrics, eleven soft algae metrics, and five IBIs (D18, H20, H21, H23, S2) were calculated following work performed on Southern California streams (Fetscher et al. 2014). Diatom and soft algae metrics fall into five categories: Tolerance/Sensitivity [association with specific water-quality constituents like nutrients; tolerance to low dissolved oxygen; tolerance to high-ionic-strength/saline waters], Autoecological Guild [nitrogen fixers; saprobic/heterotrophic taxa], Morphological Guild [sedimentation indicators; motility], Taxonomic Groups [Chlorophyta, Rhodophyta, Zygnemataceae, heterocystous cyanobacteria], and the Relationship to Reference sites. IBI scoring ranges and values were provided by Dr. A. Elizabeth Fetscher (personal communication). After each metric was scored, values were summed and then converted to a 100-point scale by multiplying the sum by the number of metrics [e.g., sum x (100/50) if five metrics included in the IBI]. The most widely-used diatom IBI ("D18") is computed from five of the eleven metrics. The eleven diatom metrics are described in Table 3-5.

### 3.4.2 Physical Habitat Condition

Physical habitat condition was assessed for the bioassessment monitoring sites using "mini-PHab" scores. Mini-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), each of which can be scored on a range 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.

Riparian assessment ("stream survey") data collected at the 10 bioassessment sites between September 14 and September 21 using the California Rapid Assessment Method (CRAM) also are used in this report to help interpret the biological data as part of the Stressor Assessment. CRAM includes an assessment of the following four attributes within a defined riparian assessment area: 1) buffer and landscape context; 2) hydrology; 3) physical structure; and 4) biotic structure.

**Table 3-5. Metrics Used In Evaluating Algae Taxonomy Data**

| Metric Name | Description | Implications | Correlation w/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 nutrient or sediment levels | Negative |
| Proportion requiring >50% DO saturation * | Proportion of diatoms that require at least 50% dissolved oxygen saturation | 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

### 3.4.3 Water and Sediment Chemistry and Toxicity

As part of the Stressor Assessment for this report, water and sediment chemistry and toxicity data generated during WY 2015 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 (SFBRWQCB, 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 may be adversely affected. 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 (per MRP Attachment H, as referenced in MRP Table 8.1).
- **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 (per MRP Attachment H, Table H-1).

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 $LC_{50}$ values ($LC_{50}$ is the concentration of a given chemical that is lethal on average to 50% of test organisms). Because organic carbon mitigates the toxicity of pyrethroid pesticides in sediments, the $LC_{50}$ 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) and in RMC SOP FS13, QA/QC Data Review (BASMAA, 2014b).

Data Quality Objectives (DQOs) were established to ensure that data collected were of sufficient 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 review was performed according to protocols defined in RMC SOP FS13, QA/QC Data Review (BASMAA, 2014b). Data quality was assessed and qualifiers were assigned as necessary in accordance with SWAMP requirements.

# 4. Results and Discussion

The MRP and Central Valley Permit require status 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 results of the initial stressor assessment (WY 2012 UCMR; BASMAA, 2013) are currently being used in follow-up efforts to plan and implement stressor/source identification (SSID) projects per MRP Provision C.8.d.

In this section, following a brief statement of data quality, biological conditions are assessed from the bioassessment monitoring data, and the biological, physical, chemical and toxicity testing monitoring data are evaluated against the trigger criteria shown in Permit Table 8.1, and, for sediment triad data, MRP Table H-1 (equivalent to Central Valley Permit Table D-1) to provide a preliminary identification of potential stressors.

In this report only the data collected during WY 2015 by CCCWP for regional/probabilistic creek status monitoring parameters are presented.

## 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 in 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, each of 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, 2014a), and monitoring was performed according to protocols specified in the RMC SOPs (BASMAA, 2014b), and in conformity with SWAMP protocols. QA/QC issues noted by the laboratories and/or RMC field crews are summarized below.

### 4.1.1 Bioassessment

The New Zealand mudsnail (*Potamopyrgus antipodarum*), a non-native invasive species, was confirmed at four sites: 207R00891 (Green Valley Creek), 207R01163 (San Ramon Creek), 207R01227 (San Ramon Creek), 543R01103 (West Antioch Creek), and possibly occurred at an additional site, 544R01305 (Marsh Creek), where the specimens were few and immature. This finding is not a QA/QC issue *per se*, but requires that field crews take special cautions to effectively decontaminate equipment so as to prevent cross-contamination and transfer of the invasive mud snail between sites.

### 4.1.2 Sediment Chemistry

For analysis of the sediment sample collected at site 207R00891 and the field duplicate collected at that site, the samples were diluted by the laboratory due to a high concentration of non-target analyte(s) in the samples (AKA “interference”), resulting in increased reporting limits for the reported analytical results.

### 4.1.3 Water Chemistry

Free chlorine exceeded total chlorine in one sample. This anomaly has occurred previously in RMC field data; the reason for these occurrences is not known.

### 4.1.4 Sediment Toxicity

No significant issues were reported.

### 4.1.5 Water Toxicity

For the samples collected on February 6, 2015, the Lab Control sample did not meet the test acceptability criteria for the *Hyalella azteca* tests; the Control 10-Day mean survival was 88%, just below the minimum test criteria of 90% specified in USEPA test protocols. The 10-day Hyalella survival tests were therefore re-run starting on February 17, 2015. The results for both of the environmental samples as a percentage of the control results were very similar for the original tests compared to the re-tests (in all cases the environmental sample survival was substantially below 50% of the Control survival); therefore the Control sample survival issue is not deemed to have had any significant effect on the test results.

Pathogen-related mortality (PRM) was not observed in any samples tested for WY 2015.

## 4.2 Biological 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 (SFBRWQCB, 2013) for RMC creeks sampled by CCCWP in WY 2015 are shown in Table 4-1. Properties of the aquatic life use indicators used for this condition assessment that were observed at the CCCWP sites monitored in WY 2014 are reported in Sections 4.2.1 (benthic macroinvertebrates) and 4.2.2 (algae), and discussed in relation to the designated aquatic life beneficial uses in section 4.2.3. Due to the relatively small sample size available after the third year of implementing the RMC regional probabilistic monitoring design, results are presented only for the available data from urbanized portions of Contra Costa County. Future reports will provide additional analysis at the countywide program and regional levels, as well as comparisons between urban and non-urban land use sites.

**Table 4-1. Designated Beneficial Uses Listed in the San Francisco Bay Region Basin Plan (SFBRWQCB, 2013) for CCCWP Bioassessment Sites Monitored in WY 2015**

| | | Human Consumptive Uses | | | | | | | Aquatic Life Uses | | | | | | | | | | Recreational Uses | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site ID | Water Body | AGR | MUN | FRSH | GWR | IND | PROC | COMM | SHELL | COLD | EST | MAR | MIGR | RARE | SPWN | WARM | WILD | REC-1 | REC-2 | NAV |
| 204R00388 | W Branch Alamo Creek | | | | E | | | | | P | | | E | E | E | E | E | E | E | |
| 204R01156 | Trib. of Alamo Creek | | | | E | | | | | P | | | E | E | E | E | E | E | E | |
| 206R00960 | Rodeo Creek | | | | | | | | | E | | | | | E | E | E | E | E | |
| 206R01024 | Rodeo Creek | | | | | | | | | E | | | | | E | E | E | E | E | |
| 207R00891 | Green Valley Creek[1] | | | | | | | | | | | | | | | E | E | E | E | |
| 207R01163 | San Ramon Creek | | | | | | | | | | | | | | | E | E | E | E | |
| 207R01227 | San Ramon Creek | | | | | | | | | | | | | | | E | E | E | E | |
| 543R01103 | W Antioch Creek[2] | E | E | | E | E | E | E | | | E | | E | E | E | E | E | E | E | E |
| 544R01049 | Dry Creek[3] | | | | | | | E | | | | | | E | | E | E | E | E | |
| 544R01305 | Marsh Creek | | | | | | | E | | | | | | E | | E | E | E | E | |

[1] Tributary to San Ramon Creek; San Ramon Creek beneficial use data used.
[2] Tributary to Sacramento-San Joaquin Delta; Sacramento-San Joaquin Delta beneficial use data used.
[3] Tributary to Marsh Creek; Marsh Creek beneficial use data used.
E = Existing beneficial use
P = Potential beneficial use

Notes: Per Basin Plan Ch. 2 (SFBRWQCB, 2013), beneficial uses for freshwater creeks include municipal and domestic supply (MUN), agricultural supply (AGR), industrial process supply (PRO), groundwater recharge (GWR), water contact recreation (REC1), noncontact water recreation (REC2), wildlife habitat (WILD), cold freshwater habitat (COLD), warm freshwater habitat (WARM), fish migration (MIGR), and fish spawning (SPWN). The San Francisco Bay Estuary supports estuarine habitat (EST), industrial service supply (IND), and navigation (NAV) in addition to all of the uses supported by streams. Coastal waters' beneficial uses include water contact recreation (REC1); noncontact water recreation (REC2); industrial service supply (IND); navigation (NAV); marine habitat (MAR); shellfish harvesting (SHELL); ocean, commercial and sport fishing (COMM); and preservation of rare and endangered species (RARE).

### 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 described in the 2012 Regional UCMR (BASMAA, 2013). BMI metrics for the 10 regional/probabilistic sites monitored annually within Contra Costa County similarly continue to exhibit a wide range of scores annually, including in WY 2015. BMI taxonomic metrics are shown in Table 4-2 for the CCCWP creek status sites monitored in the spring index period of WY 2015.

B-IBI scores and other essential site characteristics are presented in Table 4-3 for the 10 Contra Costa County sites monitored in WY 2015. As noted above, based upon an a comparison and analysis of the NorCal and SoCal B-IBIs, the SoCal B-IBI score was chosen for the biological condition assessment in the 2012 UCMR (BASMAA, 2013). For consistency with the 2012 UCMR and other RMC programs, the SoCal B-IBI score is included in the condition assessment analysis in this report. The preliminary Contra Costa B-IBI also is reported for purposes of comparison with the extensive historical database of bioassessment data produced by CCCWP during 2001–2011.

**Table 4-2. Benthic Macroinvertebrate Metrics for CCCWP Bioassessment Sites Monitored in WY 2015**

| Metrics | CCCWP Bioassessment Sampling Sites, Spring 2015 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 204R00388 | 204R01156 | 207R00891 | 544R01049 | 544R01305 | 206R00960 | 206R01024 | 207R01163 | 207R01227 | 543R01103 |
| | W Branch Alamo Creek | Tributary of Alamo Creek | Green Valley Creek | Dry Creek | Marsh Creek | Rodeo Creek | Rodeo Creek | San Ramon Creek | San Ramon Creek | West Antioch Creek |
| Richness | | | | | | | | | | |
| Taxonomic | 17 | 13 | 16 | 11 | 17 | 26 | 14 | 24 | 20 | 15 |
| EPT | 2 | 0 | 1 | 1 | 2 | 1 | 1 | 5 | 4 | 2 |
| Ephemeroptera | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 |
| Plecoptera | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Trichoptera | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 2 | 1 |
| Coleoptera | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Predator | 4 | 2 | 4 | 2 | 3 | 14 | 6 | 7 | 3 | 3 |
| Diptera | 5 | 6 | 5 | 5 | 4 | 11 | 4 | 8 | 7 | 6 |
| Composition | | | | | | | | | | |
| EPT Index (%) | 1.6 | 0.0 | 3.1 | 0.1 | 0.3 | 0.3 | 0.2 | 11 | 19 | 25 |
| Sensitive EPT Index (%) | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 |
| Shannon Diversity | 2.2 | 1.6 | 1.9 | 1.6 | 1.7 | 2.1 | 1.4 | 1.5 | 2.0 | 2.0 |
| Dominant Taxon (%) | 28 | 51 | 33 | 43 | 31 | 30 | 46 | 60 | 43 | 33 |
| Non-insect Taxa (%) | 53 | 46 | 50 | 45 | 53 | 27 | 29 | 33 | 40 | 40 |
| Tolerance | | | | | | | | | | |
| Tolerance Value | 6.4 | 5.6 | 5.6 | 6.8 | 6.1 | 6.0 | 6.7 | 7.3 | 6.9 | 6.4 |
| Intolerant Organisms (%) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.1 | 0.1 | 0.0 |
| Intolerant Taxa (%) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.8 | 0.0 | 4.2 | 5.0 | 0.0 |
| Tolerant Organisms (%) | 32 | 10 | 9 | 44 | 18 | 11 | 50 | 71 | 61 | 34 |
| Tolerant Taxa (%) | 41 | 31 | 38 | 36 | 41 | 35 | 50 | 38 | 40 | 33 |
| Functional Feeding Groups: | | | | | | | | | | |
| Collector-Gatherers (%) | 69 | 85 | 91 | 94 | 96 | 59 | 51 | 24 | 46 | 48 |
| Collector-Filterers (%) | 22 | 12 | 1.8 | 0.0 | 0.5 | 33 | 0.0 | 12 | 6.3 | 11 |
| Scrapers (%) | 2.8 | 1.1 | 2.1 | 1.0 | 2.0 | 0.2 | 0.0 | 61 | 43 | 33 |
| Predators (%) | 5.8 | 1.5 | 4.7 | 5.5 | 1.5 | 8.4 | 49 | 2.3 | 3.2 | 4.7 |

**Table 4-2. Benthic Macroinvertebrate Metrics for CCCWP Bioassessment Sites Monitored in WY 2015**

| Metrics | CCCWP Bioassessment Sampling Sites, Spring 2015 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 204R00388 | 204R01156 | 207R00891 | 544R01049 | 544R01305 | 206R00960 | 206R01024 | 207R01163 | 207R01227 | 543R01103 |
| | W Branch Alamo Creek | Tributary of Alamo Creek | Green Valley Creek | Dry Creek | Marsh Creek | Rodeo Creek | Rodeo Creek | San Ramon Creek | San Ramon Creek | West Antioch Creek |
| Shredders (%) | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Other (%) | 0.6 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 1.0 | 0.9 | 2.9 |
| Estimated Abundance | | | | | | | | | | |
| Composite Sample (11 ft2) | 6,581 | 7,332 | 9,776 | 16,272 | 1,640 | 1,280 | 869 | 16,344 | 23,968 | 5,224 |
| #/ft2 | 598 | 667 | 889 | 1,479 | 149 | 116 | 79 | 1,486 | 2,179 | 475 |
| #/m2 | 6,389 | 7,118 | 9,491 | 15,798 | 1,592 | 1,243 | 844 | 15,868 | 23,270 | 5,072 |
| Supplemental Metrics | | | | | | | | | | |
| Collectors (%) | 91 | 97 | 93 | 94 | 96 | 91 | 51 | 36 | 53 | 60 |
| Non-Gastropoda Scrapers (%) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 |
| Shredder Taxa (%) | 0.0 | 7.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Diptera Taxa** | 2.0 | 3.0 | 2.0 | 2.0 | 1.0 | 8.0 | 1.0 | 5.0 | 3.0 | 3.0 |
| SoCal B-IBI Score | 6 | 4 | 3 | 4 | 3 | 26 | 26 | 30 | 20 | 20 |
| CC B-IBI Score | 21 | 17 | 20 | 18 | 16 | 33 | 30 | 39 | 32 | 30 |

Metrics are calculated from standard classifications, based on level I standard taxonomic effort except Chironomids, which are identified to subfamily/ tribe*.
*Standard taxonomic effort source: Southwest Association of Freshwater Invertebrate Taxonomists (http://www.waterboards.ca.gov/swamp/docs/safit/ste_list.pdf).
** Calculated based on Chironomids identified to family level.

**Table 4-3. B-IBI scores and Key Characteristics for CCCWP Bioassessment Sites Monitored in WY 2015**

| Site ID | Creek Name | Land Use | Flow Class | 3-Sided Concrete Channel? | COLD | WARM | SoCal B-IBI Score | SoCal B-IBI Condition | Contra Costa B-IBI Score | Contra Costa B-IBI Condition |
|---|---|---|---|---|---|---|---|---|---|---|
| 204R00388 | W Branch Alamo Creek | Urban | Per. | | * | E | 6 | Very Poor | 21 | Marginal |
| 204R01156 | Trib. of Alamo Creek | Urban | Per. | | * | E | 4 | Very Poor | 17 | Marginal |
| 207R00891 | Green Valley Creek | Urban | Per. | | | E | 3 | Very Poor | 20 | Marginal |
| 544R01049 | Dry Creek | Urban | NP | | | E | 4 | Very Poor | 18 | Marginal |
| 544R01305 | Marsh Creek | Urban | NP | | | E | 3 | Very Poor | 16 | Marginal |
| 206R00960 | Rodeo Creek | Urban | NP | | E | E | 26 | Poor | 33 | Fair |
| 206R01024 | Rodeo Creek | Urban | Per. | | E | E | 26 | Poor | 30 | Fair |
| 207R01163 | San Ramon Creek | Urban | Per. | Yes | | E | 30 | Poor | 39 | Good |
| 207R01227 | San Ramon Creek | Urban | Per. | Yes | | E | 20 | Poor | 32 | Fair |
| 543R01103 | W Antioch Creek | Urban | Per. | | | E | 20 | Poor | 30 | Fair |

Per. = perennial flow; NP = non-perennial (i.e., intermittent) flow (based on site evaluations performed during drought conditions)
E = Existing beneficial use; *Alamo Creek is listed as potential for COLD beneficial use

As indicated in Tables 4-2 and 4-3, the B-IBI scores separate into two groups: a lower B-IBI group, ranging from 3-6 for the SoCal B-IBI and from 16-20 for the Contra Costa B-IBI, and a higher B-IBI group, ranging from 20-30 for the SoCal B-IBI and from 30-39 for the Contra Costa B-IBI. The higher B-IBI scores are attributable principally to lower numbers of collector individuals (collectors are generalists; higher numbers of specialized species tend to indicate healthier biodiversity). Secondary factors affecting the higher scores are fewer numbers of non-insect taxa (higher diversity of insects is indicative of healthy stream assemblages) and higher numbers of predator taxa (predators are specialists).

Flow status (perennial vs. non-perennial) does not appear to be a determining factor in the separation of the B-IBI scores into two groups, as two of the three non-perennial streams are found in the lower-IBI group, while one is found in the higher-IB group. There are two concrete-lined channels among the ten sites monitored, but both are found in the higher-IBI group, while the opposite may be expected to be true (concrete-lined channels are presumed to have generally lower biodiversity).

### 4.2.2 Algae Metrics

The average D18 diatom IBI score across all ten Contra Costa sites in WY 2015 was 37.4 (Table 4-4). In comparison, the average D18 scores across samples collected in 2012 through 2014 was 38.7, indicating little change in the overall health of the diatom community. The highest scores occurred at sites 204R00388 (64) and 207R01227 (62) while three sites had scores of 20 or below: 204R01156 (10), 206R00960 (10), and 207R00891 (14). Higher scores tended to be associated with a lower proportion of halobiontic species, nitrogen heterotrophic species, and sediment tolerant, highly motile species but higher proportion of species requiring >50% dissolved oxygen saturation (Tables 4-4, 4-5). Nine of ten sites scored 1 or below for the proportion of diatom species indicative of low total phosphorous levels suggesting phosphorous is not a limiting factor in those streams. Cocconeis spp and Nitschia spp were the dominant diatom species found in six of ten sites. Fetscher et al. (2014) found the diatom IBI (D18) to be responsive to stream order, watershed area, and percent fines so these values could also play a role in IBI scores.

The soft algae S2 IBI had an average score of 37.3 compared to the average score of 30.0 in 2014 (only the D18 score was calculated for years 2012 and 2013; see Table 4-6). The highest scores occurred at sites 206R01024 (97) and 204R00388 (68), with the other eight sites scoring below 50. Site 206R01024 scored high because it did not have any soft algae indicative of high copper or DOC concentrations, of non-reference conditions, and species belonging to the green algae CRUS (*Cladophora glomerata*, *Rhizoclonium hieroglyphicum*, *Ulva flexuosa*, and *Stigeoclonium spp*; see Tables 4-6, 4-7). In contrast, site 207R00891 (10) had the lowest S2 IBI score because it did not have any soft algae species representative of low phosphorous conditions and ZHR species (Zygnemataceae, Rhodophyta, heterocystous cyanobacteria) but it had a high proportion of CRUS species and species indicative of high DOC concentrations. The biomass of *Cladophera glomerata* was proportionally the dominant taxa at six of ten sites while species richness was dominated by *Heteroleibleinia kossinskajae*, *Heteroleibleinia kuetzingii*, and *Leptolyngbya foveolarum* at eight of ten sites. The soft algae results also indicated phosphorous is not a limiting factor at eight of ten sites. Copper concentrations may be an issue at sites 204R01156 and 544R01305 since a third of the species in the samples are indicative of high dissolved copper sensitivity. Fetscher et al. (2014) found soft algae IBIs were most responsive (negatively) to canopy cover and slope.

The hybrid IBIs (H20, H21, and H23) consisting of both soft algae and diatom metrics produced similar results in determining the highest (sites 204R00388 and 206R01024) and lowest (sites 204R01156 and 206R00960) scores among the ten sites (Tables 4-8, 4-9, 4-10). However, the average IBI score varied slightly among the three IBIs (H20 = 36.6, H21 = 35.7, H23 = 38.3). The main differences in the H20 IBI scores were due to the proportion of halobiontic diatoms, highly motile diatoms, high copper sensitive soft algae, and low total phosphorous sensitive soft algae. H21 IBI scores were driven by the biomass proportion of Chlorophyta and ZHR (Zygnemataceae, Rhodophyta, heterocystous cyanobacteria) taxonomic groups. The proportion of ZHR and CRUS soft algae species affected the differences in H23 IBI scores as well as the proportion of sediment tolerant, highly motile diatoms. Fetscher et al. (2014) designated H20 as the overall top-performing IBI for Southern California streams, although differences with H23 were not pronounced.

Overall, site 204R00388 had the highest score across four of the five IBIs and had the second highest S2 score. Site 206R01024 had the highest S2 score, tied for the highest H20 score, and had the second highest H21 and H23 scores. Site 207R01227 had the second highest D18 and H20 scores. Lowest IBI scores occurred at sites 204R01156, 206R00960, and 207R00891. The proportion of halobiontic and sediment tolerant, highly motile diatom species affected scores across IBIs suggesting the importance of low ionic strength/salinities and sediment qualities on a stronger diatom community. Soft algae scores were more affected by the proportion of taxonomic groups and species found within sites.

**Table 4-4. Diatom IBI (D18) and Individual Metric Scores for CCCWP Bioassessment Sites Monitored in WY 2015**

| Station Code | Creek Name | Sample Date | D18 IBI Score | Proportion halobiontic (d) Score | Proportion low TP indicators (d) Score | Proportion N heterotrophs (d) Score | Proportion requiring >50% DO saturation (d) Score | Proportion sediment tolerant (highly motile) (d) Score |
|---|---|---|---|---|---|---|---|---|
| 204R00388 | W Branch Alamo Creek | 05/06/15 | 64 | 6 | 7 | 7 | 7 | 5 |
| 204R01156 | Trib. of Alamo Creek | 05/06/15 | 10 | 0 | 0 | 0 | 5 | 0 |
| 206R00960 | Rodeo Creek | 04/22/15 | 10 | 0 | 1 | 4 | 0 | 0 |
| 206R01024 | Rodeo Creek | 05/05/15 | 44 | 4 | 1 | 5 | 5 | 7 |
| 207R00891 | Green Valley Creek | 04/22/15 | 14 | 1 | 1 | 4 | 0 | 1 |
| 207R01163 | San Ramon Creek | 05/04/15 | 58 | 3 | 1 | 8 | 8 | 9 |
| 207R01227 | San Ramon Creek | 05/04/15 | 62 | 3 | 1 | 9 | 9 | 9 |
| 543R01103 | W Antioch Creek | 04/21/15 | 40 | 4 | 1 | 6 | 4 | 5 |
| 544R01049 | Dry Creek | 04/20/15 | 52 | 6 | 1 | 7 | 5 | 7 |
| 544R01305 | Marsh Creek | 04/23/15 | 20 | 1 | 1 | 5 | 1 | 2 |
| | | Average: | 37.4 | | | | | |

Note: The overall IBI score was calculated by converting the sum of individual scores to a 100-point scale by summing the scores and multiplying by the number of metrics [sum x (100/50)].

**Table 4-5. Diatom Metric Results for CCCWP Bioassessment Sites Monitored in WY 2015**

| Station Code | Sample Date | Proportion *A. minutissimum* (d) | Proportion halobiontic (d) | Proportion highly motile (d) | Proportion low TN indicators (d) | Proportion low TP indicators (d) | Proportion N heterotrophs (d) | Proportion oligo- & beta-mesosaprobic (d) | Proportion poly- & eutrophic (d) | Proportion requiring >50% DO saturation (d) | Proportion requiring nearly 100% DO saturation (d) | Proportion sediment tolerant (highly motile) (d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 204R00388 | 05/06/15 | 0.382 | 0.238 | 0.277 | 0.476 | 0.515 | 0.161 | 0.699 | 0.512 | 0.894 | 0.482 | 0.278 |
| 204R01156 | 05/06/15 | 0 | 0.641 | 0.618 | 0.007 | 0.007 | 0.578 | 0.626 | 0.982 | 0.799 | 0.012 | 0.625 |
| 206R00960 | 04/22/15 | 0 | 0.717 | 0.575 | 0.055 | 0.06 | 0.293 | 0.235 | 0.895 | 0.561 | 0.012 | 0.6 |
| 206R01024 | 05/05/15 | 0.01 | 0.317 | 0.139 | 0.035 | 0.06 | 0.264 | 0.514 | 0.926 | 0.817 | 0.049 | 0.172 |
| 207R00891 | 04/22/15 | 0 | 0.523 | 0.457 | 0.018 | 0.018 | 0.289 | 0.239 | 0.91 | 0.462 | 0.039 | 0.457 |
| 207R01163 | 05/04/15 | 0.015 | 0.363 | 0.055 | 0.053 | 0.07 | 0.087 | 0.872 | 0.828 | 0.936 | 0.037 | 0.065 |
| 207R01227 | 05/04/15 | 0.007 | 0.393 | 0.024 | 0.02 | 0.029 | 0.029 | 0.942 | 0.96 | 0.965 | 0.019 | 0.027 |
| 543R01103 | 04/21/15 | 0 | 0.353 | 0.228 | 0.018 | 0.012 | 0.2 | 0.503 | 0.947 | 0.764 | 0.015 | 0.255 |
| 544R01049 | 04/20/15 | 0.01 | 0.235 | 0.126 | 0.022 | 0.023 | 0.146 | 0.623 | 0.879 | 0.811 | 0.033 | 0.134 |
| 544R01305 | 04/23/15 | 0.002 | 0.505 | 0.42 | 0.011 | 0.018 | 0.244 | 0.442 | 0.831 | 0.652 | 0.009 | 0.428 |

Note: All calculations were based on count data.

**Table 4-6. Soft Algae IBI (S2) and Individual Metric Scores for CCCWP Bioassessment Sites Monitored in WY 2015**

| Station Code | Creek Name | Sample Date | S2 IBI Score | Proportion high Cu indicators (s, sp) Score | Proportion high DOC indicators (s, sp) Score | Proportion low TP indicators (s, sp) Score | Proportion non-reference indicators (s, sp) Score | Proportion of green algae belonging to CRUS (s, b) Score | Proportion ZHR (s, m) Score |
|---|---|---|---|---|---|---|---|---|---|
| 204R00388 | W Branch Alamo Creek | 05/06/15 | 68 | 8 | 8 | 3 | 6 | 9 | 7 |
| 204R01156 | Trib. of Alamo Creek | 05/06/15 | 20 | 1 | 4 | 0 | 6 | 0 | 1 |
| 206R00960 | Rodeo Creek | 04/22/15 | 25 | 6 | 4 | 0 | 5 | 0 | 0 |
| 206R01024 | Rodeo Creek | 05/05/15 | 97 | 10 | 10 | 8 | 10 | 10 | 10 |
| 207R00891 | Green Valley Creek | 04/22/15 | 10 | 2 | 3 | 0 | 1 | 0 | 0 |
| 207R01163 | San Ramon Creek | 05/04/15 | 28 | 2 | 7 | 0 | 7 | 0 | 1 |
| 207R01227 | San Ramon Creek | 05/04/15 | 33 | 4 | 7 | 0 | 7 | 0 | 2 |
| 543R01103 | W Antioch Creek | 04/21/15 | 47 | 2 | 6 | 0 | 3 | 10 | 7 |
| 544R01049 | Dry Creek | 04/20/15 | 23 | 3 | 4 | 0 | 3 | 2 | 2 |
| 544R01305 | Marsh Creek | 04/23/15 | 22 | 1 | 5 | 0 | 5 | 1 | 1 |

Note: The overall IBI score was calculated by converting the sum of individual scores to a 100-point scale by summing the scores and multiplying by the number of metrics [sum x (100/60].

**Table 4-7. Soft Algae Metric Results for CCCWP Bioassessment Sites Monitored in WY 2015**

| Station Code | Sample Date | Proportion high Cu indicators (s, sp) | Proportion high DOC indicators (s, sp) | Proportion low TP indicators (s, sp) | Proportion non-reference indicators (s, sp) | Proportion ZHR (s, sp) | Proportion Chlorophyta (s, b) | Proportion high DOC indicators (s, b) | Proportion non-reference indicators (s, b) | Proportion of green algae belonging to CRUS (s, b) | Proportion ZHR (s, b) | Proportion ZHR (s, m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 204R00388 | 05/06/15 | 0.077 | 0.231 | 0.077 | 0.231 | 0.333 | 0.033 | 0.011 | 0.011 | 0.021 | 0.5 | 0.417 |
| 204R01156 | 05/06/15 | 0.333 | 0.462 | 0 | 0.231 | 0.062 | 0.75 | 1 | 0.75 | 1 | 0 | 0.031 |
| 206R00960 | 04/22/15 | 0.143 | 0.5 | 0 | 0.25 | 0 | 0.667 | 1 | 1 | 1 | 0 | 0 |
| 206R01024 | 05/05/15 | 0 | 0 | 0.25 | 0 | 0.571 | 0 | 0 | 0 | 0 | 1 | 0.786 |
| 207R00891 | 04/22/15 | 0.286 | 0.556 | 0 | 0.444 | 0 | 0.8 | 1 | 0.8 | 1 | 0 | 0 |
| 207R01163 | 05/04/15 | 0.286 | 0.3 | 0 | 0.2 | 0.077 | 1 | 1 | 1 | 1 | 0 | 0.038 |
| 207R01227 | 05/04/15 | 0.2 | 0.294 | 0 | 0.176 | 0.143 | 1 | 1 | 1 | 1 | 0 | 0.071 |
| 543R01103 | 04/21/15 | 0.286 | 0.375 | 0 | 0.375 | 0.1 | 0 | 1 | 0 | 0 | 0.75 | 0.425 |
| 544R01049 | 04/20/15 | 0.25 | 0.5 | 0 | 0.375 | 0.167 | 1 | 1 | 1 | 0.878 | 0 | 0.083 |
| 544R01305 | 04/23/15 | 0.333 | 0.4 | 0 | 0.267 | 0.056 | 0.592 | 0.813 | 0.789 | 0.982 | 0 | 0.028 |

Notes: Calculations were based on either species counts (sp) or biovolume (b).
Proportion ZHR (s, m) was based on the mean of the species and biovolume results.

**Table 4-8. Hybrid (diatom and soft algae) IBI (H20) and Individual Metric Scores for CCCWP Bioassessment Sites Monitored in WY 2015**

| Station Code | Sample Date | H20 IBI Score | Proportion halobiontic (d) Score | Proportion high Cu indicators (s, sp) Score | Proportion high DOC indicators (s, sp) Score | Proportion low TN indicators (d) Score | Proportion low TP indicators (s, sp) Score | Proportion N heterotrophs (d) Score | Proportion requiring >50% DO saturation (d) Score | Proportion sediment tolerant (highly motile) (d) Score |
|---|---|---|---|---|---|---|---|---|---|---|
| 204R00388 | 05/06/15 | 62 | 6 | 8 | 8 | 6 | 3 | 7 | 7 | 5 |
| 204R01156 | 05/06/15 | 12 | 0 | 1 | 4 | 0 | 0 | 0 | 5 | 0 |
| 206R00960 | 04/22/15 | 19 | 0 | 6 | 4 | 1 | 0 | 4 | 0 | 0 |
| 206R01024 | 05/05/15 | 62 | 4 | 10 | 10 | 1 | 8 | 5 | 5 | 7 |
| 207R00891 | 04/22/15 | 15 | 1 | 2 | 3 | 1 | 0 | 4 | 0 | 1 |
| 207R01163 | 05/04/15 | 48 | 3 | 2 | 7 | 1 | 0 | 8 | 8 | 9 |
| 207R01227 | 05/04/15 | 52 | 3 | 4 | 7 | 1 | 0 | 9 | 9 | 9 |
| 543R01103 | 04/21/15 | 35 | 4 | 2 | 6 | 1 | 0 | 6 | 4 | 5 |
| 544R01049 | 04/20/15 | 41 | 6 | 3 | 4 | 1 | 0 | 7 | 5 | 7 |
| 544R01305 | 04/23/15 | 20 | 1 | 1 | 5 | 1 | 0 | 5 | 1 | 2 |

Note: The overall IBI score was calculated by converting the sum of individual scores to a 100-point scale by summing the scores and multiplying by the number of metrics [sum x (100/80].

**Table 4-9. Hybrid (diatom and soft algae) IBI (H21) and Individual Metric Scores for CCCWP Bioassessment Sites Monitored in WY 2015**

| Station Code | Sample Date | H21 IBI Score | Proportion Chlorophyta (s, b) Score | Proportion halobiontic (d) Score | Proportion low TP indicators (d) Score | Proportion N heterotrophs (d) Score | Proportion requiring >50% DO saturation (d) Score | Proportion sediment tolerant (highly motile) (d) Score | Proportion ZHR (s, b) Score |
|---|---|---|---|---|---|---|---|---|---|
| 204R00388 | 05/06/15 | 66 | 9 | 6 | 7 | 7 | 7 | 5 | 5 |
| 204R01156 | 05/06/15 | 11 | 3 | 0 | 0 | 0 | 5 | 0 | 0 |
| 206R00960 | 04/22/15 | 11 | 3 | 0 | 1 | 4 | 0 | 0 | 0 |
| 206R01024 | 05/05/15 | 60 | 10 | 4 | 1 | 5 | 5 | 7 | 10 |
| 207R00891 | 04/22/15 | 13 | 2 | 1 | 1 | 4 | 0 | 1 | 0 |
| 207R01163 | 05/04/15 | 41 | 0 | 3 | 1 | 8 | 8 | 9 | 0 |
| 207R01227 | 05/04/15 | 44 | 0 | 3 | 1 | 9 | 9 | 9 | 0 |
| 543R01103 | 04/21/15 | 54 | 10 | 4 | 1 | 6 | 4 | 5 | 8 |
| 544R01049 | 04/20/15 | 37 | 0 | 6 | 1 | 7 | 5 | 7 | 0 |
| 544R01305 | 04/23/15 | 20 | 4 | 1 | 1 | 5 | 1 | 2 | 0 |

Note: The overall IBI score was calculated by converting the sum of individual scores to a 100-point scale by summing the scores and multiplying by the number of metrics [sum x (100/70].

**Table 4-10. Hybrid (diatom and soft algae) IBI (H23) and Individual Metric Scores for CCCWP Bioassessment Sites Monitored in WY 2015**

| Station Code | Sample Date | H23 IBI Score | Proportion halobiontic (d) Score | Proportion high DOC indicators (s, sp) Score | Proportion low TP indicators (d) Score | Proportion N heterotrophs (d) Score | Proportion of green algae belonging to CRUS (s, b) Score | Proportion requiring >50% DO saturation (d) Score | Proportion sediment tolerant (highly motile) (d) Score | Proportion ZHR (s, m) Score |
|---|---|---|---|---|---|---|---|---|---|---|
| 204R00388 | 05/06/15 | 70 | 6 | 8 | 7 | 7 | 9 | 7 | 5 | 7 |
| 204R01156 | 05/06/15 | 12 | 0 | 4 | 0 | 0 | 0 | 5 | 0 | 1 |
| 206R00960 | 04/22/15 | 11 | 0 | 4 | 1 | 4 | 0 | 0 | 0 | 0 |
| 206R01024 | 05/05/15 | 65 | 4 | 10 | 1 | 5 | 10 | 5 | 7 | 10 |
| 207R00891 | 04/22/15 | 12 | 1 | 3 | 1 | 4 | 0 | 0 | 1 | 0 |
| 207R01163 | 05/04/15 | 46 | 3 | 7 | 1 | 8 | 0 | 8 | 9 | 1 |
| 207R01227 | 05/04/15 | 50 | 3 | 7 | 1 | 9 | 0 | 9 | 9 | 2 |
| 543R01103 | 04/21/15 | 54 | 4 | 6 | 1 | 6 | 10 | 4 | 5 | 7 |
| 544R01049 | 04/20/15 | 42 | 6 | 4 | 1 | 7 | 2 | 5 | 7 | 2 |
| 544R01305 | 04/23/15 | 21 | 1 | 5 | 1 | 5 | 1 | 1 | 2 | 1 |

Note: The overall IBI score was calculated by converting the sum of individual scores to a 100-point scale by summing the scores and multiplying by the number of metrics [sum x (100/80].

### 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.

#### 4.2.3.1 Benthic Macroinvertebrate Metrics

There are marked differences among the condition categories indicated by the different B-IBI scores, as shown in Table 4-3. The SoCal B-IBI condition categories differ markedly from the Contra Costa B-IBI categories, with the Contra Costa conditions often scoring two categories higher than the SoCal B-IBI categories. A comparison of the number of sites in the various condition categories is shown in Table 4-11 for SoCal B-IBI scores and Contra Costa B-IBI scores.

Based simply on the distribution of sites in the various categories, and on the prior CCMAP monitoring results (which revealed an even broader distribution of scores and categories), it appears that the Contra Costa B-IBI may more accurately represent benthic biological conditions in Contra Costa County streams. Looking at the scores and condition categories at the extremes (highest and lowest), the Contra Costa B-IBI generally appears to reasonably characterize the sites monitored under CCMAP and by CCCWP under the RMC for MRP compliance. However, the SoCal B-IBI was developed using a more rigorous and more recently-evolved protocol than the earlier provisional Contra Costa B-IBI, and the Contra Costa B-IBI should undergo additional investigation in accordance with more recent standards in procedural approach to B-IBI development (e.g., per Stoddard et al., 2008).

As indicated in Table 4-1, most sites monitored by CCCWP for the RMC during WY 2015 are presumed to have both the WARM (warm water fishery) beneficial use, but only Rodeo Creek is listed for an existing 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 in the lower categories (poor or very poor for SoCal B-IBI, marginal or poor for Contra Costa B-IBI) may indicate some difficulty in supporting the designated aquatic life beneficial uses.

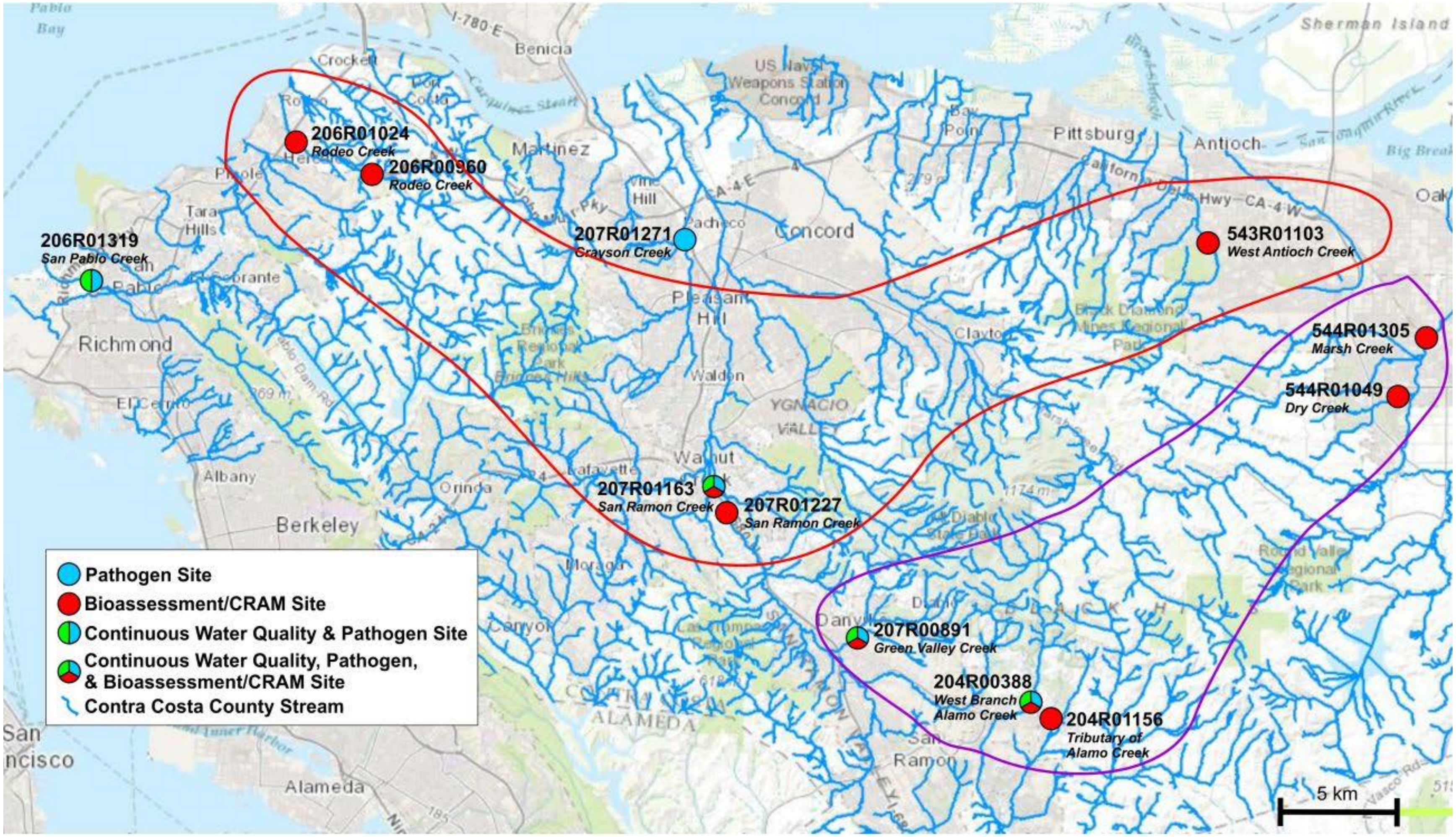
Using the SoCal B-IBI scores, all ten of the urban sites monitored by CCCWP in WY 2015 would be considered potentially deficient regarding biological conditions necessary to support a viable fishery. Using the Contra Costa B-IBI scores, five of the non-urban sites monitored by CCCWP would be considered potentially deficient regarding biological conditions necessary to support a viable fishery. In the absence of an available B-IBI developed for the San Francisco Bay Region, the SoCal B-IBI was used principally to assess the condition of BMI data sampled in the RMC area, and therefore these results should be considered provisional. But the differences apparent between the SoCal B-IBI scores and Contra Costa preliminary B-IBI scores indicate that further development of a Contra Costa or SF Bay area B-IBI is warranted.

As shown in Tables 4-2 and 4-3, an interesting feature of the WY 2015 B-IBI scores is that the scores can be separated into two groups – a lower group and a higher group. This separation holds true and is consistent for both the SoCal and Contra Costa B-IBI scores. The groupings are illustrated in Figure 4-1. No explanation is currently available for this separation of B-IBI scores into two distinct groups. The five sites with higher B-IBI scores tended to have lower numbers of collector individuals (collectors are generalists; higher numbers of specialized species tend to indicate healthier biodiversity), as well as fewer numbers of non-insect taxa (higher diversity of insects is indicative of healthy stream assemblages) and higher numbers of predator taxa (predators are specialists).

**Table 4-11. Summary of Biological Conditions Categories Based on SoCal B-IBI and Contra Costa B-IBI Scores for CCCWP Bioassessment Sites Monitored in WY 2015**

| So. California B-IBI Condition | | Contra Costa B-IBI Condition | |
|---|---|---|---|
| # Sites | Category | # Sites | Category |
| 0 | Very Good | 0 | Very Good |
| 0 | Good | 1 | Good |
| 0 | Fair | 4 | Fair |
| 5 | Poor | 5 | Marginal |
| 5 | Very Poor | 0 | Poor |

**Figure 4-1. Grouping of Lower (Blue Outline) and Higher (Red Outline) B-IBI Scores at CCCWP Bioassessment Sites, WY 2015**



## 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 CCCWP during WY 2015 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, in some cases non-detect data (ND) were substituted with a concentration equal to one-half of the respective MDL as reported by the laboratory.

### 4.3.1 Stressor Indicators – Analytical Results

#### 4.3.1.1 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 4-12), computed for Contra Costa County sites from three physical habitat attributes (epifaunal substrate/cover, sediment deposition, and channel alteration) measured in the field during bioassessment monitoring in WY 2015. The composite mini-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.

An alternative evaluation of riparian habitat is available through the CRAM scores, shown in Table 4-13 (see ADH, 2016, for details regarding these parameters, as reported in the Local/Targeted Creek Status Report). The CRAM methodology includes an assessment of the following four attributes within a defined riparian assessment area: 1) buffer and landscape context; 2) hydrology; 3) physical structure; and 4) biotic structure; those four scores are shown along with the overall CRAM score in Table 4-13.

**Table 4-12. Physical Habitat Metrics and Scores for CCCWP Bioassessment Sites Monitored in WY 2015**

| Site Code | Creek name | Sample Date | Epifaunal Substrate | Sediment Deposition | Channel Alteration | Mini-PHab Score |
|---|---|---|---|---|---|---|
| 204R00388 | W Branch Alamo Creek | 05/06/15 | 14 | 14 | 15 | 43 |
| 204R01156 | Trib. of Alamo Creek | 05/06/15 | 12 | 6 | 8 | 26 |
| 206R00960 | Rodeo Creek | 04/22/15 | 13 | 13 | 16 | 42 |
| 206R01024 | Rodeo Creek | 05/05/15 | 4 | 3 | 3 | 10 |
| 207R00891 | Green Valley Creek | 04/22/15 | 6 | 8 | 18 | 32 |
| 207R01163 | San Ramon Creek | 05/04/15 | 5 | 11 | 1 | 17 |
| 207R01227 | San Ramon Creek | 05/04/15 | 4 | 19 | 2 | 25 |
| 543R01103 | W Antioch Creek | 04/21/15 | 14 | 17 | 13 | 44 |
| 544R01049 | Dry Creek | 04/20/15 | 3 | 3 | 13 | 19 |
| 544R01305 | Marsh Creek | 04/23/15 | 8 | 4 | 3 | 15 |

**Table 4-13. CRAM Metrics and Scores for CCCWP Bioassessment Sites Monitored in WY 2015**

| Station Code | Assessment Area Name | Buffer | Hydrology | Physical | Biotic | Overall CRAM Score | CRAM Rank |
|---|---|---|---|---|---|---|---|
| 204R00388 | W. Branch Alamo Creek | 86 | 83 | 75 | 78 | 81 | Excellent |
| 206R00960 | Rodeo Creek | 63 | 67 | 88 | 81 | 74 | Good |
| 543R01103 | W. Antioch Creek | 43 | 75 | 63 | 64 | 61 | Fair |
| 204R01156 | Trib. of Alamo | 43 | 58 | 63 | 69 | 58 | Fair |
| 207R00891 | Green Valley Creek | 75 | 50 | 50 | 53 | 57 | Fair |
| 206R01163 | San Ramon Creek | 63 | 33 | 63 | 64 | 56 | Fair |
| 544R01305 | Marsh Creek | 63 | 67 | 38 | 47 | 53 | Fair |
| 544R01049 | Dry Creek | 38 | 50 | 25 | 44 | 39 | Poor |
| 206R01024 | Rodeo Creek | 38 | 50 | 25 | 44 | 39 | Poor |
| 207R01227 | San Ramon Creek | 43 | 33 | 38 | 42 | 39 | Poor |

#### 4.3.1.2 Water Chemistry Parameters

Table 4-14 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 4-14. Descriptive Statistics for Water Chemistry Results from CCCWP Bioassessment Sites Monitored in WY 2015**

| Analyte | Units | Mean** | Min. | Max. | N | N ≥ MDL |
|---|---|---|---|---|---|---|
| Alkalinity as CaCO3 | mg/L | 332 | 138 | 494 | 10 | 10 |
| Ammonia as N | mg/L | 0.11 | ND | 0.2 | 10 | 9 |
| Ash Free Dry Mass | mg/L | 37100 | 5510 | 192000 | 10 | 10 |
| Bicarbonate | mg/L | 329 | 138 | 494 | 10 | 10 |
| Carbonate | mg/L | 3.3 | ND | 12 | 10 | 3 |
| Chloride | mg/L | 100 | 42 | 200 | 10 | 10 |
| Chlorophyll a | mg/m^3 | 2400 | 690 | 5600 | 10 | 10 |
| Dissolved Organic Carbon | mg/L | 4.4 | 2.2 | 6.7 | 10 | 10 |
| Hydroxide | mg/L | ND | ND | ND | 10 | 0 |
| Nitrate as N | mg/L | 0.17 | ND | 1 | 10 | 7 |
| Nitrite as N | mg/L | 0.005 | ND | 0.017 | 10 | 3 |
| Nitrogen, Total Kjeldahl | mg/L | 1.14 | 0.31 | 1.9 | 10 | 10 |
| Nitrogen, Total* | mg/L | 1.31 | 0.32 | 2.2 | 10 | 10 |
| Orthophosphate as P | mg/L | 0.20 | ND | 0.54 | 10 | 9 |
| Phosphorus as P | mg/L | 0.25 | 0.045 | 0.75 | 10 | 10 |
| Silica as SiO2 | mg/L | 29 | 12 | 65 | 10 | 10 |
| Suspended Sediment (SSC) | mg/L | 8.1 | ND | 51 | 10 | 4 |

ND = non-detect
*Total nitrogen calculated as sum of Nitrite+Nitrate+TKN
**Non-detects estimated as ½ MDL for calculation of mean

#### 4.3.1.3 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.

For water sample toxicity tests, Permit 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 (and Central Valley Permit Table D-1) identifies toxicity results more than 20% less than the control as requiring follow-up action.[9] Therefore, in the results 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).

[9] 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."

Toxicity samples for sediment triad sites (those including bioassessment, sediment chemistry analysis, and sediment toxicity testing) 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 sites monitored for wet and dry weather toxicity testing were Rodeo Creek (site code 206R01024) and Green Valley Creek (site code 207R00891). The toxicity testing results are presented in context of the following three groups:

1. Wet season aquatic toxicity (water samples)
2. Dry season aquatic toxicity (water samples)
3. Dry season sediment toxicity (sediment samples)

### *Wet Season Aquatic Toxicity*

Per the MRP, ambient water samples were collected by CCCWP from two sites during storm events in spring 2015, 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).

As shown in Table 4-15, neither of the WY 2015 wet weather samples were found to be toxic to *S. capricornutum*, *C. dubia*, or fathead minnow (*P. promelas)*, for either acute (survival) or chronic (growth or reproduction) endpoints. In fact, the sample water from both Rodeo Creek and Green Valley Creek was conducive to algae growth, as the measured cell growth was substantially higher in the test samples than in the control.

Both samples were acutely toxic to *H. azteca*, in each case with statistically significant toxicity relative to the acute endpoint criterion (survival). Additional wet weather samples were collected on April 7, 2015 from both sites for retesting of *H. azteca* survival only; those samples also were found to be acutely toxic to *H. azteca*. For the Feb. 6$^{th}$ Rodeo Creek sample and both of the Green valley Creek samples, *H. azteca* survival was less than 50% of the applicable Control sample values, triggering the Permit Table 8.1 threshold (less than 50% of the Control value).

**Table 4-15. Summary of CCCWP WY 2015 Wet Season Water Toxicity Results**

| Wet Season Water Samples | | | Toxicity Test Results | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | *Selenastrum capricornutum* | *Ceriodaphnia dubia* | | *Hyalella azteca* | *Pimephales promelas* | |
| Site Code | Creek Name | Sample Collection Date | Growth (cells/mL x $10^6$) | Survival (%) | Reproduction (# neonates/ female) | Survival (%) | Survival (%) | Growth (mg) |
| Control | - | - | 3.00 | 100 | 35.8 | 100 | 87.5 | 0.60 |
| 206R01024 | Rodeo Creek | 02/06/15 | 7.01 | 100 | 35.8 | 36* | 97.5 | 0.65 |
| 207R00891 | Green Valley Creek | 02/06/15 | 8.27 | 100 | 39.7 | 32* | 87.5 | 0.79 |
| Re-Test (*H. azteca* survival only): | | | | | | | | |
| Control | - | - | | | | 98 | | |
| 206R01024 | Rodeo Creek | 04/07/15 | | | | 72* | | |
| 207R00891 | Green Valley Creek | 04/07/15 | | | | 6* | | |

*The response at this test treatment was significantly less than the Lab Control treatment response at p < 0.05; the bolded test results also were highly toxic, and met the Permit aquatic toxicity threshold, with survival at less than 50% of the Control.

### *Dry-Season Aquatic Toxicity*

Water samples were collected during the summer 2015 period from the same two sites where wet season sampling occurred, and were again tested for aquatic toxicity using the same four test species. The results are summarized in Table 4-16.

In the summer water samples there was again no significant toxicity to *S. capricornutum*, *C. daphnia*, or fathead minnows. As with the spring water samples, the samples appeared to enhance algae growth, as the *S. capricornutum* growth results from the field samples exceeded the control sample growth.

Only the Rodeo Creek sample was determined to be toxic to *H. azteca* in relation to the acute endpoint (survival); in that sample *H. azteca* survival was 94%, but that relatively small degree of toxic effect apparently was determined to be statistically different than the Control sample value (100%). That sample result did not meet the Permit Table 8.1 trigger threshold (more than 50% less than the Control).

**Table 4-16. Summary of CCCWP WY 2015 Dry Season Water Toxicity Results**

| Dry Season Water Samples | | | Toxicity Test Results | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | *Selenastrum capricornutum* | *Ceriodaphnia dubia* | | *Hyalella azteca* | *Pimephales promelas* | |
| Site Code | Creek Name | Sample Collection Date | Growth (cells/mL x $10^6$) | Survival (%) | Reproduction (# neonates/ female) | Survival (%) | Survival (%) | Growth (mg) |
| Control | - | - | 2.67 | 80 | 25.9 | 100 | 100 | 0.42 |
| 206R01024 | Rodeo Creek | 07/07/15 | 4.08 | 100 | 25.7 | 94* | 100 | 0.52 |
| 207R00891 | Green Valley Creek | 07/07/15 | 6.56 | 100 | 25.1 | 98 | 95 | 0.57 |

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

### *Dry Season Sediment Toxicity*

During the dry season, sediment samples were collected at the same two sites where water toxicity samples were collected, 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 that has been shown to be sensitive to toxicity from certain pesticides. Both acute (survival) and chronic (growth) endpoints were reported.

The results of the sediment toxicity testing in Water Year 2015 are summarized in Table 4-17. The Green Valley Creek (site code 207R00891) sediment sample was determined to be toxic to *H. azteca* for both the acute endpoint (survival) and the chronic endpoint (growth, measured as biomass). The chronic result was more than 20% less than the Control, and therefore met the MRP Attachment H threshold for sediment toxicity.

The Rodeo Creek sediment sample (site code 206R01024) was not found to be toxic to *H. azteca*.

**Table 4-17. Summary of CCCWP WY 2015 Dry Season Sediment Toxicity Results**

| Dry-Season Sediment Samples | | | Toxicity Test Results | |
|---|---|---|---|---|
| | | | *H. azteca* | |
| Site Code | Creek Name | Sample Collection Date | Survival (%) | Growth (mg) |
| Control | - | - | 96.3 | 0.13 |
| 206R01024 | Rodeo Creek | 07/07/15 | 92.5 | 0.14 |
| 207R00891 | Green Valley Creek | 07/07/15 | 87.5* | 0.08* |

*The response at this test treatment was determined to be significantly less than the Lab Control treatment response at $p < 0.05$; the bolded test result also met the sediment toxicity Permit threshold, at more than 20% less than the Control

### *Sediment Chemistry Parameters*

Results for sediment chemistry constituents for samples collected in WY 2015 are provided in Table 4-18. Analytes are presented in alphabetical order by chemical analyte group.

**Table 4-18. CCCWP WY 2015 Sediment Chemistry Results**

| | | Site 206R01024 | | | Site 207R00891 | | |
|---|---|---|---|---|---|---|---|
| | | Rodeo Creek | | | Green Valley Creek | | |
| Analyte | Units* | Result | MDL | RL | Result | MDL | RL |
| *Metals* | | | | | | | |
| Arsenic | mg/Kg | 5.8 | 0.33 | 0.54 | 5.4 | 0.33 | 0.55 |
| Cadmium | mg/Kg | 0.52 | 0.011 | 0.04 | 0.17 | 0.011 | 0.04 |
| Chromium | mg/Kg | 17 | 0.065 | 0.11 | 22 | 0.066 | 0.11 |
| Copper | mg/Kg | 16 | 0.082 | 0.22 | 24 | 0.083 | 0.22 |
| Lead | mg/Kg | 9.3 | 0.044 | 0.11 | 13 | 0.044 | 0.11 |
| Mercury | mg/Kg | 0.056 | 0.00088 | 0.022 | 0.054 | 0.00089 | 0.022 |
| Nickel | mg/Kg | 28 | 0.065 | 0.11 | 24 | 0.066 | 0.11 |
| Zinc | mg/Kg | 70 | 0.87 | 2.2 | 110 | 1.8 | 4.4 |

**Table 4-18. CCCWP WY 2015 Sediment Chemistry Results**

| Analyte | Units* | Site 206R01024 Rodeo Creek | | | Site 207R00891 Green Valley Creek | | |
|---|---|---|---|---|---|---|---|
| | | Result | MDL | RL | Result | MDL | RL |
| *Organochlorine/Organophosphorus Pesticides* | | | | | | | |
| Chlordane, cis- | ng/g | -1.1 | 1.1 | 2.2 | -1.1 | 1.1 | 2.2 |
| Chlordane, trans- | ng/g | -1.1 | 1.1 | 2.2 | -1.1 | 1.1 | 2.2 |
| DDD(o,p') | ng/g | -2.2 | 2.2 | 2.2 | -2.2 | 2.2 | 2.2 |
| DDD(p,p') | ng/g | -0.86 | 0.86 | 2.2 | 2.8 | 0.89 | 2.2 |
| DDE(o,p') | ng/g | -2.2 | 2.2 | 2.2 | -2.2 | 2.2 | 2.2 |
| DDE(p,p') | ng/g | -1.3 | 1.3 | 2.2 | 3.6 | 1.3 | 2.2 |
| DDT(o,p') | ng/g | -2.2 | 2.2 | 2.2 | -2.2 | 2.2 | 2.2 |
| DDT(p,p') | ng/g | -1.1 | 1.1 | 2.2 | -1.1 | 1.1 | 2.2 |
| Dieldrin | ng/g | -1.3 | 1.3 | 2.2 | -1.3 | 1.3 | 2.2 |
| Endrin | ng/g | -1.1 | 1.1 | 2.2 | -1.1 | 1.1 | 2.2 |
| HCH, gamma- | ng/g | -0.76 | 0.76 | 2.2 | -0.78 | 0.78 | 2.2 |
| Heptachlor Epoxide | ng/g | -1.2 | 1.2 | 2.2 | -1.2 | 1.2 | 2.2 |
| *Polycyclic Aromatic Hydrocarbons (PAHs)* | | | | | | | |
| Acenaphthene | ng/g | -3.2 | 3.2 | 5 | -3.3 | 3.3 | 5 |
| Acenaphthylene | ng/g | -3.2 | 3.2 | 5 | -3.3 | 3.3 | 5 |
| Anthracene | ng/g | 5.4 | 3.2 | 5 | -3.3 | 3.3 | 5 |
| Benz(a)anthracene | ng/g | 22 | 3.2 | 5 | -3.3 | 3.3 | 5 |
| Benzo(a)pyrene | ng/g | 65 | 16 | 19 | -3.3 | 3.3 | 5 |
| Benzo(b)fluoranthene | ng/g | -3.2 | 3.2 | 5 | -3.3 | 3.3 | 5 |
| Benzo(e)pyrene | ng/g | 86 | 16 | 19 | -3.3 | 3.3 | 5 |
| Benzo(g,h,i)perylene | ng/g | 43 | 16 | 19 | -3.3 | 3.3 | 5 |
| Benzo(k)fluoranthene | ng/g | -3.2 | 3.2 | 5 | -3.3 | 3.3 | 5 |
| Biphenyl | ng/g | 4.3 | 3.6 | 5 | 4.4 | 3.7 | 5 |
| Chrysene | ng/g | 65 | 16 | 19 | -3.3 | 3.3 | 5 |
| Dibenz(a,h)anthracene | ng/g | 22 | 16 | 19 | -3.3 | 3.3 | 5 |
| Dibenzothiophene | ng/g | -3.6 | 3.6 | 5 | -3.7 | 3.7 | 5 |
| Dimethylnaphthalene, 2,6- | ng/g | 65 | 3.2 | 5 | 110 | 3.3 | 5 |
| Fluoranthene | ng/g | -3.2 | 3.2 | 5 | -3.3 | 3.3 | 5 |
| Fluorene | ng/g | -3.2 | 3.2 | 5 | -3.3 | 3.3 | 5 |
| Indeno(1,2,3-c,d)pyrene | ng/g | -3.2 | 3.2 | 5 | -3.3 | 3.3 | 5 |
| Methylnaphthalene, 1- | ng/g | 4.3 | 3.2 | 5 | -3.3 | 3.3 | 5 |
| Methylnaphthalene, 2- | ng/g | 7.6 | 3.2 | 5 | -3.3 | 3.3 | 5 |
| Methylphenanthrene, 1- | ng/g | -3.2 | 3.2 | 5 | -3.3 | 3.3 | 5 |
| Naphthalene | ng/g | 5.4 | 3.2 | 5 | 4.4 | 3.3 | 5 |
| Perylene | ng/g | -16 | 16 | 19 | -3.3 | 3.3 | 5 |
| Phenanthrene | ng/g | 22 | 3.2 | 5 | -3.3 | 3.3 | 5 |
| Pyrene | ng/g | -3.2 | 3.2 | 5 | 11 | 3.3 | 5 |
| *Pyrethroid Pesticides* | | | | | | | |
| Bifenthrin | ng/g | 2.7 | 0.11 | 0.27 | 16 | 0.11 | 0.28 |
| Cyfluthrin, total | ng/g | 0.72 | 0.12 | 0.27 | 1.1 | 0.12 | 0.28 |
| Cyhalothrin, Total lambda- | ng/g | 0.16 | 0.065 | 0.27 | 0.5 | 0.067 | 0.28 |

**Table 4-18. CCCWP WY 2015 Sediment Chemistry Results**

| Analyte | Units* | Site 206R01024 Rodeo Creek | | | Site 207R00891 Green Valley Creek | | |
|---|---|---|---|---|---|---|---|
| | | Result | MDL | RL | Result | MDL | RL |
| Cypermethrin, total | ng/g | 0.21 | 0.11 | 0.27 | -0.11 | 0.11 | 0.28 |
| Deltamethrin/Tralomethrin | ng/g | 0.68 | 0.13 | 0.27 | 3.7 | 0.13 | 0.28 |
| Esfenvalerate/Fenvalerate, total | ng/g | -0.14 | 0.14 | 0.27 | -0.14 | 0.14 | 0.28 |
| Permethrin, cis- | ng/g | 1 | 0.12 | 0.4 | 0.57 | 0.12 | 0.4 |
| Permethrin, trans- | ng/g | 0.45 | 0.12 | 0.4 | 0.34 | 0.12 | 0.4 |
| *Organic Carbon* | | | | | | | |
| Total Organic Carbon | % | 2.4 | 0.023 | 0.23 | 3.4 | 0.033 | 0.33 |

* All measurements reported as dry weight
J = estimated value
ND = not detected

## 4.3.2 Stressor Analysis

Stressor analysis provides an analysis of the physical habitat parameters in relation to the B-IBI scores, as well as analysis of the water and sediment chemistry and toxicity testing results in comparison to various thresholds included in the Permit. This analysis is intended to provide a means of identifying potential stressors that may impact beneficial uses at the creek status monitoring locations.

### 4.3.2.1 Physical Habitat Parameters

In an initial evaluation, the WY 2015 mini-PHab scores did not correlate well with either the Contra Costa B-IBI scores or the SoCal B-IBI scores. CRAM scores also were compared to B-IBI scores, and again there was virtually no correlation. The PHab and CRAM scores are shown in Table 4-19, along with the SoCal IB-IBI, Contra Costa B-IBI and algae D-18 A-IBI scores, for the ten bioassessment sites monitored in WY 2015 in Contra Costa County (Table 4-19).

**Table 4-19. B-IBI scores and Key Characteristics for CCCWP Bioassessment Sites Monitored in WY15**

| Site ID | Creek Name | SoCal B-IBI Score | SoCal B-IBI Condition | Contra Costa B-IBI Score | Contra Costa B-IBI Condition | Algae D-18 A-IBI Score | Mini-PHab Score | CRAM Score |
|---|---|---|---|---|---|---|---|---|
| 204R00388 | W Branch Alamo Creek | 6 | Very Poor | 21 | Marginal | 64 | 43 | 81 |
| 204R01156 | Trib. of Alamo Creek | 4 | Very Poor | 17 | Marginal | 10 | 26 | 58 |
| 207R00891 | Green Valley Creek | 3 | Very Poor | 20 | Marginal | 14 | 32 | 57 |
| 544R01049 | Dry Creek | 4 | Very Poor | 18 | Marginal | 52 | 19 | 39 |
| 544R01305 | Marsh Creek | 3 | Very Poor | 16 | Marginal | 20 | 15 | 53 |
| 206R00960 | Rodeo Creek | 26 | Poor | 33 | Fair | 10 | 42 | 74 |
| 206R01024 | Rodeo Creek | 26 | Poor | 30 | Fair | 44 | 10 | 39 |
| 207R01163 | San Ramon Creek | 30 | Poor | 39 | Good | 58 | 17 | 56 |
| 207R01227 | San Ramon Creek | 20 | Poor | 32 | Fair | 62 | 25 | 39 |
| 543R01103 | W Antioch Creek | 20 | Poor | 30 | Fair | 40 | 44 | 61 |

Correlation coefficients and coefficient of determination (r-squared; goodness of fit) values were computed for the SoCal and Contra Costa B-IBIs, the D-18 algae IBI, and PHab and Cram scores; see Table 4-20. The SoCal and Contra Costa B-IBI scores were very well correlated, and each B-IBI was slightly correlated with the D-18 algae IBI. The two habitat composite scores (PHab and CRAM) were well correlated with each other. However, the biological metrics were in most cases not correlated with either the PHab or CRAM composites; only the D-18 algae IBI was slightly correlated with the CRAM scores.

This was further investigated by comparing the SoCal B-IBI scores with the individual CRAM attributes scores (i.e., riparian buffer, hydrology, physical structure and biotic structure), with similar statistical results. Those comparisons are presented graphically in Figure 4-2.

This analysis suggests that physical habitat characteristics and riparian condition are not the primary drivers for biological health at these sites. However, additional CRAM and benthic macro invertebrate (BMI) data collection across a wider range of sites in Contra Costa County watersheds would be needed to better evaluate the relationship between riparian and biological conditions.

Other factors may be responsible for the responsible for the low benthic IBI scores derived from the observed BMI taxonomy at the monitored s120

ites, including water and sediment chemistry data, as discussed below. For one or more sites, factors such as temperature anomalies may be relevant, as discussed in the local/targeted creek status report (ADH, 2016).

**Table 4-20. Statistical Comparisons of Biological Condition and Habitat Metrics for CCCWP Bioassessment Sites Monitored in WY 2015**

| Metrics Compared | Correlation Coefficient | Coefficient of Determination ($R^2$) |
|---|---|---|
| SoCal B-IBI:Contra Costa B-IBI | 0.97 | 0.94 |
| SoCal B-IBI:D-18 A-IBI | 0.27 | 0.07 |
| Contra Costa B-IBI:D-18 A-IBI | 0.36 | 0.13 |
| SoCal B-IBI:PHab | -0.05 | 0.002 |
| Contra Costa B-IBI:PHab | 0.05 | 0.003 |
| D-18 A-IBI:PHab | -0.12 | 0.02 |
| SoCal B-IBI:CRAM | -0.07 | 0.004 |
| Contra Costa B-IBI:CRAM | -0.008 | 0.00006 |
| D-18 A-IBI:CRAM | -0.22 | 0.05 |
| PHab:CRAM | 0.78 | 0.61 |

The following graphs show the coefficients of determination between CRAM component scores and SoCal B-IBI scores at ten Contra Costa bioassessment sites during WY15.

**Figure 4-2. SoCal B-IBI vs. Buffer Metric CRAM Score for CCCWP Bioassessment Sites Monitored in WY 2015**

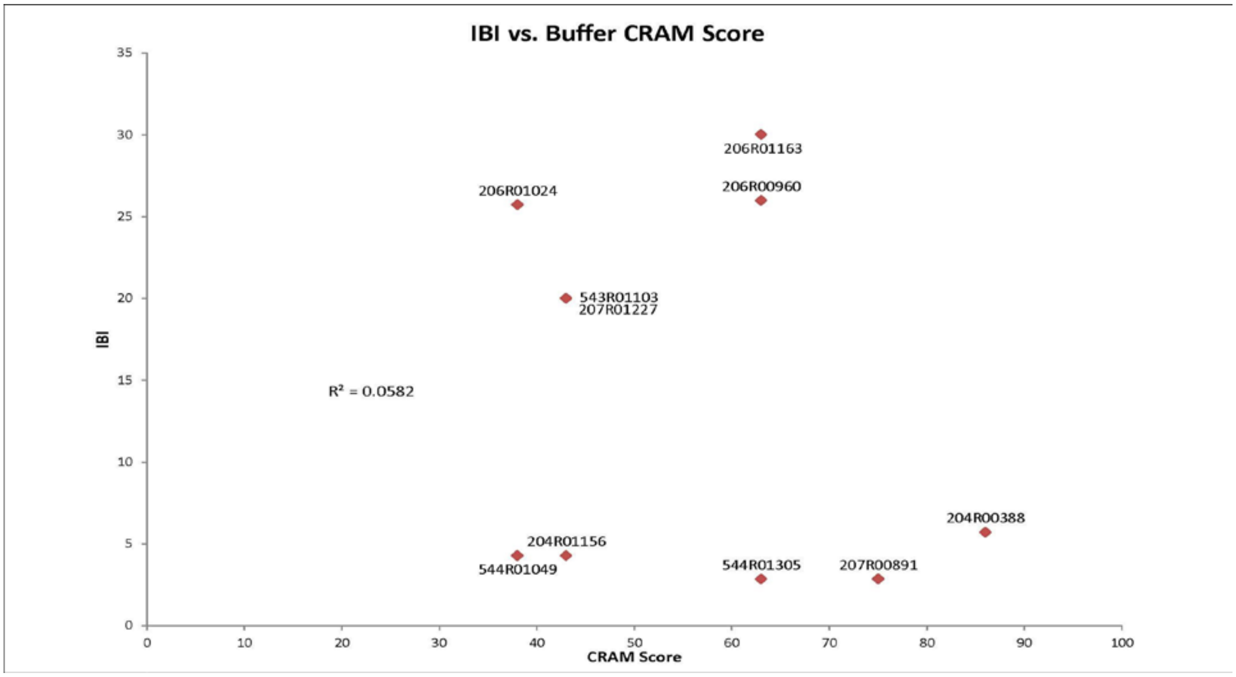


**Figure 4-3. SoCal B-IBI vs. Hydrology Metric CRAM Score for CCCWP Bioassessment Sites Monitored in WY 2015**

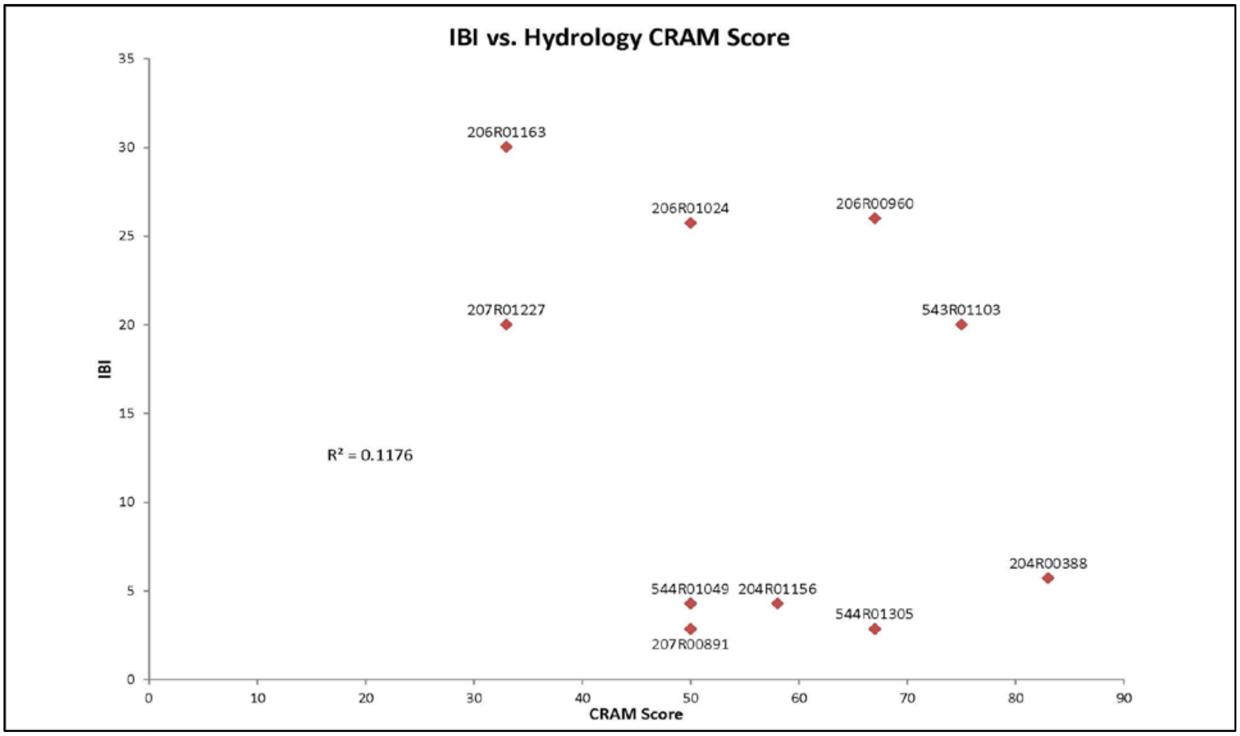



**Figure 4-4. SoCal B-IBI vs. Physical Metric CRAM Score for CCCWP Bioassessment Sites Monitored in WY 2015**

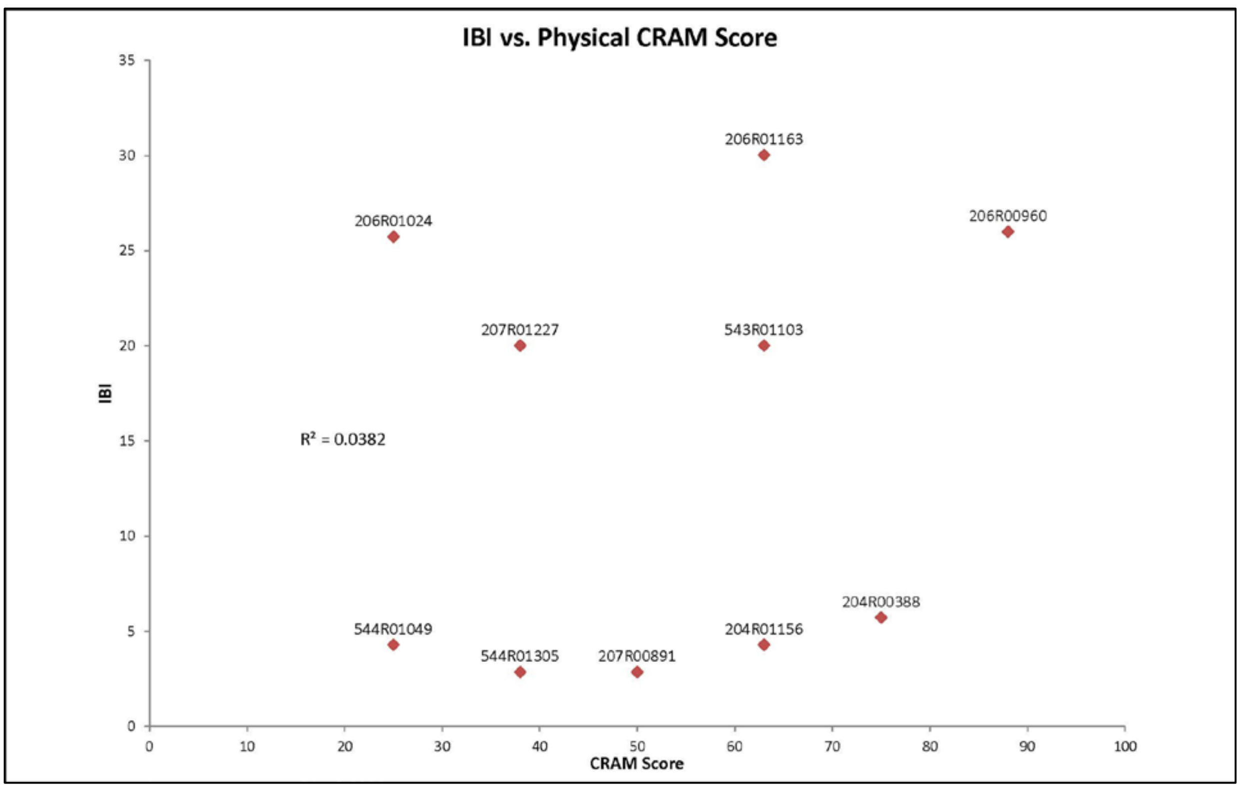


**Figure 4-5. SoCal B-IBI vs. Biotic Metric CRAM Score for CCCWP Bioassessment Sites Monitored in WY 2015**

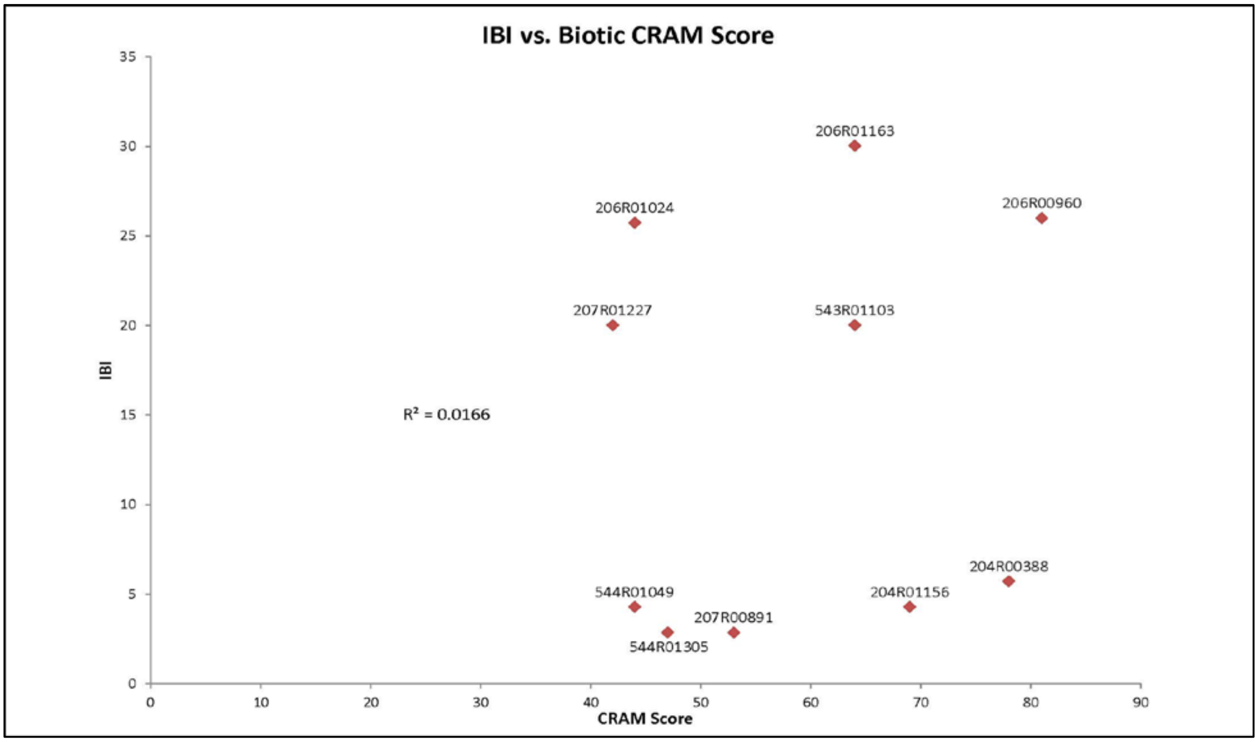
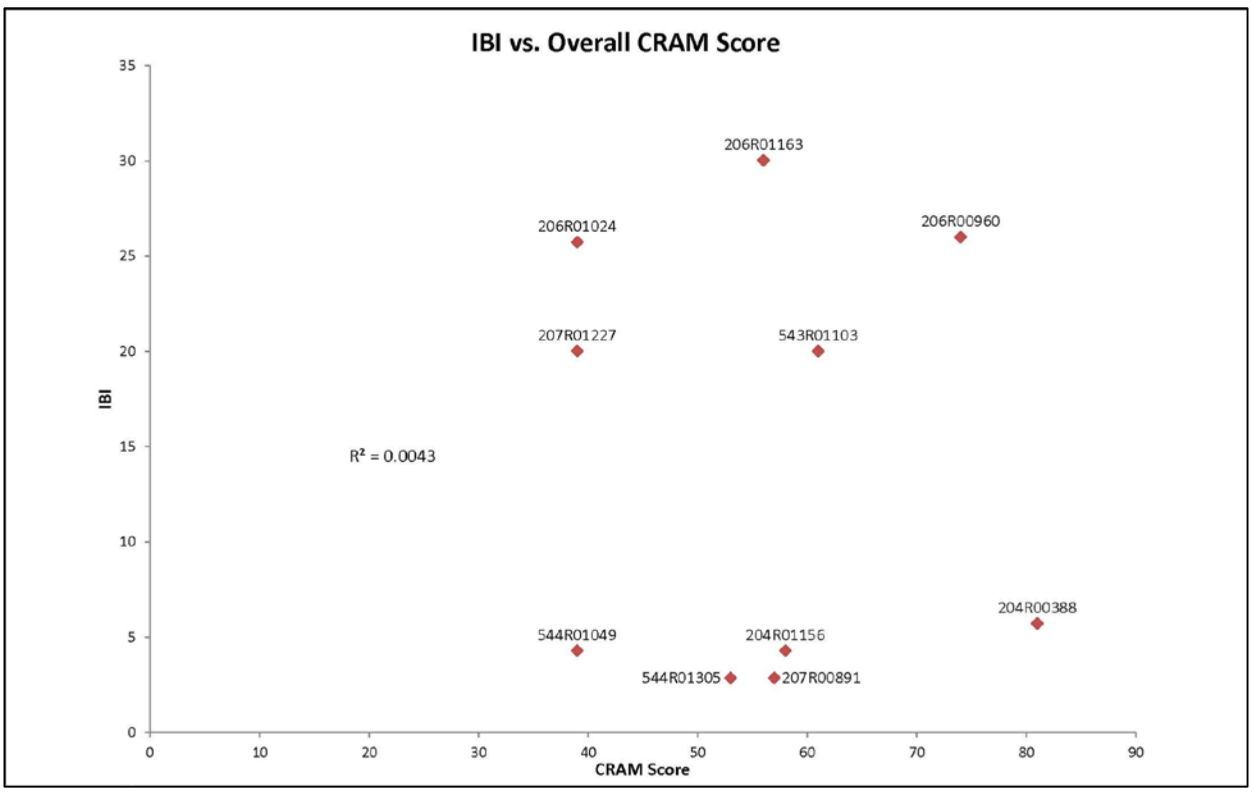



**Figure 4-6. SoCal B-IBI vs. Overall CRAM Score for CCCWP Bioassessment Sites Monitored in WY 2015**



#### 4.3.2.2 Water Chemistry Parameters

According to Permit 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"; SFBRWQCB, 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 Permit Table 8.1), water quality standards or established thresholds are available only for ammonia (unionized form), chloride, and nitrate plus nitrite – the latter for waters with MUN beneficial use only, as indicated in Table 4-21.

For ammonia, the standard provided in the Basin Plan (SFBRWQCB, 2013; section 3.3.20) 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,[10] 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)[11] for the protection of aquatic life were used for comparison purposes.[12]

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.

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

[11] 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.

[12] Per the WY 2012 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 4-21. Water Quality Thresholds Available for Comparison to WY 2015 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 |
| 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; 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 |

The comparisons of the measured nutrients data to the thresholds listed in Table 4-20 are shown in Table 4-22. There were no exceedances of the applicable criteria; therefore the MRP Table 8.1 trigger for "Water Quality (Nutrients)" (20% of results in one water body exceed one or more water quality standards or applicable thresholds) was not exceeded at any of the 10 sites monitored in WY 2015.

**Table 4-22. Comparison of Water Quality ("nutrient") Data to Associated Water Quality Thresholds for WY 2015 Water Chemistry Results**

| Site Code | Creek Name | MUN | Parameter and Threshold | | | # of Parameters >Threshold/ Water Body | % of Parameters >Threshold/ Water Body [4] |
|---|---|---|---|---|---|---|---|
| | | | Un-ionized Ammonia (as N) | Chloride | Nitrate + Nitrite (as N) | | |
| | | | 25 µg/L | 230/250 mg/L [1] | 10 mg/L [2] | | |
| 204R00388 | W Branch Alamo Creek | | 0.43 | 42 | 0.01 | 0 | 0% |
| 204R01156 | Trib. of Alamo Creek | | 0.75 | 59 | 0.04 | 0 | 0% |
| 206R00960 | Rodeo Creek | | 0.52 | 150 | 0.32 | 0 | 0% |
| 206R01024 | Rodeo Creek | | 1.43 | 96 | 0.008 | 0 | 0% |
| 207R00891 | Green Valley Creek | | 1.88 | 58 | 0.123 | 0 | 0% |
| 207R01163 | San Ramon Creek | | 8.70 | 50 | 0.0075 | 0 | 0% |
| 207R01227 | San Ramon Creek | | 12.0 | 53 | 0.01 | 0 | 0% |
| 543R01103 | W Antioch Creek | | 2.0 | 170 | 1.00 | 0 | 0% |
| 544R01049 | Dry Creek | | 3.04 | 200 | 0.18 | 0 | 0% |
| 544R01305 | Marsh Creek | | 1.86 | 120 | 0.07 | 0 | 0% |
| # Values >Threshold: | | | 0 | 0 | 0 | 0 | 0% |
| % Values >Threshold: | | | 0% | 0% | 0% | | |

[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
[4] Nitrate+nitrite threshold does not apply, as none of the sampled creeks have MUN beneficial use
NA = threshold does not apply
Shaded value indicates threshold exceeded.

#### 4.3.2.3 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 4-23. The MRP trigger criterion for chlorine states, "After immediate resampling, concentrations remain >0.08 mg/L."

Of the 10 measurements collected, only one (10%) exceeded the threshold for free chlorine and total chlorine, at site 206R00960, Rodeo Creek. The initial results for that site were immediately confirmed in the field.

The results obtained at that site are perplexing, as the free chlorine should not read higher than total chlorine. This phenomenon has occasionally been observed by RMC Program field crews in the past, but the discrepancy in this case is particularly troublesome. It is not known what could cause this apparent incongruity, and this remains an unsolved QA/QC issue.

**Table 4-23. Summary of Chlorine Testing Results for Samples Collected in WY 2015 in Comparison to Municipal Regional Permit Trigger Criteria**

| Site Code | Creek Name | Sample Date | Chlorine, Free | Chlorine, Total | Exceeds Trigger Threshold? |
|---|---|---|---|---|---|
| 204R00388 | W Branch Alamo Creek | 05/06/15 | 0 | 0 | |
| 204R01156 | Trib. of Alamo Creek | 05/06/15 | 0 | 0 | |
| 206R00960 | Rodeo Creek | 04/22/15 | 0.16* | 0.04* | Yes |
| 206R01024 | Rodeo Creek | 05/05/15 | 0.02 | 0.06 | |
| 207R00891 | Green Valley Creek | 04/22/15 | 0.04 | 0.04 | |
| 207R01163 | San Ramon Creek | 05/04/15 | 0 | 0 | |
| 207R01227 | San Ramon Creek | 05/04/15 | 0.02 | 0.02 | |
| 543R01103 | W Antioch Creek | 04/21/15 | 0 | 0 | |
| 544R01049 | Dry Creek | 04/20/15 | 0 | 0 | |
| 544R01305 | Marsh Creek | 04/23/15 | 0 | 0 | |
| Number of samples exceeding 0.08 mg/L: | | | 1 | 0 | |
| Percentage of samples exceeding 0.08 mg/L: | | | 10% | 0% | |

NR = not recorded
Bolded value exceeds trigger criterion
*Re-test in field confirmed result

#### 4.3.2.4 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 4-24 for WY 2015 samples that registered statistically significant toxicity.

Three test results (all for *H. azteca*) met the Permit Table 8.1 trigger criterion for water column toxicity, which 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.."

In WY 2015 only the chronic test result for *H. azteca* from the Green Valley Creek sample met the corresponding sediment toxicity trigger threshold (MRP Attachment H, Central Valley Permit Attachment D); sample result is more than 20% less than the Control).

This evidence of toxic conditions in both Rodeo Creek and Green Valley Creek during wet weather conditions, and in Green Valley Creek sediments during dry weather, indicates that chemical stressors may be contributing to degraded biological conditions in these two creeks. By extension, these toxicity testing results potentially point to similar conditions in other creeks with sub-par biological conditions.

**Table 4-24. Overall Summary of WY 2015 Aquatic and Sediment Toxicity Samples with Toxic Response in Comparison to Permit Trigger Criteria**

| Site Code | Creek Name | Sample Collection Date | Species Tested | Test Regimen | Meets Table 8.1 (Water) or Table H-1 (Sediment) Trigger Criteria? |
|---|---|---|---|---|---|
| Water | | | | | |
| 206R01024 | Rodeo Creek | 02/06/15 | *H. azteca* | Acute (survival) | Yes (<50% of control) |
| 207R00891 | Green Valley Creek | 02/06/15 | *H. azteca* | Acute (survival) | Yes (<50% of control) |
| 206R01024 | Rodeo Creek | 04/07/15 | *H. azteca* | Acute (survival) | No (not <50% of control) |
| 207R00891 | Green Valley Creek | 04/07/15 | *H. azteca* | Acute (survival) | Yes (<50% of control) |
| 206R01024 | Rodeo Creek | 07/07/15 | *H. azteca* | Acute (survival) | No (not <50% of control) |
| Sediment | | | | | |
| 207R00891 | Green Valley Creek | 07/07/15 | *H. azteca* | Acute (survival) | No (not more than 20% less than the control) |
| 207R00891 | Green Valley Creek | 07/07/15 | *H. azteca* | Chronic (Biomass/Growth) | Yes (more than 20% less than the control) |

#### 4.3.2.5 Sediment Chemistry Parameters

Sediment chemistry results are evaluated as potential stressors in three ways, based upon the following criteria from MRP Table H-1 (Central Valley Permit Table D-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.[13]
- 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. 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

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

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. For the Total PAHs calculations, the non-detected PAHs were included in the sum at a concentration equal to ½ the MDL. Otherwise, TEC and PEC ratios were not calculated for constituents that were reported as non-detect.

Table 4-25 provides TEC quotients for all non-pyrethroid sediment chemistry constituents, calculated as the ratio of 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, per the Permit Table H-1/Table D-1 threshold.

Table 4-25 also provides PEC quotients for all non-pyrethroid sediment chemistry constituents, calculated as the ratio of the measured concentration divided by the PEC value, per MacDonald et al. (2000). This table also provides calculated mean values of the PEC quotients for each site, for identification of any sites with a mean PEC quotient greater than or equal to 0.5, per the Permit Table H-1/Table D-1 threshold.

The Rodeo Creek sediment sample exhibited one TEC ratio higher than 1; for the constituent nickel. The Green Valley Creek sample had TEC quotients higher than one for nickel, DDEs, and Total DDTs (which includes the sum of all DDDs, DDEs, and DDTs; the “Total DDTs” TEC value of 1.21 for Green Valley Creek derives from detected concentrations of DDD and DDE; DDT itself was not detected in the sample). The Green valley Creek sample results therefore meet the relevant trigger criterion from MRP Table H-1 (Central Valley Permit Table D-1), which is interpreted to stipulate three or more constituents with TEC quotients greater than or equal to 1.0 in a given sample.

Neither site met the MRP Table H-1 (Central Valley Permit Table D-1) action criterion for PECs consisting of a mean PEC greater than 0.5.

**Table 4-25. Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) Quotients for WY 2015 Sediment Chemistry Constituents**

| | | Site 206R01024 | | | Site 207R00891 | | |
|---|---|---|---|---|---|---|---|
| | | Rodeo Creek | | | Green Valley Creek | | |
| Metals | Sample Units* | Sample | TEC Ratio | PEC Ratio | Sample | TEC Ratio | PEC Ratio |
| Arsenic | mg/Kg | 5.8 | 0.59 | 0.18 | 5.4 | 0.55 | 0.16 |
| Cadmium | mg/Kg | 0.52 | 0.53 | 0.10 | 0.17 | 0.17 | 0.03 |
| Chromium | mg/Kg | 17 | 0.39 | 0.15 | 22 | 0.51 | 0.20 |
| Copper | mg/Kg | 16 | 0.51 | 0.11 | 24 | 0.76 | 0.16 |
| Lead | mg/Kg | 9.3 | 0.26 | 0.07 | 13 | 0.36 | 0.10 |
| Mercury | mg/Kg | 0.056 | 0.31 | 0.05 | 0.054 | 0.30 | 0.05 |
| Nickel | mg/Kg | 28 | 1.23 | 0.58 | 24 | 1.06 | 0.49 |
| Zinc | mg/Kg | 70 | 0.58 | 0.15 | 110 | 0.91 | 0.24 |
| *Pesticides* | | | | | | | |
| Chlordane | ng/g | ND | | | ND | | |
| Dieldrin | ng/g | ND | | | ND | | |
| Endrin | ng/g | ND | | | ND | | |
| Heptachlor Epoxide | ng/g | ND | | | ND | | |
| Lindane (gamma-BHC) | ng/g | ND | | | ND | | |
| Sum DDD | ng/g | ND | | | 2.8 | 0.57 | 0.10 |
| Sum DDE | ng/g | ND | | | 3.6 | 1.14 | 0.12 |
| Sum DDT | ng/g | ND | | | ND | | |
| Total DDTs | ng/g | ND | | | 6.4 | 1.21 | 0.01 |
| *PAHs* | | | | | | | |
| Anthracene | ng/g | ND | | | ND | | |
| Fluorene | ng/g | ND | | | ND | | |
| Naphthalene | ng/g | 5.4 | 0.03 | 0.01 | 4.4 | 0.03 | 0.01 |
| Phenanthrene | ng/g | 22 | 0.11 | 0.02 | ND | | |
| Benz(a)anthracene | ng/g | 22 | 0.20 | 0.021 | ND | | |
| Benzo(a)pyrene | ng/g | 65 | 0.43 | 0.045 | ND | | |
| Chrysene | ng/g | 65 | 0.39 | 0.05 | ND | | |
| Fluoranthene | ng/g | ND | | | ND | | |
| Pyrene | ng/g | ND | | | 11 | 0.06 | 0.01 |
| Total PAHs** | ng/g | 441.0 | 0.27 | 0.019 | 163 | 0.10 | 0.01 |
| Number with TECq ≥ 1.0: | | | 1 | | | 3 | |
| COMBINED TEC RATIOS | | | 5.8 | | | 7.7 | |
| AVERAGE TEC RATIO | | | 0.42 | | | 0.55 | |
| COMBINED PEC RATIOS | | | | 1.56 | | | 1.69 |
| AVERAGE PEC RATIO | | | | 0.11 | | | 0.12 |

Note: Yellow-highlighted cell indicates result exceeds Permit trigger threshold
* All measurements reported as dry weight
** Total PAHs include 24 individual PAH compounds; NDs were substituted at 1/2 MDL to compute total
ND = not detected

Table 4-26 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 organic carbon-normalized pyrethroid concentrations. Therefore, the pyrethroid concentrations as reported by the lab were divided by the measured TOC concentration (as a percentage) at each site, and the TOC-normalized concentrations were then used to compute TU equivalents for each pyrethroid, based on the published LC50 values. (TOC was measured at 2.4% for Rodeo Creek and 3.4% for Green Valley Creek.) The individual TU equivalents were then summed to produce a total pyrethroid TU equivalent value for each site.

Several pyrethroid pesticides were detected at each of the two WY 2015 monitoring sites, and in the case of Green Valley Creek, the summed TU quotient was greater than 1.0, as shown in Table 4-26. Therefore the Green Valley Creek site met the Permit Table H-1 action criterion of a TU quotient greater than or equal to 1.0. At a calculated TU equivalent of 0.90, the common urban pyrethroid pesticide bifenthrin contributed the vast majority of the overall 1.11 TU equivalent in Green Valley Creek.

**Table 4-26. Calculated Pyrethroid Toxic Unit Equivalents, WY 2015 Sediment Chemistry Data**

| Pyrethroid pesticides | LC50 (µg/g organic carbon) | 206R01024 Rodeo Creek | | | 207R00891 Green Valley Creek | | |
|---|---|---|---|---|---|---|---|
| | | Sample (ng/g) | Sample (µg/g organic carbon) | TU Equiv. | Sample | Sample (µg/g organic carbon) | TU Equiv. |
| Bifenthrin | 0.52 | 2.7 | 0.11 | 0.22 | 16 | 0.47 | 0.90 |
| Cyfluthrin | 1.08 | 0.72 | 0.03 | 0.028 | 1.1 | 0.032 | 0.03 |
| Cyhalothrin, lambda | 0.45 | 0.16 | 0.007 | 0.015 | 0.5 | 0.015 | 0.03 |
| Cypermethrin | 0.38 | 0.21 | 0.009 | 0.023 | ND | | |
| Deltamethrin/Tralomethrin | 0.79 | 0.68 | 0.03 | 0.036 | 3.7 | 0.109 | 0.14 |
| Esfenvalerate/Fenvalerate | 1.54 | ND | | | ND | | |
| Permethrin | 10.8 | 1.45 | 0.06 | 0.006 | 0.91 | 0.027 | 0.002 |
| Sum (Pyrethroid TUs): | | | | 0.32 | | | 1.11 |

Notes: Yellow-highlighted cell indicates result exceeds Permit trigger threshold
Toxic Unit Equivalents (TUs) are calculated as ratios of measured pyrethroid concentrations to literature *Hyalella azteca* LC50 values.
See: http://www.tdcenvironmental.com/resources/Pyrethroids-Aquatic-Tox-Summary.pdf for associated references.

The results of the calculations of TEC quotients and pyrethroid pesticide toxic unit equivalents at the Green Valley Creek monitoring site provide evidence of specific chemical stressors that may be impacting creek water quality; the identified pollutants (nickel, DDD, DDE, and pyrethroid pesticides, particularly bifenthrin) represent potential stressors contributing to degraded biological conditions in this creek.

### 4.3.2.6 Sediment Triad Analysis

Table 4-27 summarizes stressor evaluation results for those sites with data collected for sediment chemistry, sediment toxicity, and bioassessment parameters by CCCWP, over the first four years of the RMC regional/probabilistic monitoring effort (WY 2012-2015). Biological condition assessments are shown using a provisional regional consensus approach based on the SoCal B-IBI. The sediment triad results are evaluated with respect to MRP Table H-1 (Central Valley Permit Table D-1) to determine whether any follow-up actions are required (see "Key to Next Steps, below). For the WY 2015 results, follow-up action is required to identify the cause(s) and spatial extent of the impacts identified in the sediment triad analysis for Green Valley Creek, and where the impacts are under the Permittees' control, to take management actions to address impacts.

**Table 4-27. Summary of Sediment Quality Triad Evaluation Results, WY 2012 - WY 2015 Data**

| Water Year | Water Body | 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* |
|---|---|---|---|---|---|---|---|---|
| 2012 | Grayson Creek | 207R00011 | Very Poor | Yes | 10 | 0.14 | 2.17 | C |
| 2012 | Dry Creek | 544R00025 | Very Poor | Yes | 11 | 0.51 | 3.62 | C |
| 2013 | Sycamore Creek | 207R00271 | Very Poor | Yes | 0 | 0.04 | 10.5 | C |
| 2013 | Marsh Creek | 544R00281 | Very Poor | Yes | 4 | 0.13 | 1.03 | C |
| 2014 | San Pablo Creek | 206R00551 | Very Poor | No | 1 | 0.09 | .016 | |
| 2014 | Grizzly Creek | 207R00843 | Very Poor | No | 1 | 0.12 | .11 | |
| 2015 | Rodeo Creek | 206R01024 | Poor | No | 1 | 0.11 | 0.32 | |
| 2015 | Green Valley Creek | 207R00891 | Very Poor | Yes | 3 | 0.12 | 1.11 | C |
| Note: yellow-highlighted cells indicate results exceed Permit trigger threshold | | | | | | | | |

***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 identify cause and spatial extent.<br>(3) Where impacts are under Permittee's control, take management actions to minimize upstream sources. |

While MacDonald et al. (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 published PECs as to their ability to predict 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, the MacDonald et al. (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 eight samples evaluated by CCCWP during WY 2012-2015, a single sample exceeded the mean PEC criterion of 0.5; significant toxicity was reported associated with this sample (Table 4-27). For the four samples in which more three or more analytes exceeded associated TECs in Contra Costa County during WY 2012-2015, statistically significant sediment toxicity was reported in all four samples.

When examining pyrethroids 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). However, all five CCCWP samples with calculated pyrethroid TU equivalents greater than 1.0 (ranging from 1.03 to 10.5 TU equivalents) during WY 2012-2015 exhibited significant sediment toxicity. The three samples with TU equivalents less than one (ranging from 0.016 to 0.32 TU equivalents) did not exhibit sediment toxicity.

# 5. Conclusions and Next Steps

During WY 2015, 10 sites were monitored by CCCWP under the RMC regional probabilistic design for bioassessment, physical habitat, and water chemistry parameters. Two 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. The bioassessment and related data are also used 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.

Based upon the bioassessment results (principally B-IBI scores for benthic macroinvertebrate taxonomy), some of the sites monitored in WY 2015 may be degraded from the standpoint of aquatic life beneficial uses. Further evidence of the apparent impacts on aquatic life beneficial uses are provided by the findings of aquatic toxicity at the Rodeo Creek site (site code 206R01024), and the findings of both aquatic and sediment toxicity at the Green Valley Creek site (site code 207R00891). The sediment chemistry testing results indicate that there are several chemical stressors potentially causing the observed sediment toxicity in Green Valley Creek. The analysis of the sediment triad results (bioassessment, sediment chemistry, sediment toxicity) indicates that the Green Valley Creek site warrants follow-up investigation and management actions to address the apparent impacts.

Candidate probabilistic sites classified with unknown sampling status as of WY 2015 may continue to be evaluated for potential sampling in WY 2016.

## 5.1 Summary of Stressor Analyses

The stressor analysis is summarized as follows, based on an analysis of the regional/probabilistic data collected by CCCWP during WY 2015:

- **Physical Habitat Conditions –** the lack of correlation between physical habitat parameters (PHab scores, CRAM scores) and biological condition indices (SoCal and Contra Costa B-IBI scores) minimizes the usefulness of these parameters in evaluating biological conditions in the urban creeks monitored in Contra Costa County during WY 2015. Additional, more comprehensive, regional investigation of these factors is warranted.

- **Water Quality –** Of 11 water quality parameters[14] required in association with bioassessment monitoring, applicable water quality standards were only identified for ammonia, chloride, and nitrate + nitrite (for sites with MUN beneficial use only). None of the results generated at the 10 sites monitored by CCCWP for those three parameters during WY 2015 exceeded the applicable water quality standard or threshold. The MRP Table 8.1 trigger threshold for “Nutrients” (i.e., 20% of results in one water body exceed one or more water quality standards or applicable thresholds) was therefore not exceeded at any of the monitored sites.

- **Water Toxicity –** Toxicity testing was performed for four test species in water samples collected by CCCWP from two sites, during one wet weather event and one dry season event in WY 2015. Samples collected during the wet weather monitoring event (2/6/2015) from both the Rodeo

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

Creek (site code 206R01024) and Green Valley Creek (site code 207R00891) sites exhibited significant acute toxicity (reduction in survival) to *H. azteca*. Both of those toxicity test results met the Permit Table 8.1 threshold (<50% of the Control value) for follow-up action, and an additional set of samples was collected during a subsequent rain event on 4/7/2015. Again, both samples were acutely toxic to *H. azteca*, but in the April tests only the Green Valley Creek sample met the 50% Permit Table 8.1 threshold. During the summer aquatic toxicity tests, the Rodeo Creek sample was determined to be statistically different from the Control for the acute *H. azteca* test. That sample, at 94% survival for *H. azteca*, did not trigger the Permit Table 8.1 threshold.

- **Sediment Toxicity –** Bedded sediment samples collected from the same two sites on Rodeo Creek and Green Valley Creek on 7/7/2015 were tested for acute and chronic toxicity. The Rodeo Creek sample was not toxic to the test species (*H. azteca*), but the Green Valley Creek sample was toxic to *H. azteca* for both the acute and chronic endpoints. Only the chronic test result (growth as measured by organism biomass) met the MRP Table H-1 (Central Valley Permit Table D-1) criterion (more than 20% less than the Control).

- **Sediment Chemistry –** Bedded sediment samples were collected from the same two sites on Rodeo Creek and Green Valley Creek on 7/7/2015 and analyzed for a suite of sediment chemistry constituents. Analytical results produced similar evidence of potential stressors as did samples analyzed in WY 2012 and 2013, based on the criteria from MRP Table H-1 (Central Valley Permit Table D-1). The Green Valley Creek sediment sample resulted in three constituents with TEC quotients greater than 1.0 (nickel[15], DDEs, and "Total DDTs"[16]), and a sum of TU equivalents for measured pyrethroids greater than 1.0 (1.11). The pyrethroid pesticide bifenthrin was found in both creek sediment samples, but not at levels expected to cause toxicity to test organisms. The Rodeo Creek site did not trigger any of the sediment chemistry criteria.

- **Sediment Triad Analyses –** bioassessment, sediment toxicity, and sediment chemistry results were evaluated as the three lines of evidence used in the triad approach for assessing overall stream condition. For the Green Valley Creek site, follow-up action is required based on the triad analysis: low bioassessment score, evidence of sediment toxicity to *H. azteca*, and sediment chemistry analysis pertaining to TEC equivalents and pyrethroid pesticide toxic unit equivalents.

The recurring findings of aquatic and sediment toxicity indicate that chemical stressors may be present that are impacting stream water quality for the monitored locations. The sediment triad analyses from WY 2012-2015 indicate that pyrethroid pesticides may be causing sediment toxicity. In samples exhibiting significant sediment toxicity, other pollutants are present at elevated concentrations as well; in WY 2015, those pollutants included nickel, DDD, and DDE. The chemical stressors may in turn be contributing to the degraded biological conditions indicated by the low B-IBI scores in many of the monitored streams.

## 5.2 Next Steps

The analysis presented in this and previous reports has identified a number of potentially impacted sites that may deserve further evaluation and/or investigation, to provide better understanding of the

[15] During WY 2012-2014 most sites also exceeded the TEC value for nickel in sediment, and some chromium concentrations in sediment also exceeded TEC values. Considering that both metals are naturally occurring at relatively high levels in Bay Area soils, and concentrations generally also exceed TEC values in reference or non-urban sites, TEC values presented in MacDonald et al. (2000) for those metals may not be appropriate for Bay Area creeks. These observations should be considered in future evaluations of sediment chemistry data collected by RMC participants in Bay Area creeks.

[16] Per MacDonald et al., 2000, "Total DDTs" includes isometric variants of DDD, DDE, and DDT

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. For CCCWP, this involves two projects designed to evaluate and further characterize causes of toxicity impacting urban creek systems, specifically Grayson Creek (Region 2) and Dry Creek (Region 5). A summary of CCCWP's SSID projects is included in the WY 2015 UCMR, and the report detailing the results of the second year of those investigations (SSID Project Part B) is included as an attachment to the UCMR.

CCCWP and the other RMC participants will continue to implement the regional probabilistic monitoring design in Water Year 2016, under the terms of the newly-adopted MRP 2 (effective Jan. 1, 2016). Site evaluation and sampling are planned at new sites for WY 2016, as well as further investigations as required to complete the evaluation of trigger thresholds per Permit requirements.

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# Appendix 2

Local/Targeted Creek Status Monitoring Report, Water Year 2015

CONTRA COSTA
CLEAN WATER
PROGRAM

# Local/Targeted Creek Status Monitoring Report Water Year 2015

***(October 2014 – September 2015)***

***Submitted to the San Francisco Bay and Central Valley Regional Water Quality Control Boards in Compliance with NPDES Permit Provisions C.8.g.iii***

***NPDES Permit Nos. CAS612008 and CAS083313***

## *February 29, 2016*

***A Program of Contra Costa County, its Incorporated Cities/Towns and the Contra Costa Flood & Water Conservation District***

This report is submitted by the participating agencies of the

CONTRA COSTA CLEAN WATER PROGRAM

**Program Participants:**

- Cities/(Towns) of: Antioch, Brentwood, Clayton, Concord, Danville (Town), El Cerrito, Hercules, Lafayette, Martinez, Moraga (Town), Oakley, Orinda, Pinole, Pittsburg, Pleasant Hill, Richmond, San Pablo, San Ramon and Walnut Creek
- Contra Costa County
- Contra Costa County Flood Control & Water Conservation District


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# Preface

Contra Costa County lies within both the Region 2 and Region 5 jurisdictions of the State Water Resources Control Board. The county-wide stormwater program is subject to both the Region 2 Municipal Regional Stormwater National Pollutant Discharge Elimination System (NPDES) Permit (MRP)[1] and the equivalent Region 5 permit (Central Valley Permit)[2].

This Local/Targeted Creek Status Monitoring Report documents the results of targeted (non-probabilistic) monitoring performed by Contra Costa Clean Water Program (CCCWP) in Water Year (WY) 2015 (October 1, 2014 – September 30, 2015). Together with the creek status monitoring data reported in the Regional/Probabilistic Creek Status Monitoring Report (ARC, 2016; in preparation), this submittal fulfills monitoring requirements for Table 8.1 monitoring specified in Permit Provision C.8.c and complies with reporting Provision C.8.g of both the MRP (SWRCB 2009) and the Central Valley Permit.

In early 2010, several members of the Bay Area Stormwater Management Agencies Association (BASMAA) joined together to form the Regional Monitoring Coalition (RMC) to coordinate and oversee water quality monitoring required by the MRP. The RMC includes the following stormwater program participants:

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

In accordance with the RMC Creek Status and Long-Term Trends Monitoring Plan (EOA and ARC, 2011), targeted monitoring data were collected following methods and protocols specified in the BASMAA RMC Quality Assurance Program Plan (QAPP; BASMAA, 2014a) and BASMAA RMC Standard Operating Procedures (BASMAA, 2014b). Where applicable, monitoring data were derived using methods comparable with methods specified by the California Surface Water Ambient Monitoring Program (SWAMP) QAPP[3]. Data presented in this report also were submitted to the San Francisco Estuary Institute for submittal to the State Water Resources Control Board (SWRCB) on behalf of CCCWP's permittees and pursuant to Permit Provision C.8.g. requirements for electronic data reporting.

[1] The San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) issued the MRP to 76 cities, counties and flood control districts (i.e., Permittees) in the Bay Area on October 14, 2009 (SFBRWQCB, 2009). The BASMAA programs supporting MRP Regional Projects include all MRP Permittees, as well as the cities of Antioch, Brentwood, and Oakley, which are not named as Permittees under the MRP but have voluntarily elected to participate in MRP-related regional activities.
[2] The Central Valley Regional Water Quality Control Board (CVRWQCB) issued the East Contra Costa County Municipal NPDES Permit (Central Valley Permit, Order No. R5-2010-0102) on September 23, 2010 (CVRWQB 2010).
[3] The current SWAMP QAPP is available at: http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/qapp/swamp_qapp_master090108a.pdf

# List of Acronyms

| | |
|---|---|
| ACCWP | Alameda Countywide Clean Water Program |
| ADH | ADH Environmental |
| ARC | Armand Ruby Consulting |
| BASMAA | Bay Area Stormwater Management Agencies Association |
| BMI | Benthic macroinvertebrate |
| CCCCDP | Contra Costa County Community Development Department |
| CCCWP | Contra Costa Clean Water Program |
| CFU | Colony forming units |
| COLD | Cold water habitat |
| CRAM | California Rapid Assessment Method |
| CVRWQB | Central Valley Regional Water Quality Control Board |
| DO | Dissolved oxygen |
| EBMUD | East Bay Municipal Utility District |
| FSURMP | Fairfield Suisun Urban Runoff Management Program |
| GM | Geometric Mean |
| IBI | Index of Biotic Integrity |
| MPC | Monitoring and Pollutants of Concern Committee |
| MPN | Most Probable Number |
| MRP | Municipal Regional Permit |
| NPDES | National Pollution Discharge Elimination System |
| QAPP | Quality Assurance Project Plan |
| Region 2 | San Francisco Regional Water Quality Control Board |
| Region 5 | Central Valley Regional Water Quality Control Board |
| RMC | Regional Monitoring Coalition |
| RWQC | Recreational Water Quality Criteria |
| RWQCB | Regional Water Quality Control Board |
| SAP | Sampling and Analysis Plan |
| SCVURPPP | Santa Clara Valley Urban Runoff Pollution Prevention Program |
| SFBRWQCB | San Francisco Bay Regional Water Quality Control Board |
| SMCWPPP | San Mateo Countywide Water Pollution Prevention Program |
| SOP | Standard Operating Procedure |
| SSID | Stressor/Source Identification |
| STV | Statistical Threshold Value |
| SWAMP | Surface Water Ambient Monitoring Program |
| SWRCB | State Water Resources Control Board |
| USEPA | United States Environmental Protection Agency |
| WARM | Warm Water Habitat |
| WAMT | Weekly Average Maximum Daily Temperature |
| WQOs | Water Quality Objectives |
| WY | Water Year |

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# Executive Summary

This Local/Targeted Creek Status Monitoring Report documents the results of targeted monitoring performed by CCCWP during Water Year 2015 (WY 2015). Together with the creek status monitoring data reported in the Regional/Probabilistic Creek Status Monitoring Report, this submittal fulfills reporting requirements for status monitoring specified in Table 8.1 under Provision C.8.c of both the Municipal Regional Permit (MRP) for urban stormwater issued by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB; Order No. R2-2009-0074) and the East Contra Costa County Municipal NPDES Permit (Central Valley Permit) issued by the Central Valley Regional Water Quality Control Board (CVRWQCB; Order No. R5-2010-0102). Reporting requirements for Table 8.1 constituents are established in provision C.8.g.iii of both permits; both permits have nearly identical provisions to promote a coordinated countywide program of water quality management.

Within Contra Costa County, targeted monitoring was conducted at:

- Four continuous water temperature monitoring locations
- Two general water quality monitoring locations
- Five pathogen indicator monitoring locations
- Ten riparian assessment monitoring locations

***Continuous Water Temperature***

Hourly water temperature measurements were recorded using HOBO® data loggers (HOBOs®) deployed at four creeks on April 15, 2015. One device was deployed at each of the following locations: the West Branch of Alamo Creek, Green Valley Creek, San Ramon Creek, and San Pablo Creek. The HOBOs® were retrieved on October 3, 2015.

***General Water Quality***

Monitoring for temperature, dissolved oxygen (DO), pH, and conductivity was conducted using YSI continuous water quality recording equipment (Sondes). Sonde deployment location was adjacent to HOBO® data loggers within the West Branch of Alamo Creek and San Ramon Creek in Contra Costa County. The Sondes were deployed over two time periods at each creek in 2015: once during spring (April to May) and once during late summer (September).

***Pathogen Indicators***

Samples were collected by on June 30, 2015 at five stations along five separate creeks in Contra Costa County. Samples were analyzed for fecal coliform and *E. coli.* The five sampling locations were located at the West Branch of Alamo Creek, Green Valley Creek, San Ramon Creek, San Pablo Creek, and Walnut Creek.

***Riparian Assessments***

Assessments were conducted at 10 sites between September 14 and September 21 using the California Rapid Assessment Method (CRAM). CRAM assessments were conducted at the same locations that were monitored for bioassessment and other parameters under the RMC probabilistic design.

## Results of Targeted Monitoring Data

Targeted monitoring data, with the exception of CRAM results and specific conductivity, were evaluated against numeric water quality objectives (WQOs) or other applicable criteria, as described in Table 8.1 in the MRP and Central Valley Permit. The results are summarized below:

### *Temperature*

A weekly running average of maximum daily temperatures (WAMT[4]) of 20.5°C was used as the applicable criterion to evaluate temperature data. At the four stations with continuously recorded temperature from April until October, two stations (Green Valley Creek and San Ramon Creek) had results that exceeded the WAMT threshold. Of the two stations where general water quality measurements were monitored in the spring and fall of WY 2015, San Ramon Creek had temperature results that exceeded the WAMT threshold. Additionally, on May 15, 2015, a temperature spike with no natural explanation occurred at West Alamo Creek.

### *Dissolved Oxygen*

WQOs for dissolved oxygen in non-tidal waters are applied as follows: 7.0 mg/L minimum for waters designated as cold habitat (COLD) and 5.0 mg/L minimum for waters designated as warm water habitat (WARM). The threshold for evaluating dissolved oxygen data for the West Branch of Alamo Creek and San Ramon Creek was 5.0 mg/L as both creeks are classified as WARM. In the West Branch of Alamo Creek, 30 percent of dissolved oxygen concentrations were measured below the WARM threshold during the September deployment, exceeding the MRP Table 8.1 threshold. At San Ramon Creek during both deployments, there were no results that measured lower than the WARM threshold.

### *pH*

In the April-May monitoring period at San Ramon Creek, 30 percent of pH measurements were above this WQO. pH measurements at the West Branch of Alamo Creek did not exceed this WQO during either monitoring period.

### *Pathogen Indicator Bacteria*

Single sample maximum concentrations of 400 MPN/100ml fecal coliform (SFBRWQCB 2011) and 410 MPN/100ml *E. coli* (USEPA, 2012) were used as Water Contact Recreation evaluation criteria for the purposes of this evaluation. Samples for fecal coliform and *E.coli* at two of the five stations (Walnut Creek and San Pablo Creek) exceeded the maximum single sample concentrations.

All exceedances for all of the parameters above are summarized in the table below:

**Table ES.1 CCCWP Exceedances for Water Year 2015**

| Creek | Index Period | Parameter | Criterion Exceedance |
|---|---|---|---|
| Green Valley Creek | April 15 – May 27, 2015; July 17 - October 3, 2015 | Continuous Water Temperature | WAMT > 20.5°C more than 20% of samples (55%) |
| San Ramon Creek | April 15 – May 27, 2015; July 17 - October 3, 2015 | Continuous Water Temperature | WAMT > 20.5°C more than 20% of samples (74%) |
| West Branch of Alamo Creek | May 15, 2015 | Continuous Water Temperature | Temperature spike with no natural explanation |

[4] In the previous two CCCWP Local/Targeted Creek Status Monitoring Reports (ADH 2013 and ADH 2014), the term "MWAT" was used to define the temperature metric that was calculated to assess compliance with the selected 20.5°C temperature threshold. The term now used ("WAMT") more accurately describes the rolling 7-day (weekly) average of daily maximum temperatures that has been and continues to be computed for this purpose, and use of the new term is intended to avoid confusion with other metrics that use the term "MWAT". The computations and analysis of this 7-day metric are consistent in the CCCWP Local/Targeted Creek Status reports throughout the three years; only the naming of the term has changed to better reflect the definition of this compliance metric.

**Table ES.1 CCCWP Exceedances for Water Year 2015**

| Creek | Index Period | Parameter | Criterion Exceedance |
|---|---|---|---|
| West Branch of Alamo Creek | September 2-15, 2015 | General Water Quality - Dissolved Oxygen | Less than 5.0 mg/L (WARM criterion) more than 20% of samples (43%) |
| San Ramon Creek | April 21-May 1, 2015 | General Water Quality - Temperature | WAMT > 20.5°C more than 20% of samples (80%) |
| San Ramon Creek | April 21-May 1, 2015 | General Water Quality - pH | Less than 6.5 or more than 8.5 more than 20% of samples (30%) |
| San Ramon Creek | September 2-15, 2015 | General Water Quality - Temperature | WAMT > 20.5°C more than 20% of samples (75%) |
| Walnut Creek | September 30, 2015 | Fecal Coliform | Single grab sample exceeded Basin Plan WQO of 400 MPN/100ml (28000) |
| Walnut Creek | September 30, 2015 | E. Coli | Single grab sample exceeded USEPA criterion of 410 CFU/100m (28000) |
| San Pablo Creek | September 30, 2015 | Fecal Coliform | Single grab sample exceeded Basin Plan WQO of 400 MPN/100ml (1400) |
| San Pablo Creek | September 30, 2015 | E. Coli | Single grab sample exceeded USEPA criterion of 410 CFU/100m (1400) |

Applicable criteria have not been developed for CRAM. As a population, the CRAM scores were poorly correlated with benthic Index of Biological Integrity (IBI) for the ten bioassessment sites. This indication suggests that riparian condition is not the primary driver for biological health at many of the sites. However, it should be noted that the application of CRAM in urban creeks of the San Francisco Bay Region is relatively recent and results should be considered preliminary. Further analysis of existing data and additional information are needed to comprehensively evaluate the utility of CRAM data for assessing stream ecosystem health and aquatic life uses.

# 1.0 Introduction

Contra Costa County lies within the jurisdictions of both the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB; Region 2) and the Central Valley Regional Water Quality Control Board (CVRWQCB; Region 5). Municipal stormwater discharges in Contra Costa County are regulated by the requirements of both the Municipal Regional Permit (MRP) for urban stormwater in Region 2 (Order No. R2-2009-0074, superseded as of January 1, 2016 by Order No. R2-2015-0049), and the East Contra Costa County Municipal NPDES Permit (Central Valley Permit) in Region 5 (Order No. R5-2010-0102) [5,6]. This Local/Targeted Creek Status Monitoring Report documents the results of targeted (non-probabilistic) monitoring performed by CCCWP during Water Year (WY) 2015, and complies with reporting Provision C.8.g of both the Region 2 and Region 5 Municipal NPDES permits (MRP and Central Valley Permit; collectively referred to herein as the "Permit") for creek status monitoring data collected during WY 2015 (October 1, 2014 – September 30, 2015). Together with the creek status monitoring data reported in the Regional/Probabilistic Creek Status Monitoring Report, this submittal fulfills reporting requirements in both permits for Table 8.1 monitoring specified in Provision C.8.c.

Members of the Bay Area Stormwater Management Agencies Association (BASMAA) formed the Regional Monitoring Coalition (RMC) in early 2010 to collaboratively implement the monitoring requirements found in Provision C.8 of the MRP (see Table 1.1). The BASMAA RMC developed a Quality Assurance Program Plan (QAPP; BASMAA, 2014a), Standard Operating Procedures (SOPs; BASMAA, 2014b), data management tools, and reporting templates and guidelines. Costs for these activities are shared among RMC members on a population-weighted basis by direct contributions and provision of in-kind services by RMC members to complete required tasks. Participation in the RMC is facilitated through the BASMAA Monitoring and Pollutants of Concern Committee (MPC).

The goals of the RMC are to:

1. Assist RMC permittees in complying with requirements of MRP Provision C.8 (Water Quality Monitoring);
2. Develop and implement regionally consistent creek monitoring approaches and designs in the Bay Area, through improved coordination among RMC participants and other agencies (e.g., Regional Water Quality Control Boards, Regions 2 and 5, and the State Water Resources Control Water Board) that share common goals; and
3. Stabilize the costs of creek monitoring by reducing duplication of efforts and streamlining reporting.

The RMC divided the creek status monitoring requirements specified in MRP Table 8.1 into those parameters that reasonably could be included within a regional/probabilistic design, and those that, for logistical and jurisdictional reasons, should be implemented locally using a targeted (non-probabilistic) design. The monitoring elements included in each category are specified in Table 1.2.

[5] The San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) issued the five-year Municipal Regional Permit for Urban Stormwater (MRP, Order No. R2-2011-0083) to 76 cities, counties and flood control districts (i.e., Permittees) in the Bay Area on October 14, 2009 (SFBRWQCB, 2009). The BASMAA programs supporting MRP Regional Projects include all MRP Permittees as well as the cities of Antioch, Brentwood, and Oakley, which are not named as Permittees under the MRP but have voluntarily elected to participate in MRP-related regional activities. The MRP was revised and reissued as Order No. R2-2015-0049, effective January 1, 2016.

[6] The Central Valley Regional Water Quality Control Board (CVRWQCB) issued the East Contra Costa County Municipal NPDES Permit (Central Valley Permit, Order No. R5-2010-0102) on September 23, 2010 (CVRWQB, 2010).

**Table 1.1 Regional Monitoring Coalition Participants**

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

**Table 1.2 Creek Status Monitoring Parameters Monitored in Compliance with MRP Provision C.8.c. and the Associated Reporting Format**

| Monitoring Elements of MRP Provision C.8.c | Monitoring Design | | Reporting | |
|---|---|---|---|---|
| | Regional/ Probabilistic | Local/ Targeted | Regional | Local |
| Bioassessment & Physical Habitat Assessment | X | | X | |
| Chlorine | X | | X | |
| Nutrients | X | | X | |
| Water Toxicity | X | | X | |
| Sediment Toxicity | X | | X | |
| Sediment Chemistry | X | | X | |
| General Water Quality | | X | | X |
| Temperature | | X | | X |
| Bacteria | | X | | X |
| Stream Survey[1] | | X | | X |

[1] CRAM for Riverine Wetlands was used to fulfill the stream survey monitoring element listed in Table 8.1 in the MRP (SFBRWQCB, 2009) and Central Valley Permit (CVRWQCB, 2010), respectively.

This report focuses on the creek status and long-term trends monitoring activities that were conducted to comply with Provision C.8.c using a targeted (non-probabilistic) monitoring design (see Table 1.2). The results of the stream surveys (riparian assessments) are addressed in this report; as indicated in Table 1.2 they are nominally considered by the RMC to be a local/targeted monitoring element, but in WY 2015, as in WY2014, the surveys were conducted at probabilistic sites to satisfy the stream survey monitoring requirement in MRP Table 8.1.

The remainder of this report describes the study area and design (Section 2.0), monitoring methods (Section 3.0), results and discussion (Section 4.0) and next steps (Section 5.0).

# 2.0 Study Area and Design

## 2.1 Regional Monitoring Coalition Area

The RMC area encompasses 3,407 square miles of land in the San Francisco Bay Area. This includes the portions of the five participating counties that fall within the jurisdiction of the SFBRWQCB (Figure 2.1). Figure 2.2 illustrates the boundaries of State Water Resources Control Board (SWRCB), Regions 2 and 5 as well as the Contra Costa County delta boundaries[7]. The eastern portion of Contra Costa County drains to the CVRWQCB region (Region 5), while the rest of the county drains into Region 2. Status and trends monitoring is conducted in flowing water bodies (i.e., creeks, streams and rivers), interspersed among the RMC area, including perennial and non-perennial creeks and rivers that run through both urban and non-urban areas.

## 2.2 Contra Costa County Targeted Monitoring Areas and Siting Rationale

Contra Costa County has 31 major watersheds and sub-watersheds containing more than 1,300 miles of creeks and drainages (CCCDD, 2003). The County's creeks discharge into the Sacramento-San Joaquin delta in the east, along the series of bays to the north (including Suisun and San Pablo bays) and to North San Francisco Bay in the west. In addition, two watersheds originate in Contra Costa County and continue through Alameda County before reaching San Francisco Bay.

Walnut Creek and San Pablo Creek watersheds were the focus of the CCCWP's targeted sampling in WY 2015. In addition to these two large watersheds, targeted sampling was conducted in the Alamo Creek/ Tassajara Creek sub-watershed to Alameda Creek. All of the above watersheds were sampled for pathogen indicators and water temperature. In addition, stream surveys were conducted on segments of ten creeks and conveyances throughout the county using CRAM. Further details and discussion about the targeted sampling areas can be found in the Methods and Results sections of this report (Sections 3 and 4, respectively).

### 2.2.1 Upper Alameda Creek Watershed – Alamo/Tassajara Sub-Watershed (Region 2)

One of the largest watersheds in the Bay Area, the Alameda Creek Watershed, stretches from the Mt. Diablo foothills in the north, to Mount Hamilton in the south. A little less than a tenth of that watershed lies in Contra Costa County. In the Contra Costa County portion of the watershed, targeted monitoring was performed in the Alamo/Tassajara Creeks Sub-Watershed. This 26,390 acre watershed is predominantly natural with 97.1 percent of the 100.99 miles of channel containing no obvious reinforcements. Impervious surface in the Alamo/Tassajara Sub-Watershed is calculated at 10 percent (CCCDD, 2003). Targeted monitoring was focused around the urban areas within the Alamo/Tassajara Sub-Watershed.

Targeted monitoring was performed in the West Branch of Alamo Creek, which merges with the main stem of Alamo Creek and eventually South San Ramon Creek. The waters then enter the Alamo Canal and flow south into Alameda County to the Arroyo de la Laguna, and then into Alameda Creek. It is not known if Alamo Creek ever supported steelhead trout, but Leidy et al. (2005) reports there being no steelhead in the creek at present. The 2015 Basin Plan states that Alamo Creek has a "potential beneficial use" as a cold water fisheries (COLD) habitat, but its present designation is a warm water fisheries (WARM) aquatic habitat.

[7] Divide between the basin boundary watershed/hydrologic sub basins within the Sacramento-San Joaquin Rivers and Delta Waterways.

**Figure 2.1 Map of BASMAA RMC Area, County Boundaries and Major Creeks**

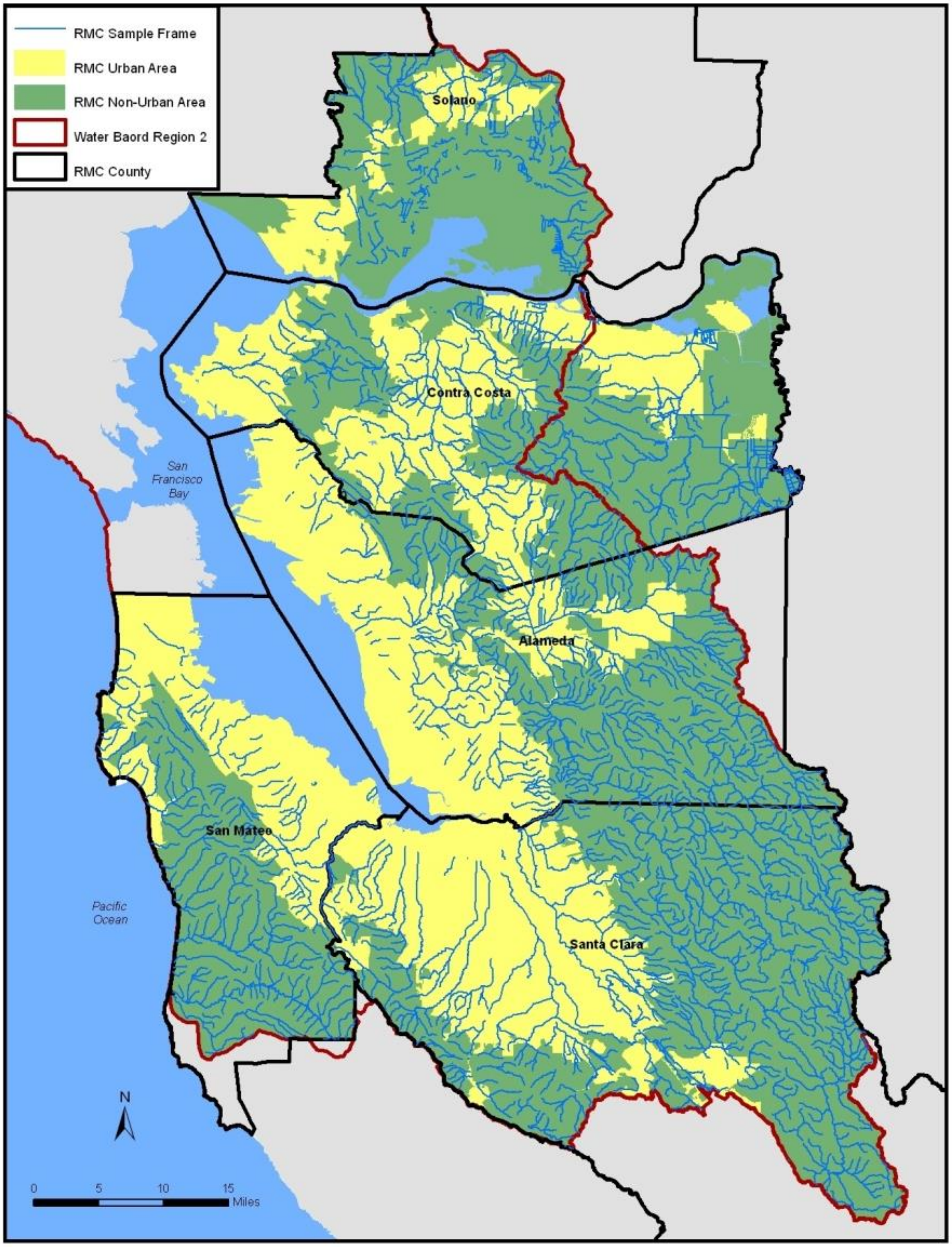
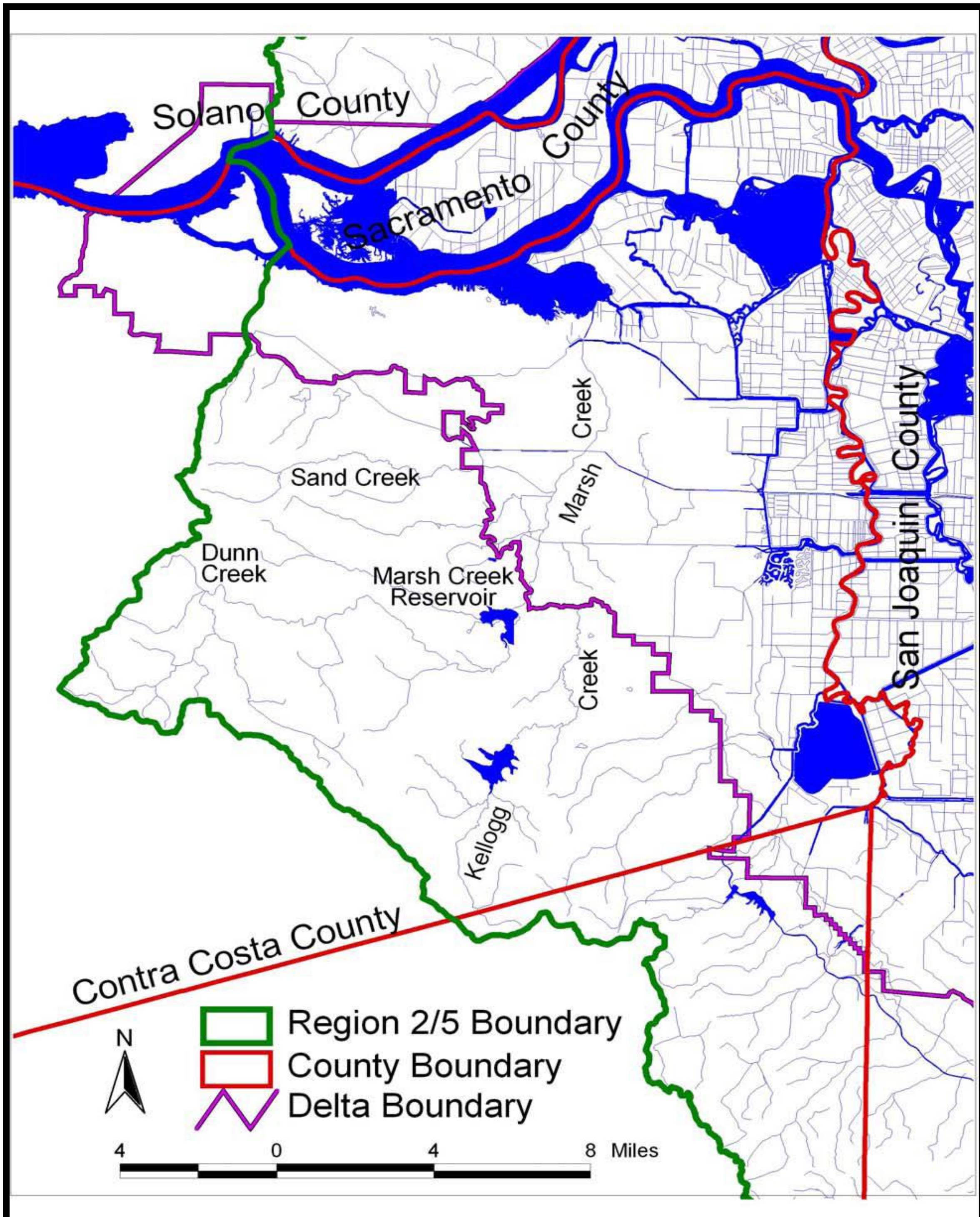


**Figure 2.2 State Water Resources Control Board Region 2 and 5 Boundaries (Source Map: CVRWQB 2010)**



### 2.2.2 Walnut Creek Watershed (Region 2)

The Walnut Creek Watershed is located in central Costa Contra County, with boundaries demarcated by the west side of Mount Diablo and the east side of the East Bay Hills. At 93,556 acres, it is the largest watershed in the county. The watershed has eight major tributaries that flow into the generally south-north trending direction of Walnut Creek. These tributaries include San Ramon Creek, Bollinger Creek, Las Trampas Creek, Lafayette Creek, Grayson Creek, Murderers Creek, Pine Creek, and Galindo Creek.

Due to steep slopes and land protection efforts, the upper watersheds along the perimeter of the Walnut Creek Watershed generally remain undeveloped open space. The valleys of the watershed are densely urbanized and populated by the cities of Walnut Creek, Lafayette, Pleasant Hill and Danville. The cities of Concord, Martinez, and small areas of Moraga and San Ramon also are partly within the watershed (Walkling, 2013).

Walnut Creek has the second longest running stream length in the county at 28.74 miles. Its highest elevation lies at 3,849 feet, while the mouth joins sea level at Suisun Bay. An estimated 71.5 percent of its stream channel remains in a natural state, with the remaining portion containing man-made reinforcements. Estimated impervious surfaces make up 30 percent of its watershed. Walnut Creek's estimated mean daily flow is 81.4 cubic feet per second (CCCDD, 2003).

There are two locations in the Walnut Creek watershed selected for targeted monitoring in WY 2015: San Ramon Creek and Green Valley Creek. The lower Walnut Creek watershed has six concrete drop structures which are barriers to the upstream migration of anadromous salmonids. Leidy et al. (2005) report that fish surveys in 1977, 1983, and 1984 failed to find any steelhead in San Ramon Creek. Fish surveys in Green Valley Creek also found no trout or steelhead in 1980 and 1985 near the targeted monitoring location of WY 2015.

### 2.2.3 San Pablo Watershed (Region 2)

The full watershed of San Pablo Creek is 27,640 acres, arising in the City of Orinda at a maximum elevation of 1,905 feet and flowing westerly 19.65 miles to San Pablo Bay. After leaving Orinda, San Pablo Creek flows across East Bay Municipal Utility District (EBMUD) land into San Pablo Reservoir. Water releases from San Pablo Dam to feed lower San Pablo Creek, where it flows through first rural, then heavily urbanized residential and commercial property. Earth or concrete channelized portions of San Pablo Creek amount to 10.6 percent of the entire channel and occur as it passes through the City of San Pablo. Impervious surface in the San Pablo Creek watershed is calculated at 20 percent (CCCDD, 2003).

San Pablo Creek once supported runs of steelhead and coho (silver) salmon. Leidy et al. (2005) reported that the lower section of San Pablo Creek below the San Pablo Reservoir Dam still had runs of steelhead in the 1950s. However, San Pablo Creek below San Pablo Reservoir is reported by EBMUD to no longer support steelhead/rainbow trout (personal communication, Jessica Purificato, Fisheries and Wildlife Biologist II with EBMUD, November 10, 2014). EBMUD conducted annual fish sampling of three sites on San Pablo Creek below the reservoir over the past eight years and found no steelhead/rainbow trout other than a few hatchery rainbow trout that apparently have come from the San Pablo Reservoir.

## 2.3 Contra Costa Targeted Monitoring Design

During WY 2015 (October 1, 2014 – September 30, 2015) water temperature, general water quality, pathogen indicators and stream surveys were monitored at the targeted locations listed in Table 2.1 and illustrated in the Figure 2.3 overview map.

Site locations were identified using a targeted monitoring design based on the directed principle[8] to address the following management questions:

1. What is the range of general water quality measurements at targeted sites of interest?
2. Do general water quality measurements indicate potential impacts to aquatic life?
3. What are the pathogen indicator concentrations at creek sites where water contact recreation may occur?
4. What are the overall physical and/or ecological conditions of creek reaches and specific point impacts within each reach?

Within Contra Costa County, targeted monitoring was conducted with the following:

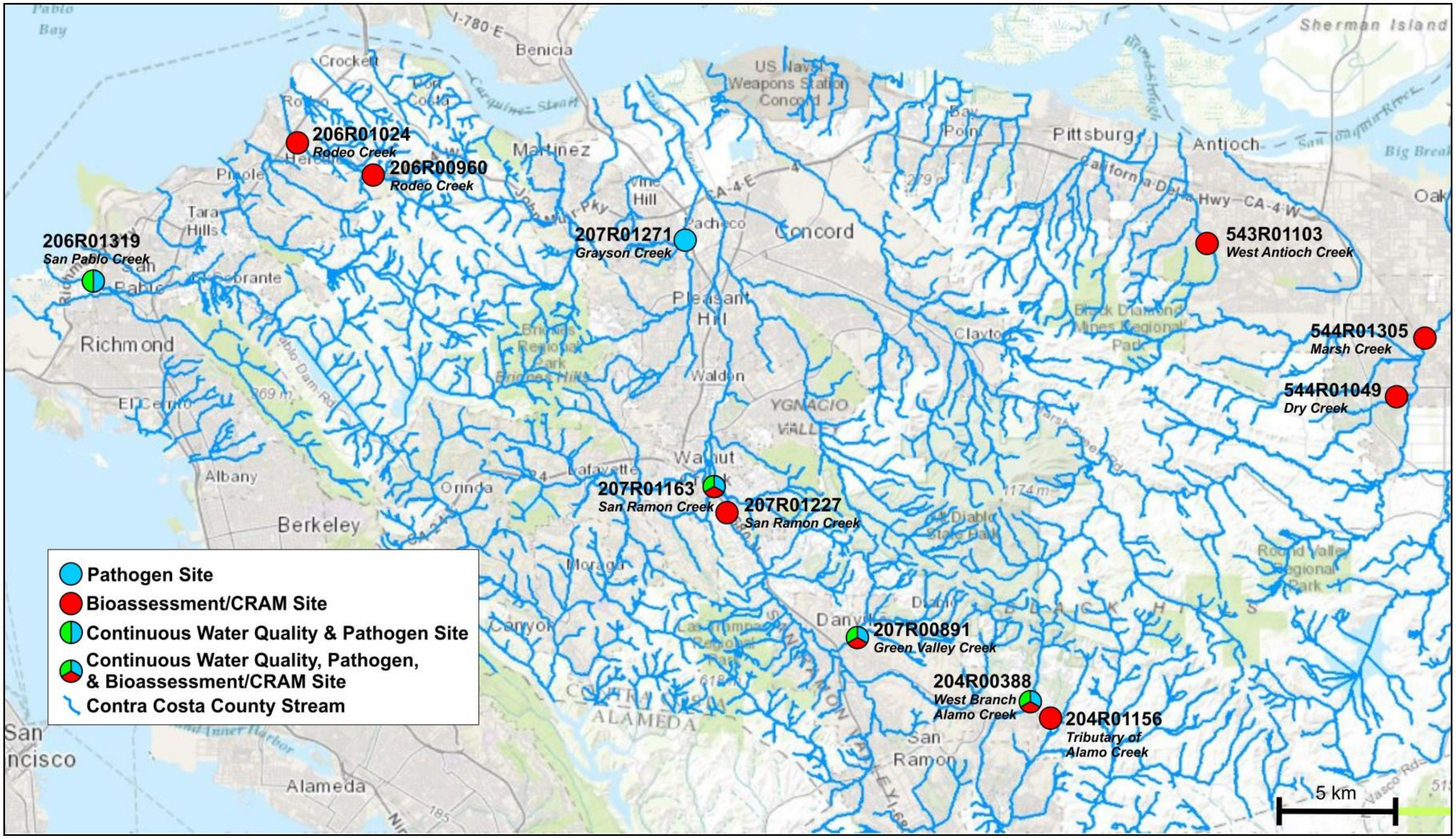
- Four continuous water temperature monitoring locations
- Two general water quality monitoring locations
- Five pathogen indicator monitoring locations
- Ten riparian assessment monitoring locations

**Table 2.1 Sites and Local Reporting Parameters Monitored in Water Year 2015 in Contra Costa County**

| Site Code | Creek Name | Latitude | Longitude | Bioassessment / CRAM | Continuous Temperature | Water Quality | Pathogen Indicators |
|---|---|---|---|---|---|---|---|
| 204R00388 | West Branch of Alamo | 37.80352 | -121.89936 | X | X | X | X |
| 207R00891 | Green Valley | 37.82838 | -121.98444 | X | X | | X |
| 206R00960 | Rodeo | 38.00768 | -122.22185 | X | | | |
| 206R01024 | Rodeo | 38.01993 | -122.25920 | X | | | |
| 544R01049 | Dry | 37.92213 | -121.71938 | X | | | |
| 543R01103 | West Antioch | 37.98026 | -121.81226 | X | | | |
| 204R01156 | Tributary of Alamo | 37.79739 | -121.88988 | X | | | |
| 207R01163 | San Ramon | 37.88713 | -122.05534 | X | X | X | X |
| 207R01227 | San Ramon | 37.87703 | -122.04847 | X | | | |
| 207R01271 | Walnut | 37.918973 | -122.053884 | | | | X |
| 544R01305 | Marsh | 37.94454 | -121.70527 | X | | | |
| 206R01319 | San Pablo | 37.96689 | -122.35916 | | X | | X |

[8] Directed Monitoring Design Principle: A deterministic approach in which points are selected deliberately based on knowledge of their attributes of interest as related to the environmental site being monitored. This principle is also known as "judgmental," "authoritative," "targeted," or "knowledge-based."

**Figure 2.3 Overview of Targeted Sites Monitored By CCCWP in 2015**



# 3.0 Monitoring Methods

Targeted monitoring data were collected in accordance with the BASMAA RMC Quality Assurance Program Plan (EOA, AMS & ARC, 2014a) and BASMAA RMC Standard Operating Procedures (EOA, AMS & ARC, 2014b). Where applicable, monitoring data were collected using methods comparable to those specified by the California Surface Water Ambient Monitoring Program (SWAMP) QAPP[9], and were submitted in SWAMP-compatible format by CCCWP to the SFBRWQCB and the CVRWQCB on behalf of CCCWP permittees and pursuant to Provision C.8.g.

## 3.1 Data Collection Methods

Water quality data were collected in accordance with SWAMP-comparable methods and procedures described in the BASMAA RMC SOPs (EOA, AMS & ARC, 2014b) and associated QAPP (EOA, AMS & ARC, 2014a). These documents are updated as needed to maintain a current and optimal applicability. The SOPs were developed using a standard format that describes health and safety precautions and considerations, relevant training, site selection, and sampling methods/procedures, including pre-fieldwork mobilization activities to prepare equipment, sample collection, and demobilization activities to preserve and transport samples.

The monitoring locations for general water quality parameters (dissolved oxygen, specific conductivity, pH, and temperature) were located in the West Branch of Alamo Creek and San Ramon Creek for this monitoring year, as discussed below.

### 3.1.1 General Water Quality Measurements

General water quality monitoring equipment (YSI 6600 V2 Sondes) were deployed over two time periods at one location in both the West Branch of Alamo Creek and San Ramon Creek. General water quality parameters (dissolved oxygen, specific conductivity, pH, and temperature) were recorded every 15 minutes. The equipment was deployed for two time periods at each creek as follows:

- West Branch of Alamo Creek: Once during spring (April 21-May 1) and once during late summer (September 2-15)
- San Ramon Creek: Once during spring (April 21-May 1) and once during late summer (September 2-15)

Procedures used for calibrating, deploying, programming and downloading data are described in RMC SOP FS-4 (EOA, AMS & ARC, 2014b).

### 3.1.2 Continuous Temperature Monitoring

In WY 2015, CCCWP monitored water temperature at four locations in the county. Digital temperature loggers (Onset HOBO® Water Temp Pro V2) were deployed at each of the following locations: West Branch of Alamo Creek, Green Valley Creek, San Ramon Creek, and San Pablo Creek. Hourly temperature measurements were recorded at each respective site from April 15, 2015 to October 3, 2015.

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

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

### 3.1.3 Pathogen Indicator Sampling

In compliance with MRP requirements, a set of pathogen indicator samples was collected on June 30, 2015 at five stations. Four out of five sampling locations were designated at or just downstream of the HOBO® water temperature data logger locations. The fifth pathogen sampling location was in a Contra Costa County flood control channel in Walnut Creek (Figure 2.3). Fecal coliform and *E. coli* were sampled and analyzed at all sites.

Sampling techniques employed by ADH included direct filling of containers and immediate transfer of samples to analytical laboratories within specified holding time requirements. Procedures used for sampling and transporting samples by ADH are described in RMC SOP FS-2 (EOA, AMS & ARC, 2014b).

### 3.1.4 California Rapid Assessment Method (CRAM) for Riverine Wetlands

Field crews conducted assessments at ten sites from September 14 to September 21, 2015 using CRAM. Assessments were conducted at the same locations that were monitored as bioassessment sites for the RMC probabilistic design (i.e., benthic macroinvertebrate and algae taxonomy, physical habitat assessments, and water quality). CRAM includes an assessment of the following four attributes within a defined riparian assessment area: 1) buffer and landscape context; 2) hydrology; 3) physical structure; and 4) biotic structure. Procedures describing methods for scoring riparian attributes are described in Collins et al. (2008).

## 3.2 Quality Assurance/Quality Control

Data quality assessment and quality control procedures are described in detail in the BASMAA RMC QAPP (EOA, AMS & ARC, 2014a). Data quality objectives were established to ensure data collected are of adequate quality and sufficient for the intended uses. Data quality objectives address both quantitative and qualitative assessment of the acceptability of data. The qualitative goals include representativeness and comparability. The quantitative goals include specifications for completeness, sensitivity (detection and quantization limits), precision, accuracy, and contamination. To ensure consistent and comparable field techniques, field training and inter-calibration exercises were conducted among field crews to ensure consistency and quality of CRAM data.

Data were collected according to the procedures described in the relevant BASMAA RMC SOPs (EOA, AMS & ARC, 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. Standard methods for CRAM are included in Collins et al. (2008).

## 3.3 Data Quality Assessment Procedures

Following completion of the field and laboratory work, the field data sheets and laboratory reports were reviewed by the local quality assurance officer (LQAO), and compared against the methods and protocols specified in the RMC SOPs and QAPP. The findings and results were then evaluated against the relevant data quality objectives to provide the basis for an assessment of programmatic data quality. A summary of data quality steps associated with water quality measurements is shown in Table 3.2. The data quality assessment consisted of the following elements:

- Conformance with field and laboratory methods, as specified in RMC SOPs and QAPP, including sample collection and analytical methods, sample preservation, sample holding times, etc.

- Numbers of measurements/samples/analyses completed vs. planned, and identification of reasons for any missed samples.
- Temperature data were checked for accuracy by comparing measurements taken by HOBOs® with National Institute of standards Technology thermometer readings in room temperature water and ice water.
- General water quality data were checked for accuracy by comparing measurements taken before and after deployment with measurements taken in standard solutions to evaluate potential drift in readings.
- Quality assessment laboratory procedures for accuracy and precision (i.e., lab duplicates, lab blanks) were not implemented for pathogen samples collected this year, but will be in subsequent years.
- Field crews participated in one CRAM training class and two inter-calibration exercises prior to field assessments.

**Table 3.2 Data Quality Steps Implemented for Temperature and General Water Quality Monitoring**

| Step | Temperature (HOBOs ®) | General Water Quality (Sondes) |
|---|---|---|
| Pre-event calibration / accuracy check conducted | X | X |
| Readiness review conducted | X | X |
| Check field datasheets for completeness | X | X |
| Post-deployment accuracy check conducted | | X |
| Post-sampling event report completed | X | X |
| Post-event calibration conducted | | X |
| Data review – compare drift against SWAMP MQOs | | X |
| Data review – check for outliers / out of water measurements | X | X |

## 3.4 Data Analysis and Interpretation

Continuous temperature and continuous general water quality data were plotted as box and whisker plots for each site during each deployment. The middle line of the box represents the median value (50$^{th}$ percentile), and top and bottom edge of the box indicate the 75$^{th}$ and 25$^{th}$ percentile, respectively. The upper whisker represents the 90$^{th}$ percentile, while the bottom whisker represents the 10$^{th}$ percentile. All data that do not fall between the 10$^{th}$ and 90$^{th}$ percentile are plotted as points outside of the whiskers.

The hourly water temperature measurements were used to calculate daily maxima over a 24-hour period from midnight to 11:00 PM. The weekly running average of maximum daily temperatures (WAMTs) were calculated by averaging each daily maximum temperature with the previous six daily maximum temperatures.

Targeted monitoring data were evaluated against WQOs or other applicable thresholds, as described in Table 8.1 in the MRP and Central Valley Permit. Table 3.3 defines thresholds used for selected targeted monitoring parameters, as they apply to Table 8.1. The subsections below provide details on thresholds selected and the underlying rationale. Criteria have not been established for conductivity or CRAM data.

**Table 3.3 Description of Water Quality Thresholds for MRP and Central Valley Permit Provision C.8.c Parameters Monitored Using a Targeted Design**

| Monitoring Parameter | Threshold Description |
|---|---|
| Temperature | 20 percent of results for the deployment period at each monitoring site exceed one or more of the following applicable temperature thresholds:<br>For a water body designated as COLD and/or supports steelhead trout population (SFBRWQCB, 2011):<br>▪ 7-day Mean Temperature should not exceed 20.5°C<br>For a water body designated as COLD or WARM (SFBRWQCB 2015):<br>▪ The temperature shall not be increased by more than 2.8°C above natural receiving water temperature. |
| General Water Quality | 20 percent 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 < 7.0 mg/L (SFBRWQCB, 2015)<br>pH: > 6.5 and < 8.5 (SFBRWQCB, 2015)<br>Conductivity: NA |
| Pathogen Indicators | Single sample result meets one or more of the following criteria:<br>Fecal coliform: ≥ 400 MPN/100 ml (based on SFBRWQCB, 2015)<br>*E. coli*: ≥ 410 MPN/100 ml (based on USEPA, 2012, infrequently used area) |
| CRAM | Not applicable |

### 3.4.1 Dissolved Oxygen

The Basin Plan (SFBRWQCB, 2015) lists WQOs for dissolved oxygen (DO) in non-tidal 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 water habitat (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. In these cases, DO data will be evaluated for the salmonid life stage and/or fish community that is expected to be present during the monitoring period. Such evaluations of both historical and current ecological conditions will be made, where possible, when evaluating water quality information.

To evaluate the results against the relevant trigger in Table 8.1 in the MRP and Central Valley Permit, the DO data were evaluated to determine whether 20 percent or more of the measurements were below the applicable water quality objectives.

### 3.4.2 pH

Water quality objectives for pH in surface waters are stated in the Basin Plan (SFBRWQCB, 2015) 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.

To evaluate the results against the relevant trigger in Table 8.1 in the MRP and Central Valley Permit, the pH data were evaluated to determine whether 20 percent or more of the measurements were outside of the water quality objectives.

### 3.4.3 Pathogen Indicators

The Basin Plan (SFBRWQCB, 2015) includes water contact recreation WQOs of fecal coliform concentrations less than 200 MPN/100ml (geometric mean of data, based on at least five samples collected over a 30-day period) and less than 400 MPN/100ml ($90^{th}$ percentile of data). For non-contact water recreation, the Basin Plan includes WQOs of fecal coliform concentrations less than 2,000 MPN/100ml (geometric mean of data) and less than 4,000 MPN/100ml ($90^{th}$ percentile of data).

In 2012, the U.S. Environmental Protection Agency (USEPA) released its recreational water quality criteria (RWQC) recommendations for protecting human health in all coastal and non-coastal waters designated for primary contact recreation use. The RWQC includes two sets of recommended criteria, as shown in Table 3.4. 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 containing organisms that indicate the presence of fecal contamination. They are not regulations themselves (USEPA, 2012), but are considered to represent “established thresholds” for purposes of evaluating threshold triggers per the MRP and Central Valley Permit Table 8.1.

**Table 3.4 USEPA 2012 Recreational Water Quality Criteria**

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

The Basin Plan objectives are based on a sampling protocol where a minimum of five consecutive samples are collected from a given site throughout a 30-day period; the USEPA geometrical mean (GM) values are based on a similar sampling regimen. Given that geometric means cannot be calculated from single-sample data, for the purposes of this evaluation, fecal coliform maximum concentrations of 400 MPN/100ml and 4,000 MPN/100ml in a single sample were used per the Basin Plan as the Water Contact Recreation and Non-water Contact Recreation evaluation criteria, respectively. As the Basin Plan does not include WQOs for *E. coli,* the USEPA statistical threshold value criterion of 410 CFU/100 mL is used to evaluate maximum or single sample concentrations of *E. coli* for Water Contact Recreation. For interpretive purposes, the CFU and MPN measurement units are considered equivalent.

To provide for additional information related to spatial variability in bacteria levels along the selected creek reaches, pathogen indicator samples were collected at five sites along each of the three creeks, analyzed for fecal coliform and *E. coli*., and compared to the Basin Plan objectives (fecal coliform) and the USEPA criteria (*E. coli*) to determine whether pathogen indicator organism concentrations reveal potential impacts to recreational beneficial uses along the selected creek reaches.

### 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). No specific water temperature objective is presented in the Basin Plan for the COLD and WARM designations; however, the Basin Plan states that a COLD water habitat should be capable of supporting salmonids year-round.

In Table 8.1 of the MRP and Central Valley Permit, 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 *Local Urban Creeks Monitoring Report, Water Year 2012* (ADH, 2013; see also Cressey, 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 Celsius (°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°C WAMT threshold is used again in this year's evaluation as the water temperature criterion for COLD water streams supporting salmonids in Contra Costa County.

The WAMT was calculated as the 7-day rolling average daily maximum stream temperature (per Sullivan et al., 2000) by averaging each daily maximum temperature with the previous six daily maximum temperatures. To evaluate the results against the relevant trigger in Table 8.1 of the MRP and Central Valley Permit, the WAMT values were evaluated to determine whether 20 percent or more of the measurements were above the applicable 20.5°C temperature threshold.

The potential responsive action to the analysis of temperature as it relates to fish habitat in the West Branch of Alamo Creek, Green Valley Creek, San Ramon Creek and San Pablo Creek is discussed below. After a brief description of the site locations monitored, the potential responsive action to the analysis of temperature as it relates to fish habitats follows.

#### *3.4.4.1 West Branch of Alamo Creek*

The water quality and water temperature monitoring station (Site 204R00388) on the West Branch of Alamo Creek in WY 2015 was located on a section of natural stream that lies north of Camino Tassajara and south, as well as downstream, of the Blackhawk Country Club.

This creek differs from the other Contra Costa County creeks monitored in that its waters drain into Alameda County. Shortly after merging with the main stem of Alamo Creek and South San Ramon Creek, the waters of West Branch of Alamo Creek enter the Alamo Canal and flow south into Alameda County to the Arroyo de la Laguna and then into Alameda Creek. It is not known if Alamo Creek ever supported steelhead, but Leidy et al. reports there being no steelhead in the creek at present. The 2015 Basin Plan states that Alamo Creek has a "potential beneficial use" as COLD habitat, but its present designation is a WARM aquatic habitat.

#### *3.4.4.2 Green Valley Creek*

The water temperature monitoring station (Site 207R00891) located on Green Valley Creek was placed in a section of stream with reinforced rip rap banks and constructed earthen channel maintained by the Contra Costa County Flood Control District. This portion of Green Valley Creek flows north to south, parallel to the eastern side of Diablo Road. It is located south of El Cerro Boulevard and north of Camino Tassajara in Danville.

Green Valley Creek drains the southwest slope of Mt. Diablo, is a primary tributary of San Ramon Creek, and currently flows intermittently. Leidy et al. states that a long-time resident reported in 1977 that Green Valley Creek once maintained perennial flow and supported trout. He also states that neither trout nor steelhead was found during surveys of Green Valley Creek in 1980 and 1985. The 2015 Basin Plan does not list Green Valley Creek, but it being unable to support a steelhead population at present qualifies this creek as a WARM aquatic habitat.

#### *3.4.4.3 San Ramon Creek*

The water quality and water temperature monitoring devices located on San Ramon Creek (Site 207R01163) were deployed in a section of natural stream, just downstream of a continuous section of concrete engineered stream channel. The stream runs south to north, parallel to the east side of South Main Street, and is located directly west of the southern end of Las Lomas High School in the City of Walnut Creek.

San Ramon Creek joins with Las Trampas Creek at the City of Walnut Creek and becomes Walnut Creek, which then flows north into Suisun Bay. Leidy et al. (2005) report six concrete drop structures in lower San Ramon/Walnut Creek which are barriers to the upstream migration of anadromous salmonids. He also reports that fish surveys in 1977, 1983 and 1984 failed to find any steelhead in San Ramon Creek. The Basin Plan designates San Ramon Creek as a WARM habitat.

#### *3.4.4.4 San Pablo Creek*

The 2015 water quality monitoring program had one monitoring site on San Pablo Creek at Fred Jackson Way (Site 206R01319), approximately 1.5 miles before it flows into San Pablo Bay and 6 miles downstream of San Pablo Reservoir. San Pablo Creek once supported runs of steelhead and coho (silver) salmon. Leidy et al (2005) reported that the lower section of San Pablo Creek below the San Pablo Reservoir Dam still had runs of steelhead in the 1950s. However, it appears that San Pablo Creek below San Pablo Reservoir no longer supports a steelhead population. Jessica Purificato, Fisheries and Wildlife Biologist II with EBMUD, stated that EBMUD personnel have been electrofishing three stations on San Pablo Creek below San Pablo Reservoir (Kennedy Grove to Hwy 80) annually for the past eight years and have never found a salmonid, except one hatchery fish that appears to have come from the reservoir (personal communication, Scott Cressey, November 10, 2014).

The Basin Plan's (2015) table of beneficial uses shows San Pablo Creek having both COLD and WARM aquatic use designations plus SPAWNING habitat designation. This is because San Pablo Creek, which is upstream of San Pablo Reservoir, still supports rainbow trout, some of which are likely linked to wild steelhead trapped upstream when the reservoir was constructed. The WARM designation is for San Pablo Creek below San Pablo Reservoir where the EBMUD annual fisheries monitoring have not found any steelhead in eight years of monitoring.

# 4.0 Results

## 4.1 Statement of Data Quality

Field data sheets and laboratory reports were reviewed by the local quality assurance officer, and the results evaluated against the relevant data quality objectives. Results were compiled for qualitative metrics (representativeness and comparability) and quantitative metrics (completeness, precision, accuracy). The following summarizes the results of the data quality assessment:

- Temperature data from HOBOs® were collected from four stations; 66 percent of the expected data was collected at the West Branch of Alamo Creek while 70 percent of the expected data were collected at Green Valley Creek, San Ramon Creek, and San Pablo Creek for the following reasons:
    - HOBOs® were deployed on April 15, 2015 at four locations in Contra Costa County. The HOBOs® remained deployed until October 3, 2015, past the September 30, 2015 target pickup date.
    - The HOBO® at station 204R00388 (West Branch of Alamo Creek), experienced a data loss from April 25 to May 1 following a storm event on April 25. The increase in stage associated with the storm event caused a debris flow that relocated the HOBO via entanglement with the HOBO security cable. The HOBO was found on the stream bank, tangled with small woody debris, during a scheduled YSI Sonde retrieval on May 1 at the same location. As a result, an additional 4 percent of the expected data was not recovered due to the device being moved. The device was reinstalled May 1.
    - The HOBOs® at the West Branch of Alamo Creek, Green Valley Creek, San Ramon Creek, and San Pablo Creek were scheduled for a routine maintenance and data download on May 27. During this download, the wireless device used to transfer data malfunctioned and discontinued logging on all monitoring devices. The equipment malfunction was not discovered until the following scheduled download on July 17. The intermediary wireless device previously used to collect data was eliminated from field use and field crews proceeded with equipment operation, launch and data download of HOBOs® using direct connection via a field laptop. All data recorded during the remaining deployment period was successfully stored without error following the switch in field equipment.
- Continuous water quality data (temperature, pH, DO, conductivity) were collected during the spring and summer seasons; 100 percent of the expected data was collected.
- Continuous water quality data generally met measurement quality objectives (accuracy) as presented in Table 4.1.
- Quality assurance laboratory procedures were implemented for pathogen indicator analyses this year. All quality assurance samples successfully met data quality objectives.
- Total CRAM scores between field crews at two pre-calibration exercises were within 10 percent.

**Table 4.1 Accuracy[1] Measurement Taken for Dissolved Oxygen, pH and Specific Conductivity (bold values exceed the Measurement Quality Objectives)**

| Parameter | Measurement Quality Objectives | Site 204R00388 West Branch of Alamo Creek | | Site 207R01163 San Ramon Creek | |
|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 1 | Event 2 |
| Dissolved Oxygen (mg/l) | ± 0.2 mg/L | 0.0 | **0.26** | **-0.48** | 0.17 |
| pH 7.0 | ± 0.2 | 0.08 | 0.01 | 0.08 | 0.11 |
| pH 10.0 | ± 0.2 | -0.01 | 0.0 | 0.01 | -0.06 |
| Conductivity (µS/cm) | ± 2 µS/cm | 0.01 | 0.02 | 0.91 | 0.17 |

Explanation:

[1] Accuracy of the water quality measurements were determined by calculating the difference between the YSI Sonde readings using a calibration standard versus the actual concentration of the calibration standard. The results displayed are those taken following measurements taken within the stream, defined as "post calibration" as opposed to the "pre calibration values", where all the YSI Sonde probes were offset to match the calibration standard prior to deployment.

## 4.2 Water Quality Monitoring Results

### 4.2.1 Water Temperature

Summary statistics for water temperature data collected at the four continuous monitoring locations from April to October 2015 are shown in Table 4.2. At the West Branch of Alamo Creek, due to device movement and equipment malfunction, approximately 114 days of hourly temperature data were collected. At Green Valley Creek, San Ramon Creek, and San Pablo Creek, due to equipment malfunction, approximately 121 days of hourly temperature data were recorded. Water temperatures measured at each station, along with the upper temperature threshold of 20.5°C (seven-day maximum) for juvenile salmonid rearing, are illustrated in Figures 4.1a – 4.3.

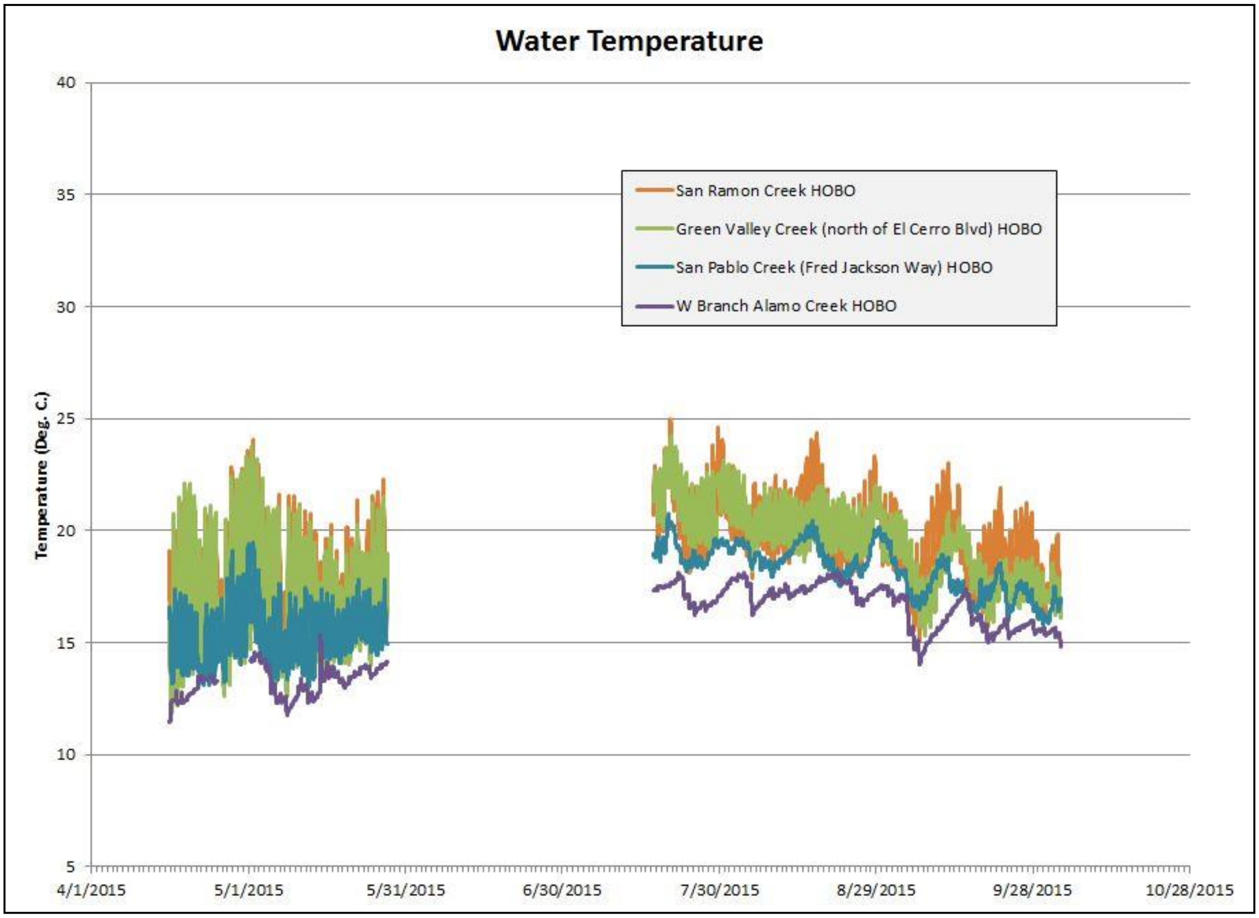
**Table 4.2 Descriptive Statistics for Continuous Water Temperature Measured at Four Sites in Contra Costa County (West Branch of Alamo Creek, Green Valley Creek, San Pablo Creek, San Ramon Creek), April 15-October 3**

| Site Temperature | 204R00388 West Branch of Alamo Creek | 207R00891 Green Valley Creek | 206R01319 San Pablo Creek | 207R01163 San Ramon Creek |
|---|---|---|---|---|
| Minimum | 11.47 | 11.86 | 13.02 | 13.52 |
| Median | 15.92 | 18.91 | 17.49 | 19.03 |
| Mean | 15.61 | 18.53 | 17.26 | 18.95 |
| Maximum | 18.15 | 24.27 | 20.77 | 24.99 |
| Maximum WAMT[1] | 18.20 | 23.42 | 19.97 | 23.57 |
| # Measurements | 2,722 | 2,871 | 2,868 | 2,871 |

Note: [1] The maximum of the 7-day running average of the daily maximum temperature

The minimum and maximum temperature for all four stations was 11.47°C and 24.99°C, respectively. The median temperature range for all four stations was 15.92°C to 19.03°C, and the WAMT range was 18.20°C to 23.57°C.

**Figure 4.1a Water Temperature Data Collected Using HOBOs® at Four Sites in Contra Costa County (West Branch of Alamo Creek, Green Valley Creek, San Pablo Creek, San Ramon Creek), April 1-October 28, 2015**




In regard to the West Branch of Alamo Creek temperature data displayed in Figure 4.1.b, it is interesting to note all of the small spikes, particularly the 3°C increase in water temperature during one hour on May 15. That large spike constitutes an exceedance of the type "a temperature spike with no natural explanation". Almost all of these peaks occur at 0200 or 0300 in the morning, and are not artifacts produced by a flawed instrument. They have no natural explanation, but it does appear they may be due to nighttime outflow from an artificial lake on a golf course upstream of the site. This lake is approximately 0.6 miles upstream from site 204R0388 on the Blackhawk Country Club Golf Course. Further investigation of this anomaly is perhaps warranted. In addition, this station had the highest CRAM rating this year and one of the lowest IBI scores, which is counter-intuitive. Perhaps the components of the IBI score at this site may help to determine if the low result is due to some kind of impact on the flora and fauna that might have occurred in this location.

**Figure 4.1b Water Temperature Data Collected Using HOBOs® in Contra Costa County (West Branch of Alamo Creek), April 12-May 24, 2015**

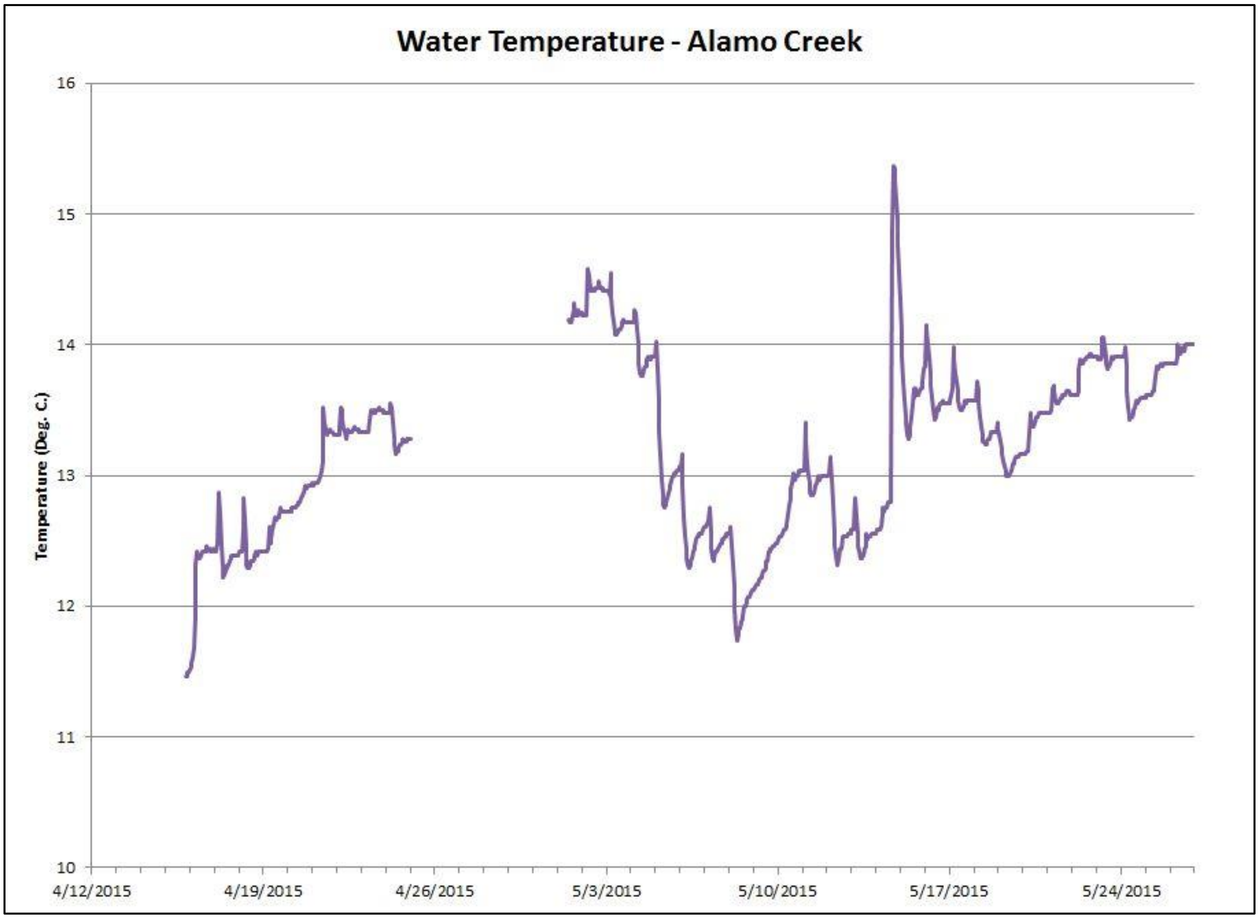
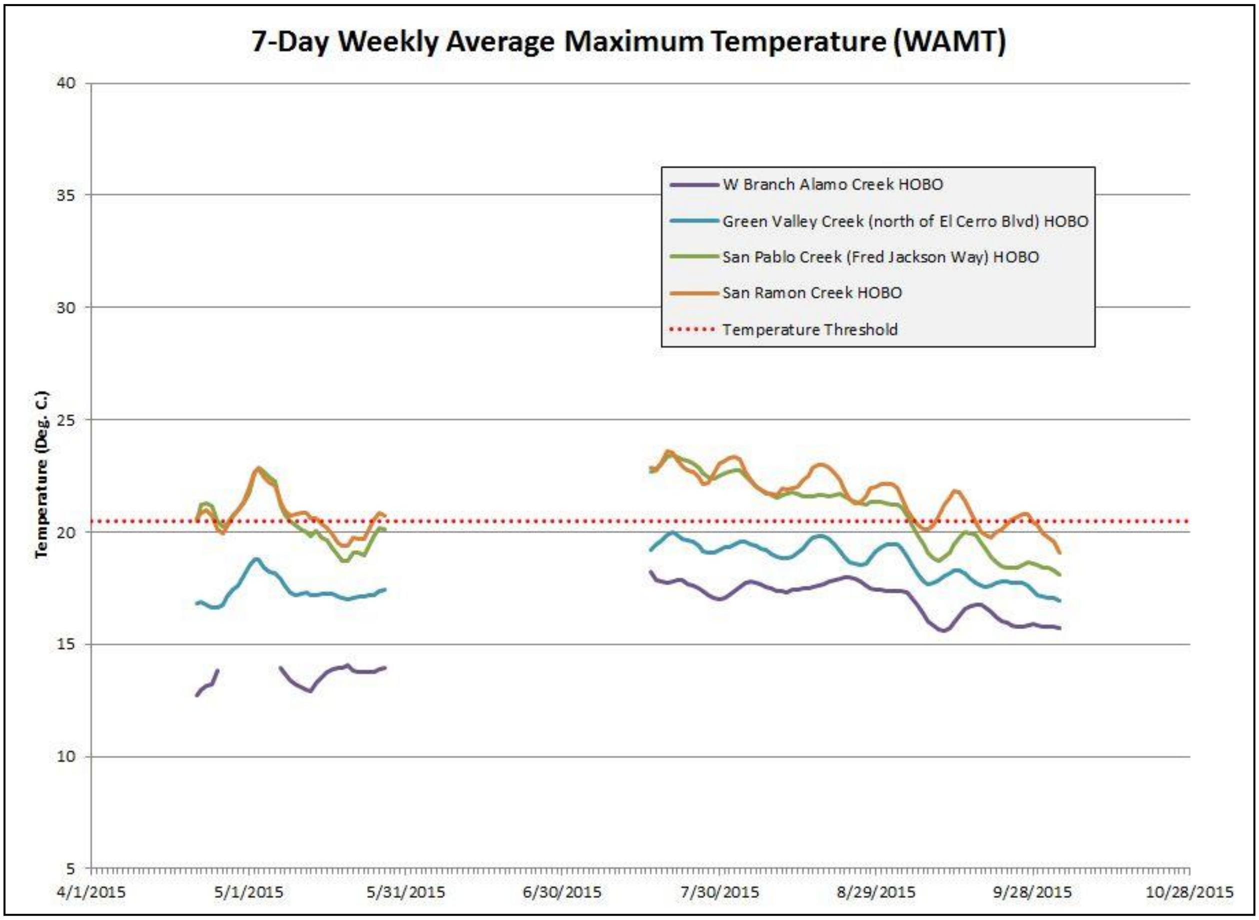


**Figure 4.2 Weekly Average Maximum Temperature Data Collected Using HOBOs ® at Four Sites in Contra Costa County (West Branch of Alamo Creek, Green Valley Creek, San Pablo Creek, San Ramon Creek), April 15-October 3**




As shown in Table 4.3, the WAMT values measured at the West Branch of Alamo Creek and San Pablo Creek were all below the selected average maximum temperature threshold for salmonids (20.5°C) for the entire duration of the sampling period. However, the WAMT values at Green Valley Creek were above 20.5°C for 55 percent of the sampling period, and the WAMT values at San Ramon Creek were above 20.5°C for 74 percent of the sampling period. Therefore, both the Green Valley Creek and San Ramon Creek stations exceeded the MRP and Central Valley Permit Table 8.1 trigger thresholds for temperature (20 percent or more of values exceed the applicable threshold; see Table 3.3).

**Figure 4.3 Box Plots of Weekly Average Maximum Temperature at Four Sites in Contra Costa County (West Branch of Alamo Creek, Green Valley Creek, San Pablo Creek, San Ramon Creek), April 15-October 3**

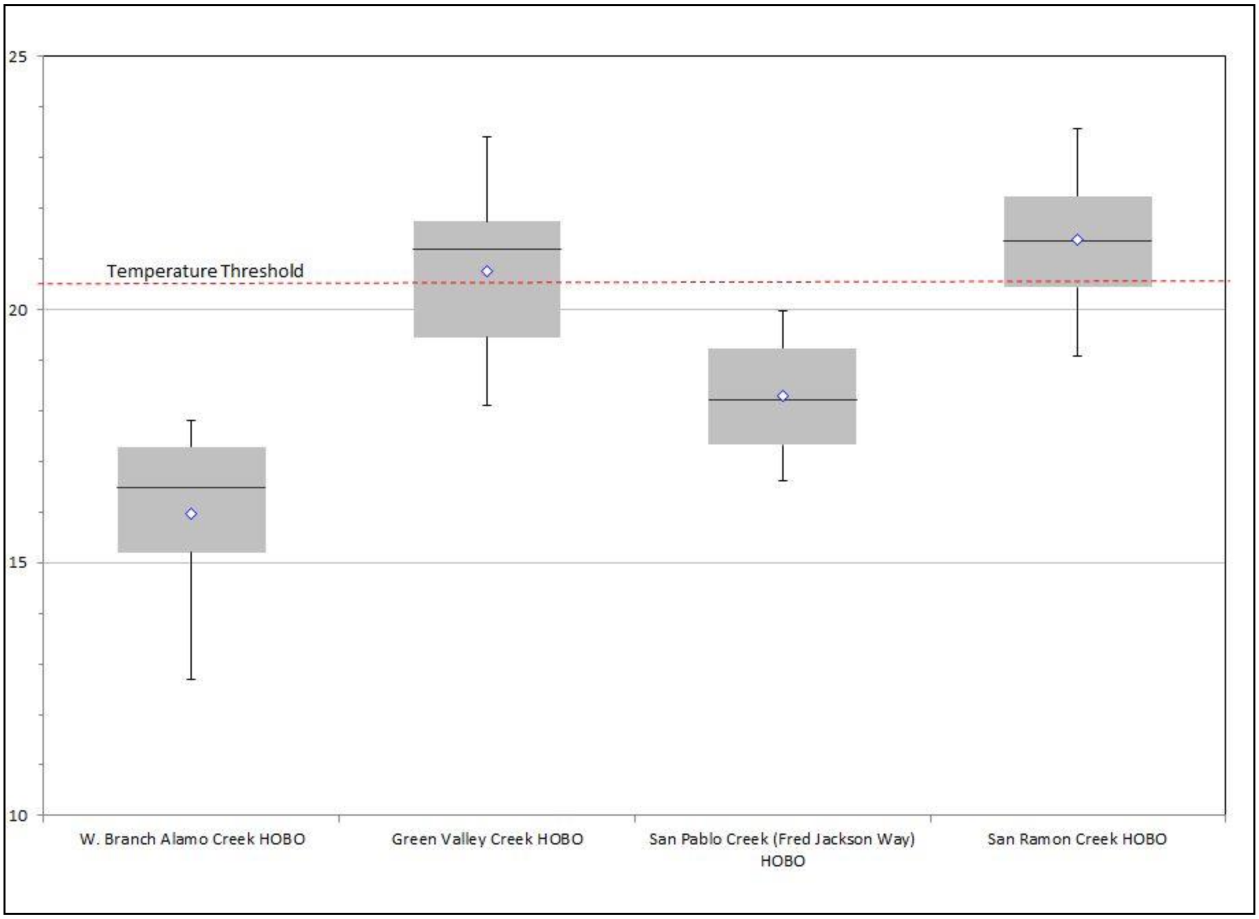



**Table 4.3 Percent of Water Temperature Data Measured at Four Sites that Exceed Water Quality Criteria**

| Site ID | Creek Name | Monitoring Period | Percent of Results Where WAMT > 20.5°C |
|---|---|---|---|
| 204R00388 | West Branch of Alamo Creek | April 15 – May 27, 2015; July 17 - October 3, 2015 | 0% |
| 207R00891 | Green Valley Creek | April 15 – May 27, 2015; July 17 - October 3, 2015 | 55% |
| 206R01319 | San Pablo Creek | April 15 – May 27, 2015; July 17 - October 3, 2015 | 0% |
| 207R01163 | San Ramon Creek | April 15 – May 27, 2015; July 17 - October 3, 2015 | 74% |

## 4.2.2 General Water Quality

Summary statistics for general water quality measurements collected at stations on the West Branch of Alamo Creek and San Ramon Creek during two periods in April-May and September are shown in Table 4.4. Data collected during both periods, along with the required thresholds, are plotted in Figures 4.4 to 4.7.

**Table 4.4 Descriptive Statistics for Daily and Monthly Continuous Water Temperature, Dissolved Oxygen, Conductivity and pH Measured at Two Sites in Contra Costa County (West Branch of Alamo Creek and San Ramon Creek), April 21-May 1 and September 2-15**

| Parameter | | Site 204R00388 West Branch of Alamo Creek | | Site 207R01163 San Ramon Creek | |
|---|---|---|---|---|---|
| | | April-May | September | April-May | September |
| Temperature (° C) | Minimum | 12.47 | 13.69 | 13.63 | 14.97 |
| | Median | 13.32 | 15.49 | 17.22 | 18.99 |
| | Mean | 13.61 | 15.61 | 17.66 | 18.86 |
| | Maximum | 16.90 | 17.23 | 23.44 | 23.00 |
| | Maximum WAMT [1] | 14.44 | 16.34 | 21.29 | 21.81 |
| Dissolved Oxygen (mg/l) | Minimum | 2.79 | 1.67 | 7.77 | 4.61 |
| | Median | 6.14 | 5.28 | 9.26 | 7.34 |
| | Mean | 5.97 | 4.83 | 9.21 | 7.37 |
| | Maximum | 9.76 | 7.86 | 10.37 | 9.73 |
| pH | Minimum | 7.66 | 7.79 | 7.91 | 7.7 |
| | Median | 7.94 | 7.94 | 8.34 | 8.12 |
| | Mean | 7.94 | 7.94 | 8.34 | 8.09 |
| | Maximum | 8.07 | 8.06 | 9.25 | 8.28 |
| Specific Conductivity (µS/cm) | Minimum | 94 | 979 | 282 | 653 |
| | Median | 1004 | 1003 | 528 | 814 |
| | Mean | 12.47 | 13.69 | 13.63 | 14.97 |
| | Maximum | 13.32 | 15.49 | 17.22 | 18.99 |

[1] The maximum of the 7-day running average of the daily maximum temperature

**Figure 4.4 General Water Quality Data (Continuous Temperature) Collected in Contra Costa County (West Branch of Alamo Creek and San Ramon Creek), April 21-May 1 and September 2-15**

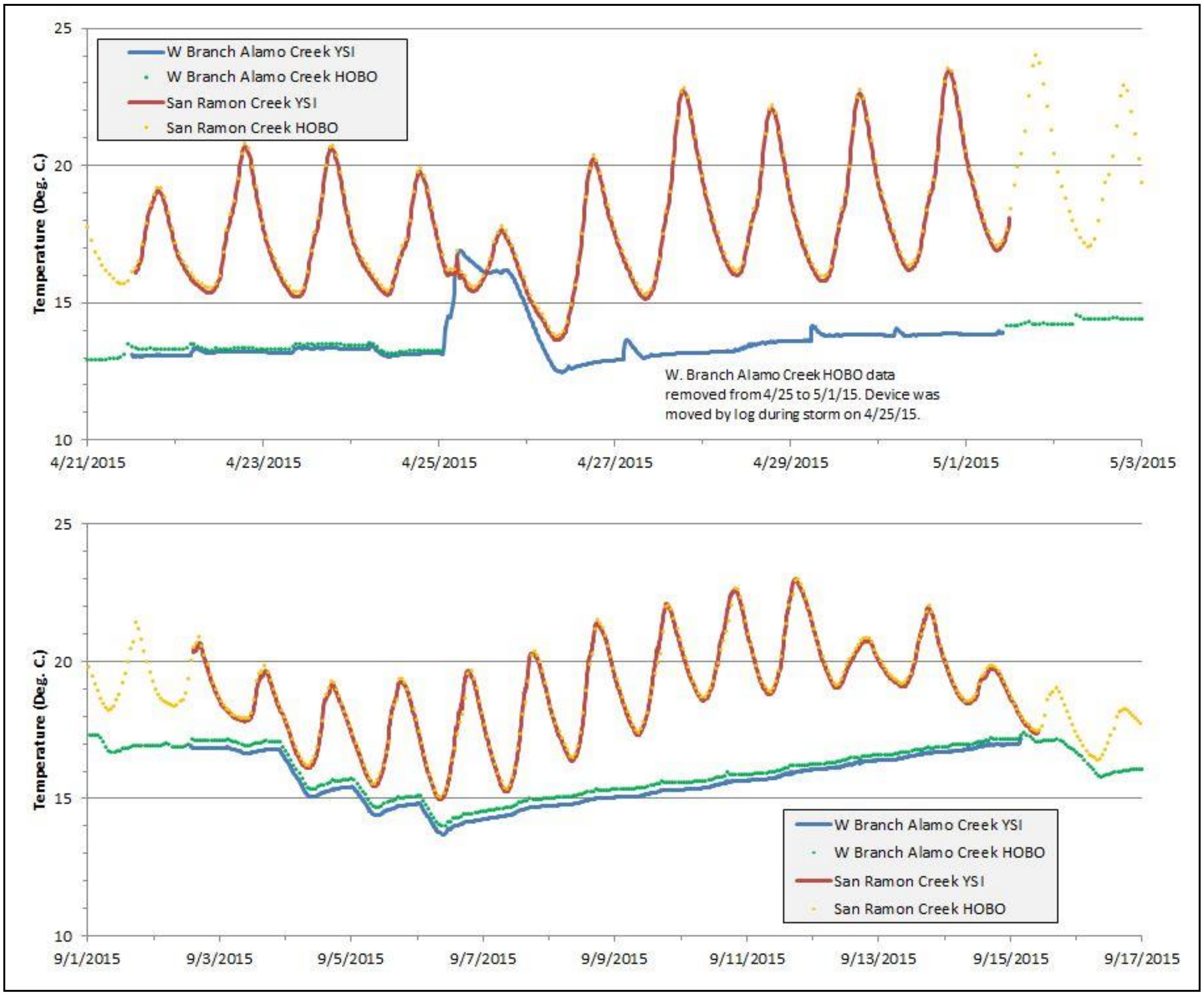


**Figure 4.5 General Water Quality Data (Continuous pH) Collected in Contra Costa County (West Branch of Alamo Creek and San Ramon Creek), April 21-May 1 and September 2-15**

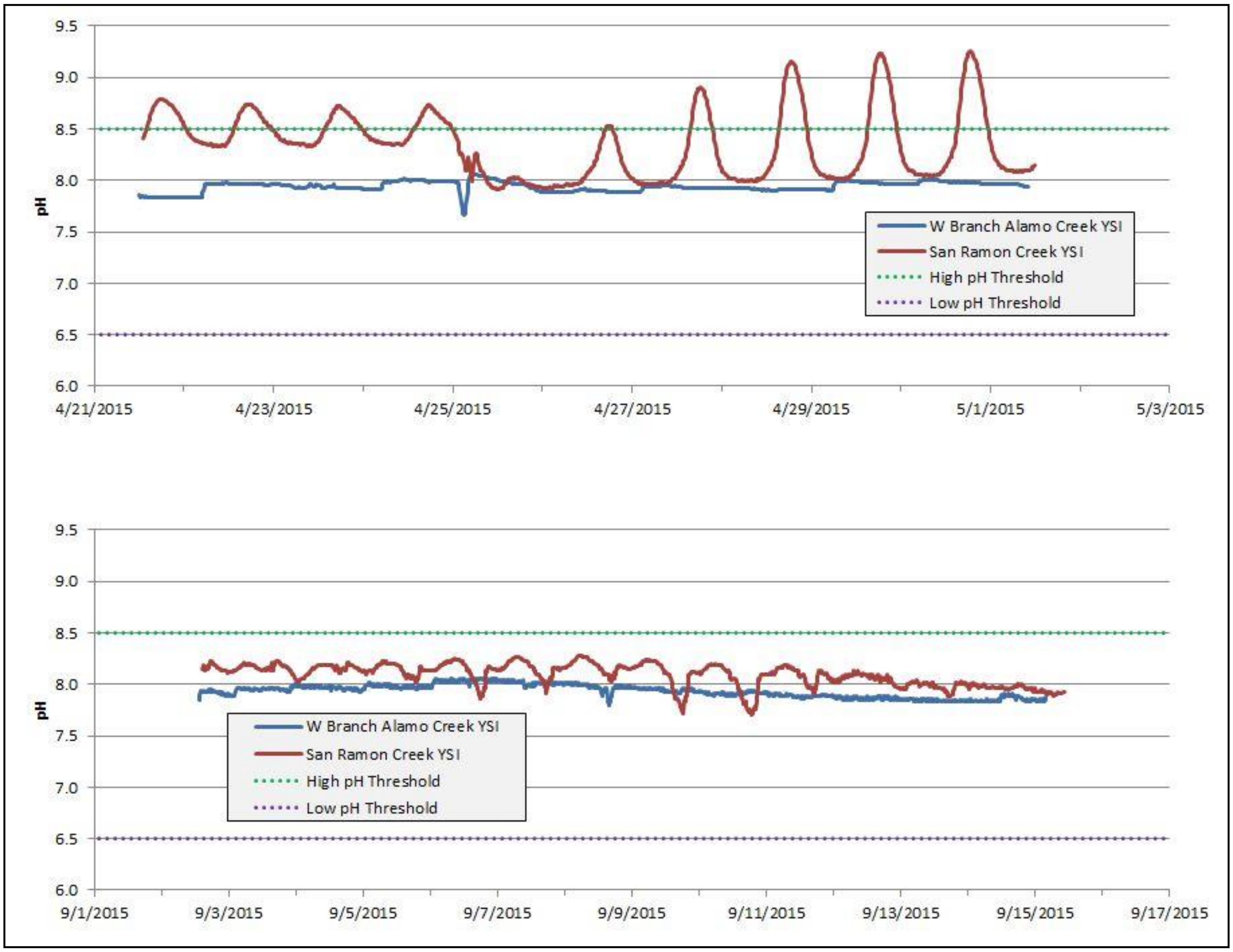


**Figure 4.6 General Water Quality Data (Continuous Dissolved Oxygen) Collected in Contra Costa County (West Branch of Alamo Creek and San Ramon Creek), April 21-May 1 and September 2-15**

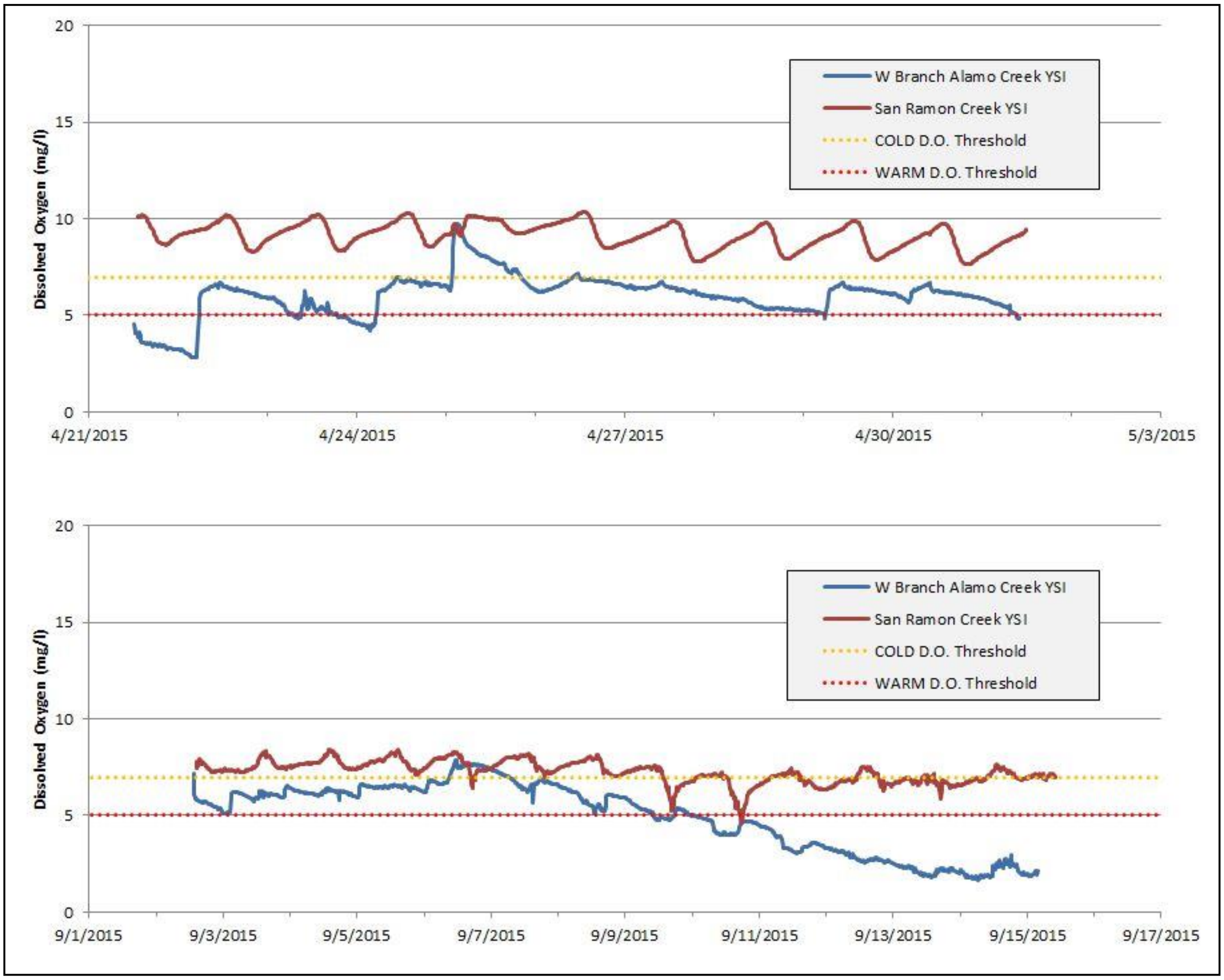


**Figure 4.7 General Water Quality Data (Continuous Specific Conductivity) Collected in Contra Costa County (West Branch of Alamo Creek and San Ramon Creek), April 21-May 1 and September 2-15**

The lowest DO concentration (1.67 mg/l) at the West Branch of Alamo Creek occurred during September 2015. The lowest DO concentration (4.61 mg/l) at San Ramon Creek occurred in September 2015 as well. The minimum and maximum pH measurements for the West Branch of Alamo Creek during both deployment periods were 7.66 and 8.06, respectively. The minimum and maximum pH measurements at the San Ramon Creek station during both periods were 7.7 and 9.25, respectively.

On April 25, there is a noticeable change in the data displayed in Figures 4.4 to 4.7. This was due to the intrusion of water in the West Branch of Alamo and San Ramon Creeks from a storm that produced about 0.5 inch of rain in the vicinity of the two locations from 2300 April 24 to 0300 April 25. The net effect of this runoff was the following in both streams:

- An increase in water temperature, particularly at Alamo Creek (Figure 4.4, top)
- A decrease and then slight increase in pH (Figure 4.5, top)
- An increase and subsequent decrease in DO, particularly at Alamo Creek (Figure 4.6, top)
- A sudden decrease in conductivity, particularly at Alamo Creek (Figure 4.7, top)

These phenomena are all consistent with warmer, relatively oxygen-rich, fresh water running into the measurement locations from storm rainfall.

Prior to and following the April 25 storm event, continuous general water quality data at San Ramon Creek follow a diurnal curve related to primary production in the stream. pH spikes that exceed water quality criteria follow this curve and can be attributed to naturally occurring primary production associated with this cycle.

Continuous general water quality data along the West Branch of Alamo Creek, however, do not follow a diurnal cycle exhibited by primary production. General water quality parameters in most cases met water quality objectives; however, a DO exceedance in September could be due to a discharge from an artificial lake upstream of site 204R00388.

During the monitoring period of early September, this region of Contra Costa County experienced a significant heat wave that brought above average high temperatures. Directly associated with this heat wave was an increase in water temperature and decrease in DO. The increase in water temperature can explain the DO exceedance due to the decreased solubility of oxygen in warmer water. The riparian corridor of the West Branch of Alamo Creek generally has a dense canopy cover that would be expected to keep flowing water temperatures more stable than during the heat wave. Therefore, it seems possible the exposed standing water in the artificial lake upstream experienced a significant warming period as reflected in the water temperature data, and would be reflected in a rise in water temperature if it was discharged into the West Branch of Alamo Creek. The artificial lake upstream of site 204R00388 will be investigated as a source for water quality issues. Figure 4.8 compares distributions of WAMT to the annual maximum temperature threshold for salmonids (20.5°C) at the West Branch of Alamo Creek and the San Ramon Creek stations, as recorded by YSI Sonde devices during April-May and September. The results show that the WAMTs recorded by these devices at the West Branch of Alamo Creek were always below the temperature threshold, while WAMTs at San Ramon Creek were above the temperature threshold for 80 percent of the April-May deployment period and 75 percent during the September deployment period. These results are consistent with those for the longer HOBO® temperature series at these two stations.

**Figure 4.8 Box Plots of Weekly Average Maximum Daily Water Temperature Collected in Contra Costa County (West Branch of Alamo Creek and San Ramon Creek), April 21-May 1 and September 2-15**

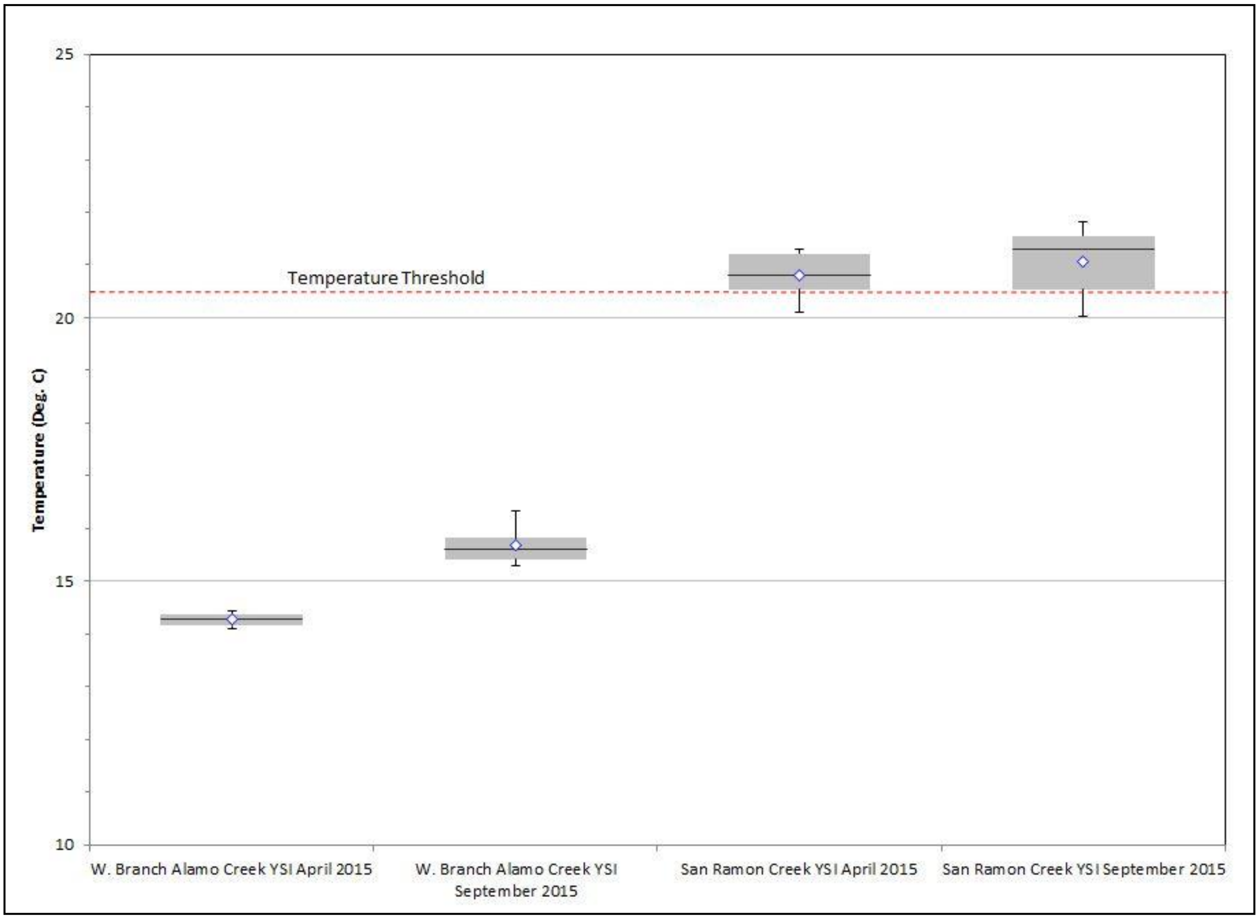



Table 4.5 presents the percentages of continuous water quality data that exceed the selected water quality criteria for temperature, DO, and pH, as measured at the West Branch of Alamo Creek and San Ramon Creek stations during both monitoring periods. The data are compared to water quality evaluation criteria specified in Table 8.1 of the MRP and Central Valley Permit (Table 3.3). The following summarizes water quality evaluation criteria exceedances that occurred at either creek as follows:

***West Branch of Alamo Creek***

During the September 2015 deployment, DO fell below the WARM threshold 43 percent of the time; therefore, the West Branch of Alamo Creek station exceeded the MRP and Central Valley Permit Table 8.1 trigger thresholds for DO (20 percent or more of values exceed the applicable threshold; see Table 3.3) during the September measurement period.

***San Ramon Creek***

During both the April-May and September deployments, water temperature exceeded the 20.5°C criterion 80 percent and 75 percent of the time, respectively.

During the April-May deployment, the pH exceeded the upper criterion range of 8.5 30 percent of the time.

**Table 4.5 Percent of Water Temperature, Dissolved Oxygen and pH Data Measured at Two Sites (West Branch of Alamo Creek and San Ramon Creek) for Both Events that Exceed Water Quality Evaluation Criteria Identified in Table 3.2**

| Site Name | Creek Name | Monitoring Period | Temperature Percent Results WAMT > 20.5°C | DO Percent Results < 5.0 mg/l (WARM) | pH Percent Results < 6.5 or > 8.5 |
|---|---|---|---|---|---|
| 204R00388 | West Branch of Alamo Creek | April 21-May 1, 2015 | 0% | 13% | 0% |
| | | September 2-15, 2015 | 0% | 43% | 0% |
| 207R01163 | San Ramon Creek | April 21-May 1, 2015 | 80% | 0% | 30% |
| | | September 2-15, 2015 | 75% | 0% | 0% |

### 4.2.3 Water Quality Data Evaluation for Steelhead Suitability

#### *4.2.3.1 West Branch of Alamo Creek*

***Water Temperature***

At the HOBO® monitoring station, the median water temperature in this small stream was 15.92°C and its maximum WAMT was 18.20°C (Table 4.2), and the temperature criterion of 20.5°C was not exceeded during the recording period (Table 4.3).

As shown in Table 4.4, during the 2015 temperature monitoring periods at the Sonde monitoring station, the maximum WAMT temperature recorded for the West Branch of Alamo Creek was lower for the April data set (14.44°C) than for the September data set (16.34°C). The temperature criterion of 20.5°C was never exceeded during either the April or September recording periods (Table 4.5).

Throughout the 2015 monitoring period (at the HOBO® and Sondes sites), temperatures did not exceed the 20.5°C criterion for rearing juvenile steelhead. Perhaps this is why the Basin Plan designates this creek as both WARM instream habitat and potential COLD instream habitat.

***Dissolved Oxygen***

Dissolved oxygen levels in April failed to meet the WARM criterion of 5.0 mg/L 13 percent of the time, and failed to meet the COLD criterion of 7.0 mg/L 91 percent of the time. September readings of DO also failed to meet the WARM criterion 43 percent of the time, and failed to meet the COLD criterion 93 percent of the recording period (Table 4.5), indicating DO levels in this creek are more suited for WARM instream habitat and biota and unsuitable for a COLD instream habitat designation.

***pH***

The pH of the West Branch of Alamo Creek always met the Basin Plan criterion during the monitoring period (Table 4.5).

***Specific Conductivity***

As shown in Table 4.4, specific conductance is typical of the region and both the April and September medians were virtually the same (1003-1004 µS/cm).

#### *4.2.3.2 Green Valley Creek*

***Water Temperature***

At the HOBO® monitoring station, this tributary of San Ramon Creek had a median water temperature of 18.91°C and a maximum WAMT of 23.42°C (Table 4.2). Water temperatures in Green Valley Creek exceeded the 20.5°C criterion for rearing juvenile steelhead during 55 percent of the 2015 monitoring period, indicating it is unsuitable for steelhead (Table 4.3).

#### *4.2.3.3 San Ramon Creek*

***Water Temperature***

During the 2015 temperature monitoring period, at the HOBO® monitoring station, San Ramon Creek at the City of Walnut Creek had a median water temperature of 19.03°C and a maximum WAMT of 23.57°C (Table 4.2). The water temperature exceeded the 20.5°C criterion at this location in San Ramon Creek 74 percent of the monitoring period and was the highest of all the Contra Costa County monitored creeks in 2015 (Table 4.3).

As shown in Table 4.4, at the Sonde monitoring station, the maximum WAMT temperature recorded for San Ramon Creek is near the same for the April data set (21.29°C) as for the September data set (21.81°C). The temperature criterion of 20.5°C was exceeded during 80 percent of the April readings and 75 percent of the September recording (Table 4.5).

***Dissolved Oxygen***

Dissolved oxygen levels in San Ramon Creek during April and September did not drop below the minimum WARM instream habitat criterion of 5.0 mg/L, but failed to meet the COLD minimum DO criterion (7.0 mg/L) during 31 percent of the recording period (Table 4.5).

***pH***

As shown in Table 4.4, although the mean and median pH levels in San Ramon Creek are very similar in both April and September (approximately 8 pH units), Table 4.5 shows that 30 percent of the April readings were outside of the Basin Plan criterion of 6.5-8.5.

***Specific Conductivity***

While without specified criterion, the median specific conductivity of 528 µS/cm to 814 µS/cm (Table 4.4) is normal for this region.

#### *4.2.3.4 San Pablo Creek*

***Water Temperature***

One would expect water temperatures in San Pablo Creek at Fred Jackson Way would be too warm for salmonids in mid- to late-summer (the HOBO® monitoring location on lower San Pablo Creek is approximately 1.5 miles from its mouth at San Pablo Bay and 6 miles downstream of San Pablo Reservoir); however, water temperatures recorded here did not exceed the 20.5°C criterion for juvenile steelhead rearing (Table 4.3) and the median temperature recorded was 17.49°C (Table 4.2). This is believed to be because the water discharged into the creek from San Pablo Reservoir is cold, and San Pablo Creek from the dam downstream to the monitoring site is well-shaded by riparian vegetation. Apparently the riparian vegetation provides sufficient shade to moderate summer water temperatures in lower San Pablo Creek. U.C. Davis' fishery professor, Peter Moyle, states in his book, *Inland Fishes of California* (2002) that, "The optimal temperatures for the growth of rainbow trout are around 15-18°C..."

The 2015 temperature data (as well as that from 2014) indicates lower San Pablo Creek does have summer water temperatures sufficiently low enough to support juvenile steelhead.

### 4.2.4 California Rapid Assessment Method (CRAM)

CRAM assessments were performed at the same sites where bioassessment monitoring was conducted (as selected under the RMC's probabilistic monitoring design) to address the following:

- What is the range of stream ecosystem conditions in Contra Costa County?
- Are CRAM indicators useful for understanding aquatic life use conditions?
- Are CRAM results useful for identifying potential stressors or sources of stress to aquatic life?

CRAM data have been used to assess the overall condition of the health of stream ecosystem resources and to develop hypotheses regarding the causes of their observed conditions (SCVURPPP, 2011). CRAM scores ranged from 39-81 based on a 0-100 scale and were ranked categorically by quartiles. Two of the ten sites were ranked as either good or excellent, while the remaining eight sites were ranked as either fair or poor. The CRAM sampling locations and ranking scores are depicted in Figure 4.9.

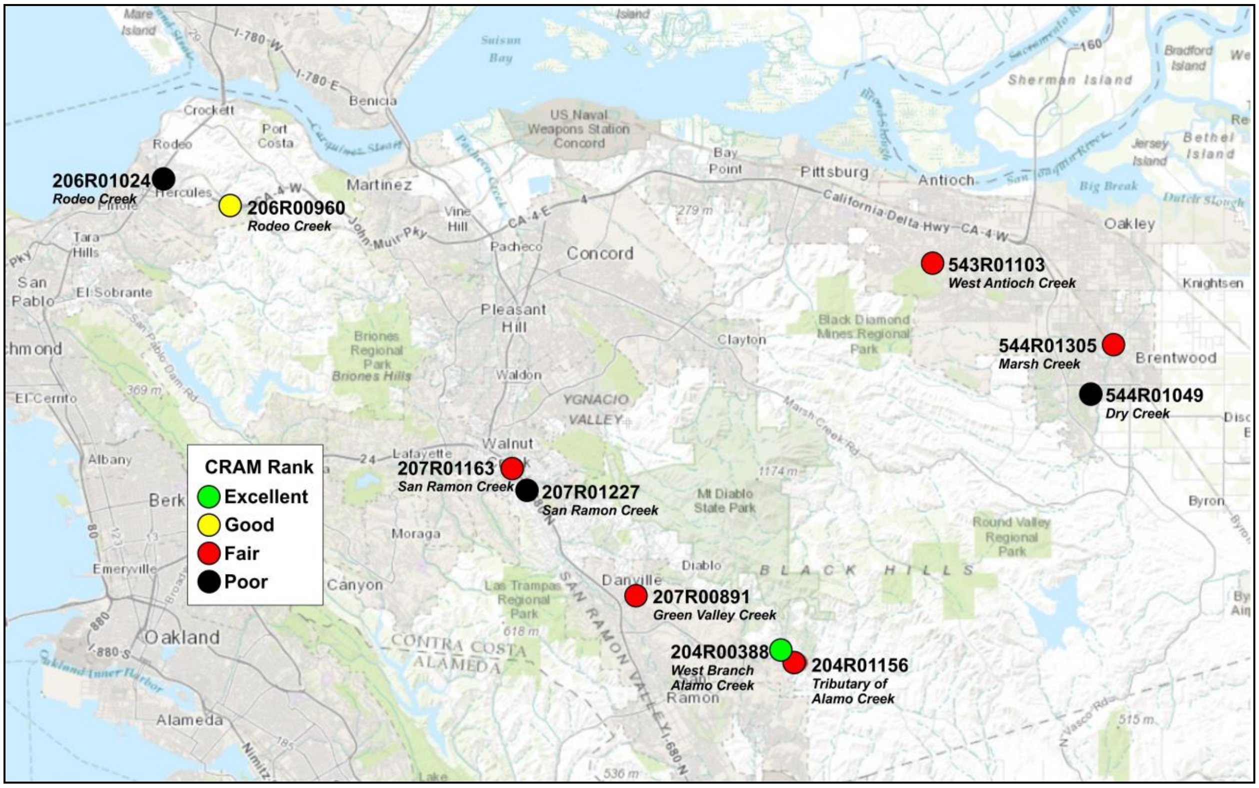
The overall CRAM scores and rankings are also provided in Table 4.6, along with the scores for the riparian area attributes that comprise the subcomponents of the overall CRAM score: 1) buffer and landscape context; 2) hydrology; 3) physical structure; and 4) biotic structure.

When collected at bioassessment sites, as done here, CRAM data provide a broader and more complete suite of indicators to use to evaluate the conditions of aquatic life uses. Previous studies in a Southern California watershed demonstrated a high correlation between benthic macroinvertebrate (BMI) community composition, as measured by the Index of Biological Integrity (IBI) scores computed from BMI taxonomic metrics, and CRAM scores (Solek et al., 2011). See the Regional/Probabilistic UCMR (ARC, 2016; in preparation) for further evaluation and discussion of the observed CRAM scores in relation to benthic IBI scores.

**Table 4.6 Metric and Total CRAM Scores and IBI Results Applied to 10 Bioassessment Monitoring Sites in Contra Costa County**

| Assessment Area Name | Station Code | Buffer | Hydrology | Physical | Biotic | Overall CRAM Score | CRAM Rank |
|---|---|---|---|---|---|---|---|
| West Branch of Alamo Creek | 204R00388 | 86 | 83 | 75 | 78 | 81 | Excellent |
| Rodeo Creek | 206R00960 | 63 | 67 | 88 | 81 | 74 | Good |
| West Antioch Creek | 543R01103 | 43 | 75 | 63 | 64 | 61 | Fair |
| Tributary of Alamo | 204R01156 | 43 | 58 | 63 | 69 | 58 | Fair |
| Green Valley Creek | 207R00891 | 75 | 50 | 50 | 53 | 57 | Fair |
| San Ramon Creek | 206R01163 | 63 | 33 | 63 | 64 | 56 | Fair |
| Marsh Creek | 544R01305 | 63 | 67 | 38 | 47 | 53 | Fair |
| Dry Creek | 544R01049 | 38 | 50 | 25 | 44 | 39 | Poor |
| Rodeo Creek | 206R01024 | 38 | 50 | 25 | 44 | 39 | Poor |
| San Ramon Creek | 207R01227 | 43 | 33 | 38 | 42 | 39 | Poor |

**Figure 4.9 CRAM Ranks for 10 Sites Assessed in 2015 in Contra Costa County**




The application of CRAM in urban creeks of the San Francisco Bay Region is relatively recent and results should be considered preliminary. Further analysis of existing data and new information is needed to comprehensively evaluate the utility of CRAM data for assessing stream ecosystem health and aquatic life uses.

## 4.3 Pathogen Indicators

In compliance with MRP and Central Valley Permit Provision C.8.g. requirements, a set of pathogen indicator samples were collected on June 30, 2015 at five stations on creeks in Contra Costa County. They were analyzed for fecal coliform and *E. coli*. Four of these stations were the same sites where the continuous monitoring devices were located. The remaining site was site 207R01271 on Walnut Creek. Table 4.8 summarizes the results of analyses of the samples collected.

As described previously (Section 3.4.3), single sample maximum concentrations of 400 MPN/100ml fecal coliform (per Basin Plan, SFBRWQCB, 2015) and 410 MPN/100ml *E. coli* (per USEPA, 2012). Recreational water quality criteria statistical threshold values were used as water contact recreation evaluation criteria for the purposes of this evaluation. In addition, a fecal coliform single sample maximum concentration of 4,000 MPN/100ml was used as a non-water contact recreation evaluation criterion.

Fecal coliform concentrations ranged from 280 to 14,000 MPN/100 ml; *E. coli* concentrations ranged from 280 to 14,000 MPN/100 ml, as well. Two samples collected exceeded both the Basin Plan fecal coliform objective and the applicable USEPA criteria: the samples collected at stations 207R0121 (Walnut Creek) and 206R01319 (San Pablo Creek), at values of 14,000 and 2800 MPN/ml, respectively.

**Table 4.7 Fecal Coliform and *E. coli* Levels Measured From Water Samples Collected at Five Locations in Creeks in Contra Costa County, June 30**

| Site ID | Creek Name | Fecal Coliform (MPN/100ml) | *E. Coli* (MPN/100ml) |
|---|---|---|---|
| 204R00388 | West Branch of Alamo | 280 | 280 |
| 207R00891 | Green Valley | 300 | 300 |
| 207R01163 | San Ramon Creek | 300 | 300 |
| 207R01271 | Walnut Creek | **14000**[1] | **14000**[2] |
| 206R01319 | San Pablo Creek | **2800**[1] | **2800**[2] |

Explanation:
[1] Exceeded Basin Plan WQO of 400 MPN/100ml fecal coliform.
[2] Exceeded USEPA criterion of 410 CFU/100ml *E. coli*

# 5.0 Next Steps

CCCWP will continue to conduct monitoring for local/targeted parameters in Water Year 2016. All permit-related water quality threshold exceedances will be included in a compilation of water quality triggers for consideration by the RMC as potential stressor/source identification (SSID) projects, and for other potential follow-up investigations and/or monitoring. Under the requirements of Provision C.8 in the new MRP (SFBRWQCB, 2015), and the Central Valley Permit, the following next steps are recommended:

## 5.1 Temperature

As part of creek status monitoring, targeted locations will continue to be monitored for temperature, with follow-up to investigate potential causes where exceedances of Permit thresholds are noted. Further investigation into temperature spikes that have no natural explanation, such as those found in the West Branch of Alamo Creek, is recommended for consideration as a potential SSID project.

In addition, temperature monitoring is recommended at new creek sites in areas that may support rainbow trout rearing and spawning habitat.

## 5.2 Dissolved Oxygen

As part of creek status monitoring, DO concentrations will continue to be monitored at targeted locations.

## 5.3 Pathogen Indicators

Exceedances of recreational water quality criteria for pathogen indicators were found in two locations for Water Year 2015. Sources of fecal indicator bacteria at Walnut Creek (207R01271) and San Pablo Creek (206R01319) likely include non-anthropogenic sources (e.g., wildlife) based upon on site observations by field crews. It should be noted that results of a re-sampling event at San Pablo Creek did not trigger an exceedance. Given these results, and that the likely sources (non-anthropogenic) are already known, at this time a follow up SSID project is not likely to be recommended for these sites.

In accordance with the new MRP, monitoring locations for pathogen indicators in Water Year 2016 will be targeted “in a creek and at an area where water-contact recreation is likely or at an opportunistic location where there is potential to detect leaking sewerage infrastructure.”

## 5.4 Riparian Assessments

In accordance with the revised MRP, riparian assessments through application of CRAM or USA stream surveys will no longer be conducted.

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# Appendix 3

Report of Stressor/Source Identification Studies in
Dry Creek and Grayson Creek, Part B

# Report of Stressor/Source Identification Studies in Dry Creek and Grayson Creek Part B

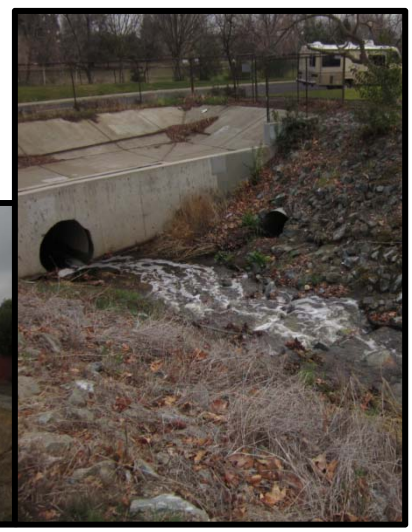
December 6, 2015

Prepared for

## Contra Costa Clean Water Program

CONTRA COSTA CLEAN WATER PROGRAM



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# Introduction / Regulatory Background

This report documents Part B of the phased efforts of Contra Costa Clean Water Program (CCCWP) to fulfill Municipal Stormwater Permit requirements[1] for implementation of stressor/ source identification (SSID) studies per Permit Provision C.8.d.i, based on creek status monitoring performed in compliance with Permit Provision C.8.c. The SSID studies also complement the work being undertaken by CCCWP to fulfill requirements under Permit Provision C.9 (Pesticides Toxicity Control). Armand Ruby Consulting (ARC), under subcontract to ADH Environmental, was contracted to support CCCWP in fulfilling the Permit requirements for SSID studies.

Together with other Bay Area Stormwater Management Agencies Association (BASMAA) members, CCCWP entered into a regional collaborative known as the Regional Monitoring Coalition (RMC) to plan and conduct Creek Status Monitoring as required by provision C.8.c of the Municipal Regional Permit (MRP), evaluate the monitoring results, and perform related follow-up studies. The Creek Status Monitoring conducted by CCCWP includes monitoring in both Region 2 and Region 5 Water Quality Control Board jurisdictions.

When creek status monitoring conducted per Permit Provision C.8.c produces results that exceed the triggers defined in Permit Table 8.1, Permit Provision C.8.d.i requires follow-up monitoring, which may include SSID Studies. MRP Attachment H and Central Valley Permit Attachment D also require Permittees to "Identify cause(s) of impacts and spatial extent" when sediment toxicity, chemistry, and bioassessment results meet certain thresholds. Per MRP Provision C.8.d.i, when the creek status monitoring is performed under a regional collaborative (such as the RMC), a maximum of ten SSID studies must be initiated during the permit term; two of those studies must be related to toxicity. By agreement within the RMC, Contra Costa County Permittees are responsible for initiating two SSID Studies during the permit term. The Central

[1] The Contra Costa Clean Water Program (CCCWP) is responsible for complying with two National Pollutant Discharge Elimination System (NPDES) permits for urban runoff discharges, jointly referred to in this report as "Permit":

- Order No. R2-2009-0074, the Municipal Regional Permit (MRP), issued by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB), Region 2
- Order No. R5-2010-0102 (Central Valley Permit), issued by the Central Valley Regional Water Quality Control Board (CVRWQCB), Region 5

To promote a coordinated countywide program of water quality management, the two permits have nearly identical provisions. Requirements for implementation of stressor/source identification (SSID) studies (termed "stormwater monitoring projects") are included in both the Region 2 and Region 5 permits per Provision C.8.d.i : Stressor/Source Identification.

Valley Permit also caps the SSID studies required of East County Permittees to one study during the permit term.

Both of the SSID studies being conducted by CCCWP involve toxicity to aquatic organisms. The current CCCWP SSID studies therefore fulfill the obligations of the Contra Costa County Permittees for conducting SSID projects under both the Region 2 and Region 5 permits, and also fulfill the RMC's obligations to conduct two SSID studies related to toxicity regionally under the MRP.

This report contains the results of data analysis and interpretation in support of CCCWP's SSID Studies, Part B. The scope of work for this report reflects discussions held during early 2015 between SF Bay Regional Water Quality Control Board staff and CCCWP staff regarding the recommended approach to conducting the two CCCWP SSID studies, and relevant guidance provided by Water Board staff.

## Creek Status Monitoring, SSID Project Selection and Status

CCCWP's Creek Status Monitoring triggered exceedances under NPDES permit Provision C.8.c, Table 8.1 and Attachment H/D, for water and sediment toxicity parameters in both Water Year (WY) 2012 and WY 2013. Both Grayson Creek (site 207R00011; Region 2) and Dry Creek (site 544R00025; Region 5) exhibited water column toxicity to *Hyalella azteca* (*H. azteca*) in creek samples collected during wet weather in WY 2012. Retests confirmed water toxicity to *H. azteca* in wet weather samples collected from both creeks in WY 2013. Other test species were not adversely affected in the water column toxicity testing. In July 2012, sediment toxicity testing also revealed toxicity to *H. azteca* in sediment samples from both creeks.

In addition to the toxicity testing results, sediment chemistry testing of the dry weather samples in WY 2012 indicated elevated levels of sediment contaminants, including pyrethroid pesticides, in both creeks. Bioassessment monitoring of Grayson Creek and Dry Creek in spring, 2012 also yielded benthic macroinvertebrate index of biological integrity (IBI) scores in the "Very Low" range for both creeks. Taken together, the WY 2012 sediment toxicity, chemistry, and bioassessment results triggered follow-up actions required in NPDES permit Attachment H/D for Dry Creek and Grayson Creek.

Based on the WY 2012 and 2013 monitoring results, the Grayson Creek and Dry Creek locations were selected for the two SSID studies to be conducted by CCCWP. The creek status monitoring results and rationales that led to the selection of the two subject SSID projects are summarized, along with current project status, in Table 1. Both projects are related to urban creek toxicity.

As detailed in the *Draft Stressor/Source ID Study Concept Plan*, CCCWP has developed a four-part, phased approach to SSID project implementation[2]. Part A of the two selected SSID studies was performed by CCCWP during WY 2014. The SSID Part A study area is shown in Figure 1.

As indicated in Table 1, the results of the two SSID Part A studies, performed during 2014 in the Grayson Creek (Region 2) and Dry Creek (Region 5) watersheds, confirmed that current-use pesticides (particularly pyrethroids) appear to be the principal causes of the toxicity observed in the two study watersheds. Those pesticides therefore constitute the stressors being investigated in the CCCWP SSID studies (per study results as reported in the SSID Part A Report). In the Part B studies, the magnitudes and patterns of pesticide applications are further investigated, to more explicitly identify the sources of the identified stressors.

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[2] This report refers to the Draft Contra Costa Clean Water Program Draft Stressor/Source ID Study Concept Plan ("Concept Plan", prepared for CCCWP by AMEC and ARC, May, 2013), and the Report of Stressor/Source Identification Studies in Dry Creek and Grayson Creek, Part A ("SSID Part A Report", prepared for CCCWP by ADH and ARC, December 3, 2014).

The results of the Part B studies as presented in this report will provide a basis for identifying the pesticide source controls to be selected and implemented as described in the SSID Study Concept Plan, Part C (to be conducted during FY 2015-16).

This report provides evidence of continuing progress in implementation of SSID Study requirements as required by the Permit and as outlined in CCCWP's SSID Study Concept Plan.

Table 1. CCCWP SSID Projects: Creek Status Monitoring Results, Rationales, Project Status

| Creek Name Site Code | Summary of Creek Status Monitoring Results | Rationale for Selecting SSID Project Per MRP Prov. C.8.d. | Status of Project |
|---|---|---|---|
| Grayson Creek 207R00011 | 32% survival of *Hyalella azteca* in water during spring of 2012; 43.8% survival of *Hyalella azteca* in sediment during summer 2012; relatively high bifenthrin in sediment; IBI Score = 13 (Very Poor). Water toxicity confirmed by retest, 2013. | Evidence of water and sediment toxicity to *Hyalella azteca*, with concurrent high concentration of bifenthrin in sediment. Recent publications by CASQA and others indicate pyrethroid pesticide-caused toxicity is a pervasive problem in urban areas of CA. Investigation of sources and solutions could be widely beneficial. | SSID Project Part A completed, WY 2014, including testing of water and sediments from sites upstream and downstream of original Grayson Creek site. Only water samples were toxic to *Hyalella*. Water TIE and concurrent chemistry point to pyrethroid pesticides as likely causes of toxicity in waters of Grayson Creek. |
| Dry Creek 544R00025 | 0% survival of *Hyalella azteca* in water during spring of 2012; 60% survival of *Hyalella azteca* in sediment during summer 2012; relatively high bifenthrin in sediment; IBI Score = 3 (Very Poor). Water toxicity confirmed by retest, 2013. | Evidence of water and sediment toxicity to *Hyalella azteca*, with concurrent high concentration of bifenthrin in sediment. Recent publications by CASQA and others indicate pyrethroid pesticide-caused toxicity is a pervasive problem in urban areas of CA. Investigation of sources and solutions could be widely beneficial. | SSID Project Part A completed, WY 2014, including testing of water and sediments from sites upstream and downstream of original Dry Creek site. All samples were toxic to *Hyalella*. Water and sediment TIEs and concurrent chemistry point to pyrethroid pesticides as likely causes of toxicity in water and sediments of Dry Creek. |

Figure 1. SSID Study Areas

## Overview of Approach

The Concept Plan includes the following description of the activities planned for Part B of the SSID studies:

> "After confirming the stressors, sources need to be identified. Presuming that pesticide applications are determined to be the source(s) for the pesticides identified as stressors in Part A, the assessment would attempt to characterize the relative magnitudes of sources attributable to the following: Contra Costa County professional Pest Control Operators vs. homeowners, spatial and temporal characteristics of pesticide applications, the role of impervious surfaces, and any potential contribution from different land uses such as agriculture or golf courses. These activities are anticipated for FY 2014 - 2015."

Available information on urban sources of the subject current-use pesticides (focusing on pyrethroids, as per the results of the SSID Part A testing) is summarized as applicable to the two SSID studies being performed in Contra Costa County. The purpose of this summary is to characterize or estimate the sources of those pesticides, including the relative magnitudes of sources attributable to Contra Costa County Professional Pest Control Operators vs. homeowners, spatial and temporal characteristics of pesticide applications, the role of impervious surfaces, and any potential contribution from non-urban land uses such as agriculture or golf courses, as indicated in the Concept Plan, Part B, to the extent feasible, based on the following information sources:

- Prior monitoring data and analysis documenting the nature and extent of pesticides contamination and effects in urban areas of California (e.g., per Ruby, 2013[3] and Moran and TenBrook, 2011[4]); this prior work indicates that contamination of urban surface waters with current-use pesticides is common throughout California, and generally results from "structural" applications (around buildings) – as opposed to landscape/garden pesticide applications – and especially applications to impervious surfaces.

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[3] Ruby, A. 2013. "Review of Pyrethroid, Fipronil and Toxicity Monitoring Data from California Urban Watersheds". Prepared for the California Stormwater Quality Association (CASQA). Prepared by Armand Ruby, Armand Ruby Consulting. July 10.

[4] Moran, K. D., and P. L. TenBrook. 2011. "Sources of Pyrethroid Insecticides in California's Urban Watersheds: A Conceptual Model." In: *Pesticide Mitigation Strategies for Surface Water Quality*; Goh, K.S., B. Bret, T. Potter, J. Gan. Eds.; ACS Symposium Series Vol. 1075, ACS Washington, D.C., 2011.

- Monitoring data, pesticide use information, and analytical approaches recently and currently being developed by the CA Department of Pesticide Regulation (DPR)[5] and its contractors[6], including UC Irvine and UC Davis, as well as work previously published by the Urban Pesticide Pollution Prevention (UP3) Project[7].

- Ongoing collaborative efforts by DPR and the Water Boards to develop a coordinated approach to pesticide monitoring and management in California's urban areas.

Pesticide use reporting and sales data were obtained from the California Department of Pesticide Regulations databases. The most recent data available reflect pesticide sales and use in 2013[8].

## Pesticides Selected for Analysis

The SSID Part A Studies report identified pyrethroid pesticides as being principally responsible for the observed water and sediment toxicity to *Hyalella azteca* during the 2014 testing. Based on the chemical testing, six pyrethroids were found to have detectable concentrations in waters and/or sediments of Grayson Creek and/or Dry Creek during the 2014 monitoring. The detected pyrethroids are summarized in Table 2; other pyrethroids were not detected in the 2014 monitoring of water or sediment samples.

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[5] California Department of Pesticide Regulation (DPR) (2013). Prevention of Surface Water Contamination by Pesticides - DPR Regulation No. 11-004. California Code of Regulations Division 6. Pesticides And Pest Control Operations. Sections 6000, 6970, and 6972.

[6] Jiang, W., et al. 2012. "Runoff of pyrethroid insecticides from concrete surfaces following simulated and natural rainfalls." Water Research 46(3): 645-652;

Jorgenson, B. C., et al. 2012. "Factors Contributing to the Off-Target Transport of Pyrethroid Insecticides from Urban Surfaces." Journal of Agricultural and Food Chemistry 60(30): 7333-7340;

Jiang, W., J. Gan and M. Rust. 2014. Runoff of Phenylpyrazole Insecticide Fipronil from Concrete Surfaces. In: *Describing the Behavior and Effects of Pesticides in Urban and Agricultural Settings*, American Chemical Society Symposium Series, Vol. 1168, Ch. 1 pp. 1-12.

[7] TDC Environmental. 2010. Pesticides in Urban Runoff, Wastewater, and Surface Water, Annual Urban Pesticide Use Data Report 2010. Prepared for the San Francisco Estuary Partnership. June 28.

[8] California Department of Pesticide Regulation (DPR). 2014. State of California, Pesticides Sold in California for Year: 2013. 6/12/15. Available at: http://www.cdpr.ca.gov/docs/mill/pdsd2013.pdf

Ibid. 2015. Summary of Pesticide Use Report Data 2013 Indexed by Chemical. May, 2015. Available at: http://www.cdpr.ca.gov/docs/pur/pur13rep/chmrpt13.pdf

Table 2. Detected Pyrethroid Pesticides, 2014 Creek Monitoring (SSID Part A Studies)

| Pesticide | # Detects / # Water Samples* | # Detects / # Sediment Samples* |
|---|---|---|
| Bifenthrin | 8 of 8 | 4 of 4 |
| Cyfluthrin | 7 of 8 | 4 of 4 |
| Cypermethrin | 1 of 8 | 4 of 4 |
| Deltamethrin | 1 of 8 | 0 of 4 |
| Lambda-Cyhalothrin | 3 of 8 | 2 of 4 |
| Permethrin | 1 of 8 | 4 of 4 |

*Grayson Creek and Dry Creek studies combined

Based on the analysis of pyrethroid concentrations and relative toxicity of the various pyrethroids, bifenthrin was determined to be the leading cause of toxicity, followed by cyfluthrin, for both water and sediment samples, with lesser contributions from the other four detected pyrethroids. For the purposes of this report, all six detected pyrethroids listed in Table 2 are included in the analysis.

## Pesticide Use Reporting Data

In California, only professional pest control operators (PCOs) are required to report amounts of pesticide used. The PCOs report amounts of pesticide applied, application site type, and other information by county to the County Agricultural Commissioners, who in turn report the data to DPR. DPR summarizes the use information annually by product and active ingredient (e.g., the commonly-used pyrethroid, bifenthrin), for each county and statewide. DPR's records include summaries of use by application site type (e.g., "Landscape Maintenance" and "Structural Pest Control"), and DPR's Pesticide Information Portal (PIP) provides reporting of pesticide use data by county categorically for agricultural uses, non-agricultural uses, or both (all reported uses).

The pesticide use reporting data do not include pesticides sold "over the counter" (OTC) and applied by non-professional applicators. Total urban uses therefore include both the amounts reported as applied by PCOs in non-agricultural uses, plus unreported amounts applied by non-professionals as a result of OTC sales.

## Statewide Pesticide Sales Data

DPR also compiles data on pesticide sales by product and active ingredient, but on a statewide basis only. The pesticide sales records document the first sale of the product within California, including wholesale purchases by retail outlets, so the sales data include both pesticides purchased by professionals (PCOs) and amounts purchased by non-professionals (e.g., residents and businesses). The difference between pesticide sales data and reported use data (by PCOs) then represents an estimate of sales to non-professionals.

## Computational Methods

For this report, unreported use amounts (assumed to be primarily attributable to residential uses) are estimated for Contra Costa County from statewide sales and use data. Unreported uses for each pyrethroid are assumed to be approximately equal to total sales amounts minus total amounts reported as used by professional applicators. The ratio of statewide sales to statewide reported uses is calculated for each pyrethroid, and that ratio is then multiplied by reported uses of pyrethroids for Contra Costa County to estimate the sales for each pyrethroid in Contra Costa County.

This analysis includes the most recent five years for which pesticide sales and use data are available from DPR data sources (2009-2013). Pesticide sales data were obtained from DPR's annual sales reports, available from the DPR web site[9]. Pesticide use data were obtained from DPR's CalPIP web site[10]. The calculations are summarized as follows (performed individually for each pesticide of concern):

*To Estimate Urban Pesticide Use for Contra Costa County:*

Urban Use (est.) = Reported Non-Agricultural (Urban) Use + OTC Sales

*where:* OTC Sales (est.) = Total Sales - All Reported Use

[Reported Non-Ag (Urban) Use and All Reported Use are known for CC County for each pesticide active ingredient from DPR Use Data]

*To Estimate Total Sales for Contra Costa County:*

Total Sales, CC County (est.) = S:U Ratio * All Reported Use (CC County)

*where:* S:U Ratio = Statewide Sales/Statewide Reported Use

[Statewide Sales and Statewide Reported Use are known for each pesticide active ingredient from DPR Sales and Use Data]

### Analytical Assumptions

The analysis makes the following assumptions:

- that essentially all pesticides sold in a given year are used in that year,
- that essentially all unreported pesticide uses result from over the counter (OTC) sales, and that the resulting applications occur principally at residences and businesses in urban areas,

[9] Reports of Pesticides Sold In California: http://www.cdpr.ca.gov/docs/mill/nopdsold.htm
[10] California Pesticide Information Portal (CalPIP): http://calpip.cdpr.ca.gov/main.cfm

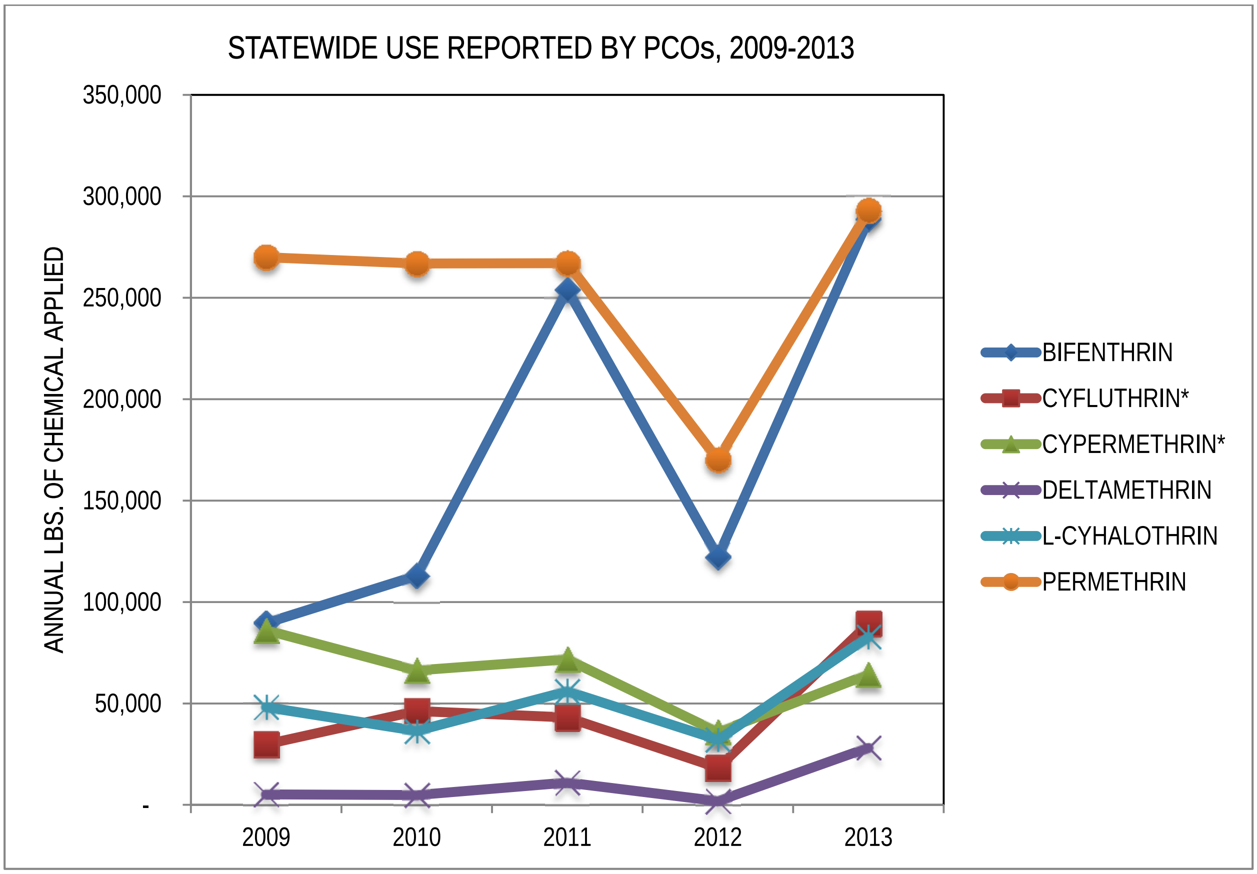
- that indoor uses of the subject pyrethroids comprise a relatively small fraction of their total use, and
- that the statewide ratio of pesticides sold to pesticides reported as used by professional operators is representative of Contra Costa County and can be applied to estimate pyrethroid sales in Contra Costa County.

The first assumption is mitigated in this analysis by the use of five-year averages covering the most recent five years of available data (2009-2013).

## Results: Pesticide Sales and Reported Use Amounts; Annual Trends

The DPR pesticide data sources listed above were used to compile pyrethroid sales and use data for the urban pyrethroids of concern over a five year period. Figure 2 illustrates the pesticide use amounts reported by PCOs statewide (from Table 3B) for the period 2009-2013. Table 3 includes the statewide pesticide sales amounts and reported chemical use amounts by PCOs for all types of sites, as well as the reported PCO chemical use as a percentage of statewide sales for the same period.

Figure 2. Statewide Pesticide Use as Reported by PCOs, 2009 - 2013




*Includes multiple isomers

**Table 3. Statewide Pesticide Sales and Reported Chemical Use (All Sites), 2009-2013**

| Chemical | 2009 | 2010 | 2011 | 2012 | 2013 | 5-Year Totals | Annual Average Sales |
|---|---|---|---|---|---|---|---|
| **3A. Chemical Sales, Statewide (Lbs)** | | | | | | | |
| Bifenthrin | 109,323 | 417,898 | 294,563 | 389,179 | 376,649 | 1,587,612 | 317,522 |
| Cyfluthrin* | 41,505 | 34,711 | 40,035 | 37,982 | 30,813 | 185,046 | 37,009 |
| Cypermethrin* | 90,583 | 78,355 | 79,010 | 86,476 | 90,079 | 424,503 | 84,901 |
| Deltamethrin | 3,935 | 2,897 | 3,007 | 4,838 | 3,922 | 18,599 | 3,720 |
| Lambda-Cyhalothrin | 55,422 | 54,266 | 67,457 | 79,922 | 75,711 | 332,778 | 66,556 |
| Permethrin | 430,776 | 489,974 | 356,083 | 333,886 | 371,261 | 1,981,980 | 396,396 |
| ANNUAL TOTALS | 731,544 | 1,078,101 | 840,155 | 932,284 | 948,435 | | |

| Chemical | 2009 | 2010 | 2011 | 2012 | 2013 | 5-Year Totals | Annual Average Sales |
|---|---|---|---|---|---|---|---|
| **3B. Reported PCO Chemical Use, Statewide (Lbs)** | | | | | | | |
| Bifenthrin | 89,663 | 112,941 | 253,989 | 122,298 | 288,883 | 867,775 | 173,555 |
| Cyfluthrin* | 29,818 | 46,282 | 43,068 | 18,254 | 89,311 | 226,734 | 45,347 |
| Cypermethrin* | 86,067 | 66,320 | 71,707 | 35,835 | 64,322 | 324,251 | 64,850 |
| Deltamethrin | 5,181 | 4,831 | 11,019 | 1,838 | 28,224 | 51,092 | 10,218 |
| Lambda-Cyhalothrin | 48,183 | 36,442 | 55,973 | 32,152 | 82,891 | 255,641 | 51,128 |
| Permethrin | 269,954 | 266,819 | 266,999 | 170,199 | 292,845 | 1,266,815 | 253,363 |
| ANNUAL TOTALS | 528,867 | 533,635 | 702,755 | 380,575 | 846,476 | | |

| Chemical | 2009 | 2010 | 2011 | 2012 | 2013 | 5-Year Averages | Ratio of Sales:Use |
|---|---|---|---|---|---|---|---|
| **3C. Reported PCO Chemical Use as % of Sales, Statewide** | | | | | | | |
| Bifenthrin | 82% | 27% | 86% | 31% | 77% | 55% | 1.8 |
| Cyfluthrin* | 72% | 133% | 108% | 48% | 290% | 123% | 1.0 |
| Cypermethrin* | 95% | 85% | 91% | 41% | 71% | 76% | 1.3 |
| Deltamethrin | 132% | 167% | 366% | 38% | 720% | 275% | 1.0 |
| Lambda-Cyhalothrin | 87% | 67% | 83% | 40% | 109% | 77% | 1.3 |
| Permethrin | 63% | 54% | 75% | 51% | 79% | 64% | 1.6 |

*Includes multiple isomers
See following paragraph for explanation of **Bolded** values

Note that because the reported statewide use amounts for cyfluthrin and deltamethrin on average exceeded the sales amounts for those chemicals, the S:U Ratio (ratio of Sales to Use amounts) as limited to a value of 1.0 in Table 3C. This phenomenon is not uncommon due to uncertainties associated with the DPR sales and use data.[11]

The statewide sales and use data (Table 3, Figure 2) show a substantial degree of annual variability. Within the five-year period studied, uses of the two principal pyrethroids of concern (bifenthrin and cyfluthrin) by PCOs peaked in the last year of available data, 2013, after uses of all of the subject pyrethroids dipped substantially in 2012.

## Contra Costa County Use Data

The reported total chemical use amounts (all uses) for Contra Costa County are shown in Table 4 for 2009-2013. The reported non-agricultural use amounts for 2009-2013 for the County are shown in Table 5 and illustrated in Figure 3. The principal site types included in the non-agricultural (urban) uses are structural pest control and landscape maintenance.

Table 4. Reported Chemical Use by PCOs (All Uses), Contra Costa County, 2009-2013 (Lbs.)

| | 2009 | 2010 | 2011 | 2012 | 2013 | 5-Year Totals | Annual Average Total Use |
|---|---|---|---|---|---|---|---|
| Bifenthrin | 2,584 | 7,230 | 2,919 | 10,270 | 15,857 | 38,860 | 7,772 |
| Cyfluthrin* | 578 | 376 | 310 | 582 | 11,140 | 12,987 | 2,597 |
| Cypermethrin* | 2,380 | 1,563 | 674 | 525 | 1,469 | 6,611 | 1,322 |
| Deltamethrin | 71 | 110 | 77 | 98 | 5,557 | 5,912 | 1,182 |
| Lambda-Cyhalothrin | 39 | 90 | 54 | 180 | 789 | 1,153 | 231 |
| Permethrin | 1,157 | 923 | 997 | 864 | 1,027 | 4,968 | 994 |
| ANNUAL TOTALS | 6,809 | 10,292 | 5,031 | 12,519 | 35,838 | | |

*Includes multiple isomers

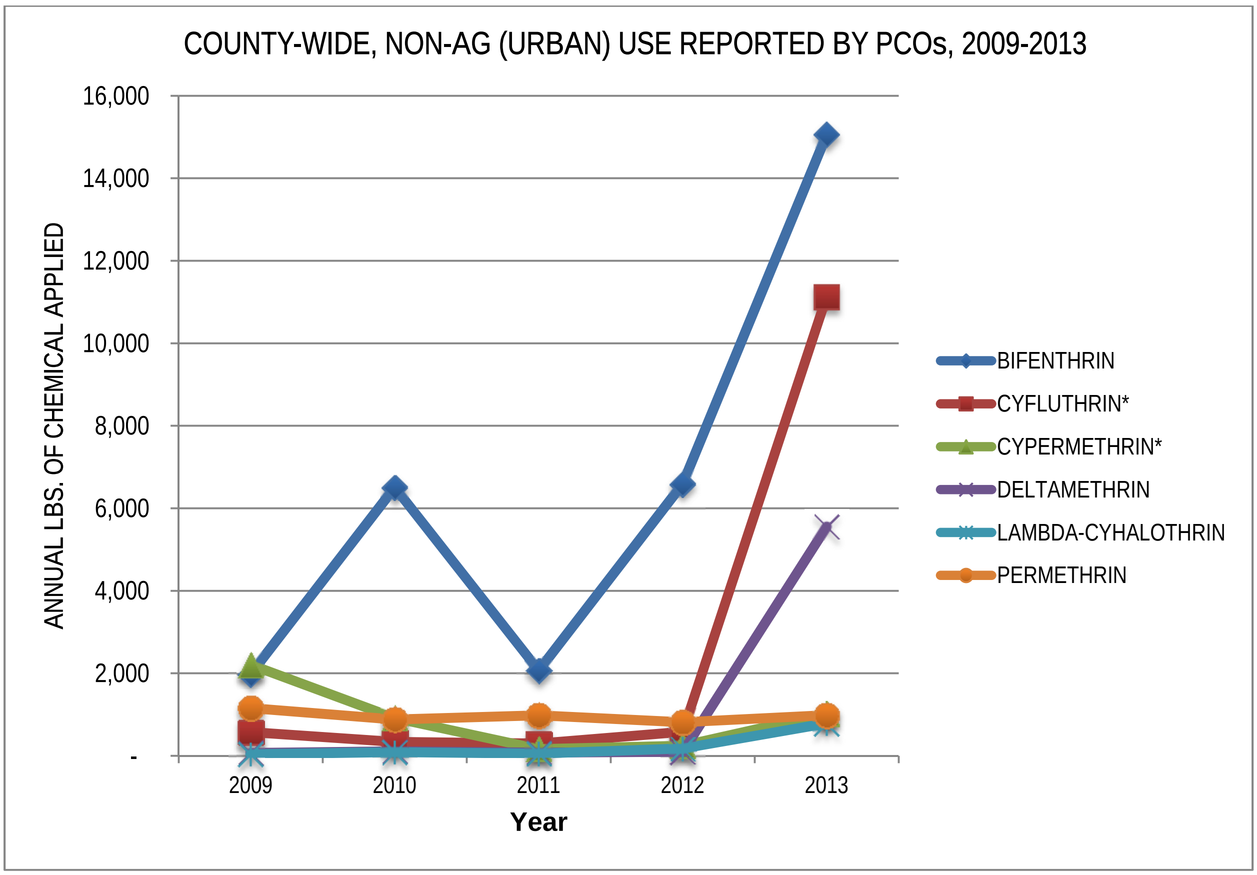
[11] For a detailed explanation of DPR data uncertainties, see: TDC Environmental. 2008. Pesticides in Urban Runoff, Wastewater, and Surface Water, Annual Urban Pesticide Use Data Report 2008. Prepared for the San Francisco Estuary Partnership. July 30. Available at: http://www.up3project.org/up3_documents.shtml

Table 5. Reported Chemical Use by PCOs (Non-Ag. (Urban) Uses Only), Contra Costa County, 2009-2013 (Lbs.)

| | 2009 | 2010 | 2011 | 2012 | 2013 | 5-Year Totals | Annual Average Non-Ag Use | Non-Ag % of Reported Use** |
|---|---|---|---|---|---|---|---|---|
| Bifenthrin | 1,985 | 6,510 | 2,067 | 6,593 | 15,062 | 32,217 | 6,443 | 83% |
| Cyfluthrin* | 572 | 337 | 297 | 582 | 11,139 | 12,927 | 2,585 | 100% |
| Cypermethrin* | 2,206 | 914 | 163 | 246 | 1,029 | 4,558 | 912 | 69% |
| Deltamethrin | 71 | 110 | 77 | 98 | 5,557 | 5,912 | 1,182 | 100% |
| Lambda-Cyhalothrin | 39 | 90 | 54 | 180 | 789 | 1,153 | 231 | 100% |
| Permethrin | 1,157 | 882 | 982 | 813 | 984 | 4,819 | 964 | 97% |
| ANNUAL TOTALS | 6,029 | 8,843 | 3,641 | 8,513 | 34,560 | | | |

* Includes multiple isomers
** Calculated as Annual Average Non-Ag. Use from Table 5 divided by Annual Average Total Use from Table 4

Figure 3. Pesticide Use in Contra Costa County, Non-Agricultural (Urban) Areas Only, As Reported by PCOs, 2009 - 2013




*Includes multiple isomers

Within Contra Costa County, both bifenthrin and cyfluthrin show steep peaks in use reported by PCOs in 2013, echoing the trends displayed in Figure 2 for statewide uses.

## Application Site Types and Amounts (PCOs)

As shown in Table 5, the majority of reported pyrethroid uses by professional applicators in Contra Costa County over the past five years have been in non-agricultural (urban) settings.

In addition to the CalPIP on-line database, DPR also presents statewide annual usage data by chemical in an annual Pesticide Use Report (PUR). The PUR data include a breakdown of the amount of each pesticide applied by “commodity” (site type). For the most recent year available (2013[12]), the major categories of non-agricultural site applications as reported by PCOs (structural pest control, landscape maintenance) are also summarized for the statewide data for the pyrethroids of interest in Table 6.

For most of the pyrethroids studied, the non-agricultural (urban) percentage of reported use is higher in Contra Costa County (per Table 5) than it is statewide (Table 6). Table 6 is focused on the non-agricultural (urban) uses; the non-urban uses are predominantly agricultural applications. So for bifenthrin, with an estimated statewide urban use amount equal to 42 percent of the total statewide usage (per Table 7), approximately 58 percent of the statewide usage by PCOs would be estimated to be applied in agricultural settings. The differences between the statewide and Contra Costa County percentages may lie in the higher proportion of agricultural land uses in a number of other counties.

[12] California DPR. 2015. Summary of Pesticide Use Report Data 2013 Indexed by Chemical. May, 2015. Available at: http://www.cdpr.ca.gov/docs/pur/pur13rep/chmrpt13.pdf

Table 6. Urban Chemical Use Reported by PCOs, Statewide, 2013 (DPR, PUR)

| Chemical | Landscape Maintenance Reported Use (Lbs) | Structural Pest Control Reported Use (Lbs) | 2013 Total Statewide Reported Use (Lbs) | Estimated Urban % of 2013 Reported Use |
|---|---|---|---|---|
| Bifenthrin | 2,104 | 120,735 | 290,027 | 42% |
| Cyfluthrin* | 238 | 76,378 | 89,891 | 85% |
| Cypermethrin* | 4,183 | 31,328 | 63,652 | 56% |
| Deltamethrin | 23 | 45,460 | 45,547 | 99.9% |
| Lambda-Cyhalothrin | 128 | 19,747 | 82,392 | 24% |
| Permethrin | 32,396 | 141,108 | 292,072 | 59% |

* Includes multiple isomers
** For Deltamethrin, the PUR datum for total reported use in 2013 differs from the amount derived from the 2013 CalPIP pesticide use data; for the other pyrethroids, the PUR and CalPIP amounts are in close agreement.

# Results: Computation of Estimated Urban Uses, Contra Costa County

The computational methods described above were used to compute the estimated annual urban use of the selected pyrethroid pesticides (Table 7) county-wide. These calculations make use of the five-year averages of sales and use data provided by DPR for the period 2009-2013. The reported annual use figures used in the calculations are for applications by PCOs only. The sales figures include sales of pesticides both for uses reported by PCOs and unreported uses (private parties, assumed to be mainly urban/residential); the unreported uses are assumed to represent the OTC sales component (sales to non-PCOs). The sum of the OTC sales and reported non-agricultural (urban) uses are assumed to represent an estimate of total urban uses for the county.

It is important to note that the Estimated Annual Urban Use amounts calculated for Contra Costa County in Table 7 are based on five-year averages. As shown above (c.f., Figures 2 and 3), variations in annual usage amounts can be substantial. For example, the 2013 non-agricultural (urban) use reported by PCOs for Contra Costa County in 2013 for bifenthrin exceeds the annual average estimate shown in Table 7, even without consideration of the OTC sales component. As discussed further below, some of the annual variations in reported uses may be related to errors in pesticide use reporting.

Table 7. Calculated Urban Chemical Use, Contra Costa County (Lbs, Based on 5 Year Averages)

| Chemical | Reported Total Annual Use (5-Year Average) | Ratio of Sales:Use** | Estimated Total Sales (County) | Estimated OTC Sales (County) | Reported Annual Non-Ag Use (5-Year Average) | Estimated Annual Urban Use (County) |
|---|---|---|---|---|---|---|
| Bifenthrin | 7,772 | 1.8 | 14,219 | 6,447 | 6,443 | 12,890 |
| Cyfluthrin* | 2,597 | 1.0*** | 2,597 | - | 2,585 | 2,585 |
| Cypermethrin* | 1,322 | 1.3 | 1,731 | 409 | 912 | 1,320 |
| Deltamethrin | 1,182 | 1.0*** | 1,182 | - | 1,182 | 1,182 |
| Lambda-Cyhalothrin | 231 | 1.3 | 300 | 70 | 231 | 300 |
| Permethrin | 994 | 1.6 | 1,554 | 561 | 964 | 1,525 |

* Includes multiple isomers
** Calculated from statewide sales and use data; see Table 3C.
*** Due to uncertainties in the DPR sales and/or use data, these ratios were set equal to the minimum value (1.), which represents 100 percent of sales resulting in reported uses by PCOs (i.e., no OTC sales to non-professional applicators)

## Results: Seasonal (Monthly) Trends

Individual non-agricultural (urban) use applications as reported by PCOs were plotted on a monthly basis for calendar year 2013 for the two pyrethroids of greatest concern, using data provided by CalPIP. Bifenthrin use applications are shown in Figure 4; cyfluthrin use applications are shown in Figure 5.

The scatter plots in Figures 4 and 5 are for individual applications of the specified pesticide. As such they are useful for identifying unusually large individual pesticide applications. For bifenthrin (Figure 4), four reported applications stand out well above the rest; for cyfluthrin, three applications stand out well above the rest. As shown in Table 8, those top four bifenthrin applications account for 81 percent of the annual reported non-agricultural (urban) uses, while the top three cyfluthrin applications account for 61 percent of the reported non-agricultural (urban) uses.

These relatively high, apparently out-of-range application amounts may represent data entry or computational errors by PCOs or DPR, so a first step should be to check/verify those data points. If the reporting data are valid, these results provide a potential direction for future investigation of specific pesticide sources and application patterns, and potential opportunities for source control. The specific site or PCO information is not provided in the DPR data set, but it seems likely that the information could be available, possibly through the County Agricultural Commissioner, who collects the use reports from the PCOs and submits them for the County to DPR after the end of the year.

Figure 4. Non-Agricultural (Urban) Applications of Bifenthrin in Contra Costa County, as Reported by PCOs During 2013

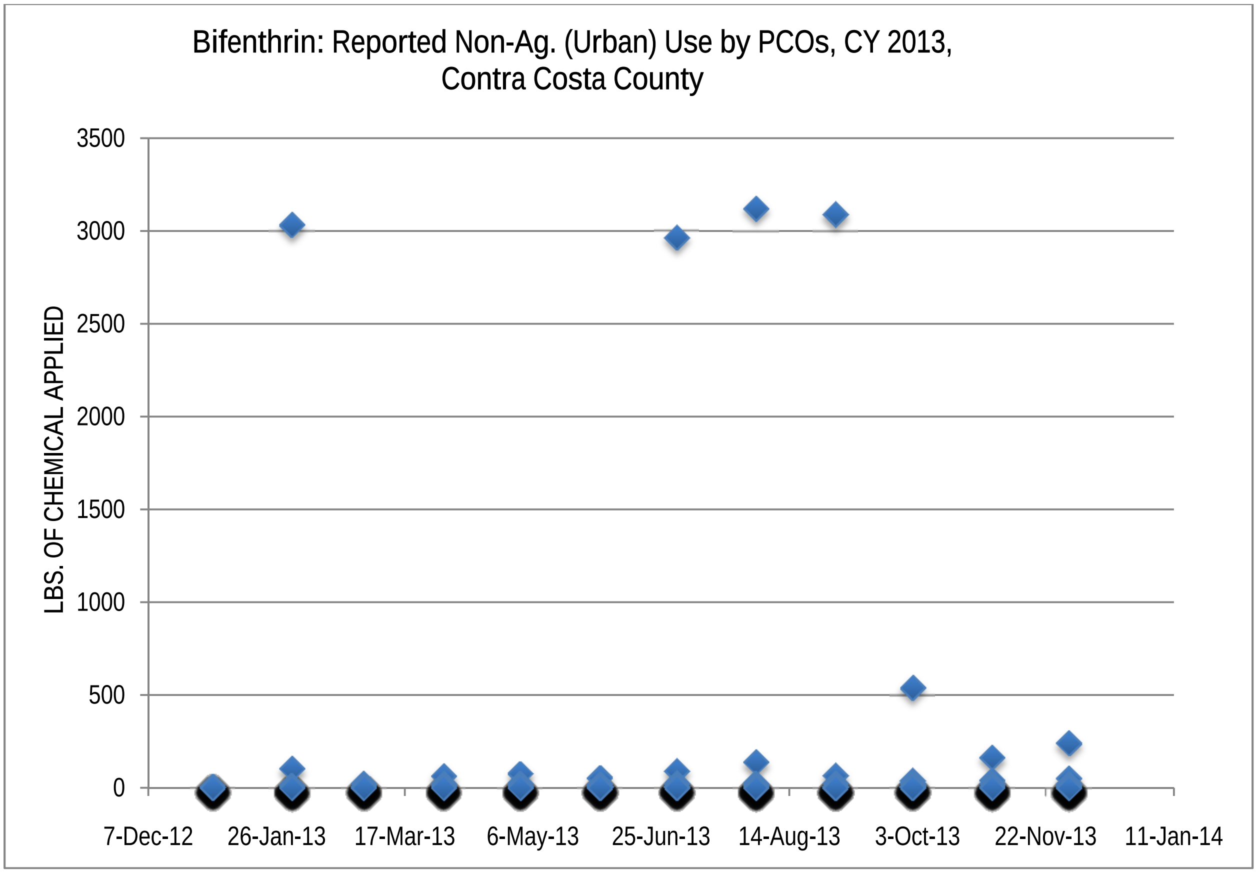
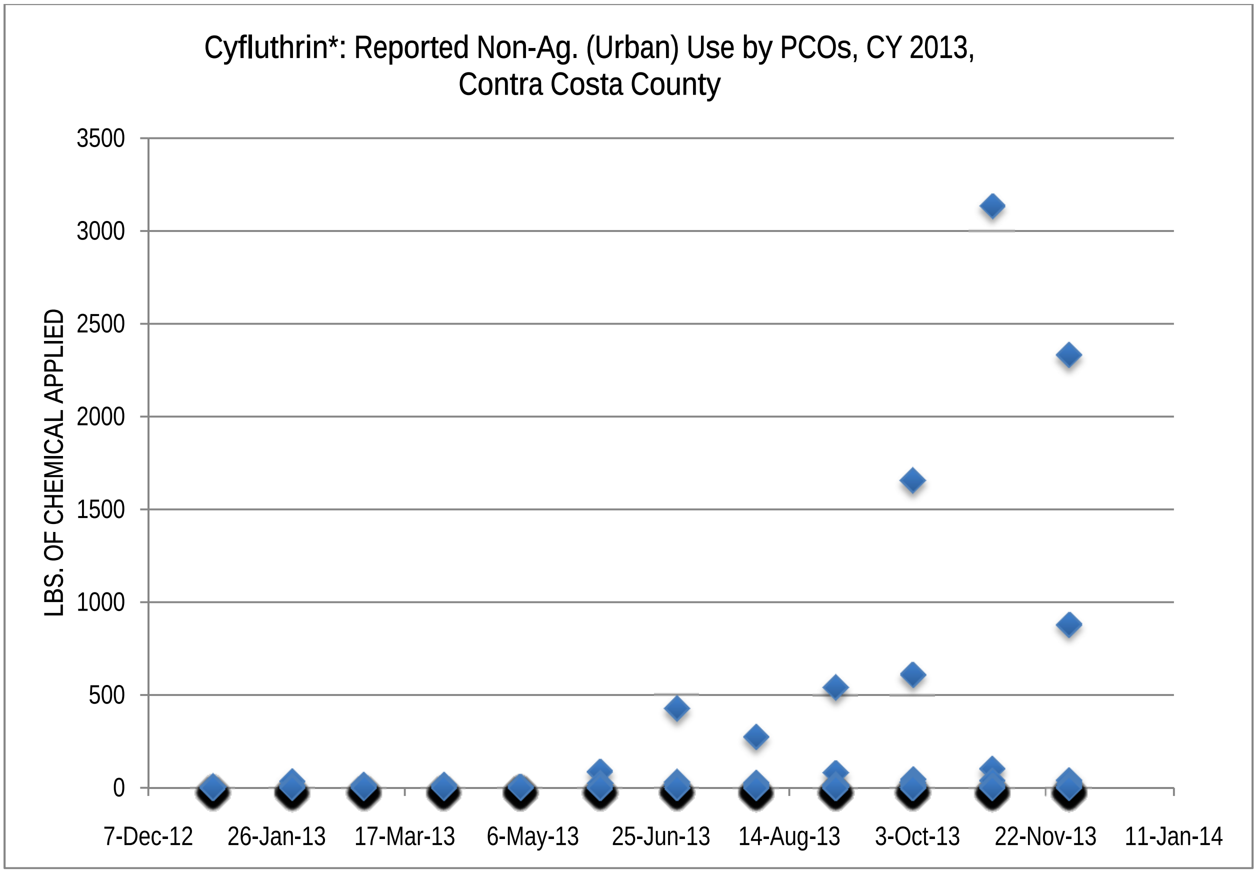


Figure 5. Non-Agricultural (Urban) Applications of Cyfluthrin* in Contra Costa County, as Reported by PCOs During 2013




* Includes multiple isomers

| Table 8. Sum of Top 2013 Chemical Use Amounts Compared to Annual Urban Chemical Use During 2013 in Contra Costa County for Bifenthrin and Cyfluthrin | | | | |
|---|---|---|---|---|
| Chemical | 2013 Reported Non-Ag Use County (Lbs) | Sum of Top Uses, 2013 County (Lbs) [See Notes >] | Top Uses % of Total 2013 | Notes |
| Bifenthrin | 15,062 | 12,211 | 81% | Top 4 of 1067 applications reported in CC County in 2013 |
| Cycluthrin* | 11,139 | 7,127 | 64% | Top 3 of 702 applications reported in CC County in 2013 |

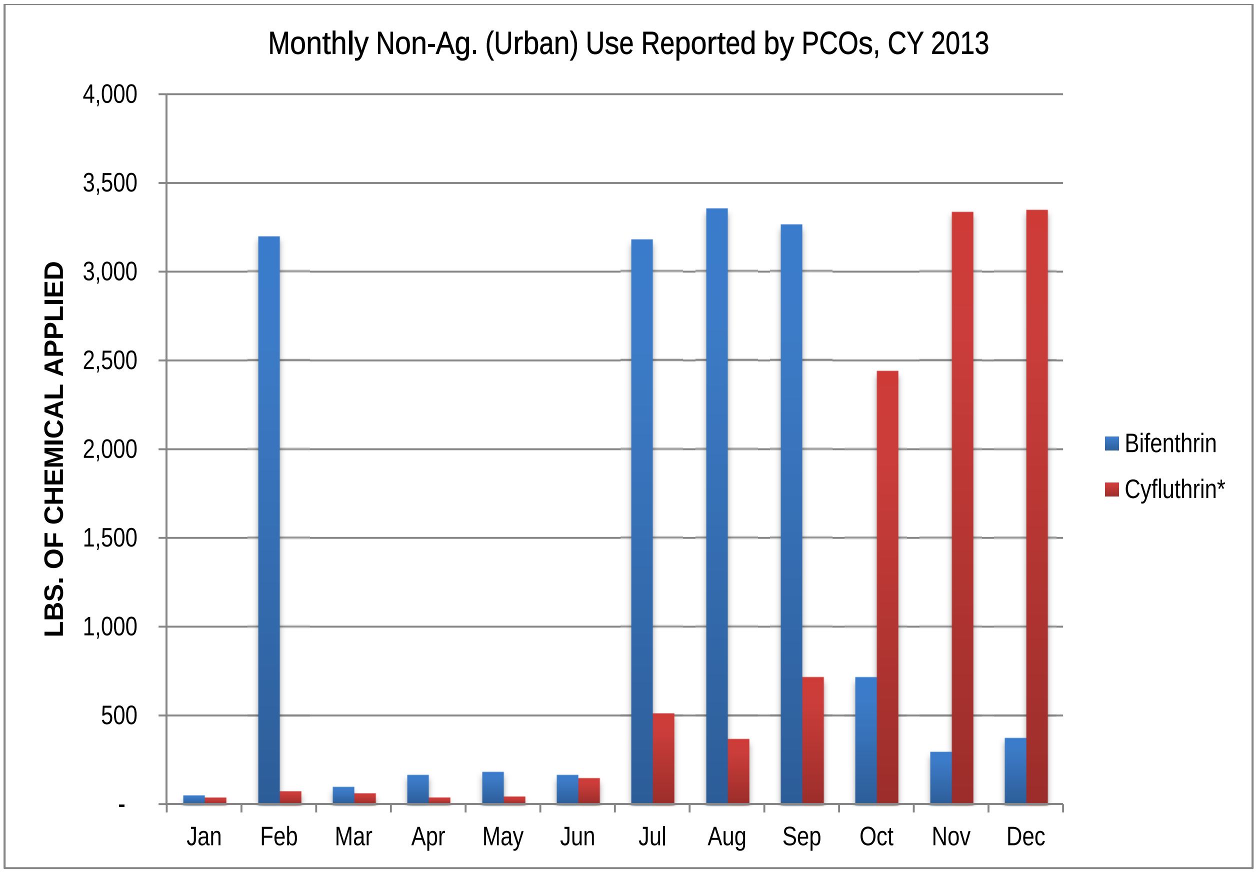
* Includes multiple isomers
** Calculated based on 5 year average, 2009-2013

Looking at the monthly professional use totals for reported non-agricultural applications in 2013, the effects of the four high bifenthrin data points and the three high cyfluthrin data points are clearly evident; see Table 9 and Figure 6. Again, the reporting data should be carefully reviewed to determine whether reporting or calculation errors may have produced these excessively high values.

| Table 9. 2013 Monthly Non-Agricultural (Urban) Use for Bifenthrin and Cyfluthrin, Contra Costa County | | |
|---|---|---|
| | Bifenthrin (Lbs) | Cyfluthrin* (Lbs) |
| January | 51 | 38 |
| February | 3,203 | 76 |
| March | 98 | 62 |
| April | 167 | 39 |
| May | 186 | 43 |
| June | 163 | 144 |
| July | 3,181 | 516 |
| August | 3,356 | 369 |
| September | 3,266 | 718 |
| October | 716 | 2,441 |
| November | 298 | 3,340 |
| December | 378 | 3,351 |
| 2013 Totals | 15,062 | 11,139 |

* Includes multiple isomers

Figure 6. Monthly Non-Agricultural (Urban) Applications of Bifenthrin and Cyfluthrin* in Contra Costa County, as Reported by PCOs, Calendar Year 2013




* Includes multiple isomers

## Role of Impervious Surfaces

In urban environments, the principal pathway for aquatic impacts from pesticides is via rainfall / runoff, which can transport pesticides rapidly from urban land uses through the municipal stormwater conveyance system and directly into surface waters. What most prominently differentiates the urban environment from agricultural land uses is the extensive presence in urban areas of impervious surfaces such as streets, driveways, parking lots, and buildings.

Impervious surfaces cause increases in both total runoff volume and pollutant quantity washed into surface waters, compared to runoff from agricultural soils or other pervious surfaces (e.g., vegetated landscaped surfaces)[13]. When pesticides are applied directly to impervious surfaces, and runoff is transported via constructed urban storm drainage systems, pesticides can be washed off and transported quickly and efficiently away from application sites and into surface waters. Consequently, applications to impervious surfaces are considered to be a primary controlling factor in urban runoff contributions to pesticide-caused receiving water toxicity in urban areas[14].

[13] Integrated Risk Assessment Branch, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. 2009. The Impacts of Imperviousness on Aquatic Ecosystems: An annotated bibliography on the effects of a key stressor of urbanization on the aquatic ecosystem. March. Available at: http://www.oehha.ca.gov/ecotox/pdf/ICbiblio0309.pdf

[14] Moran, K. D., and P. L. TenBrook. 2011. "Sources of Pyrethroid Insecticides in California's Urban Watersheds: A Conceptual Model." In: Pesticide Mitigation Strategies for Surface Water Quality ; Goh, K.S., B. Bret, T. Potter, J. Gan. Eds.; ACS Symposium Series 1075, ACS Washington, D.C., 2011.

## Implications for Source Identification and Controls; Next Steps

Based on the compiled data from 2009-2013, as presented above, it appears that use of the most toxic and impactful pyrethroids (bifenthrin and cyfluthrin) has increased in urban areas in Contra Costa County in recent years. This is surprising, given the restrictions placed on bifenthrin uses by DPR in its recently adopted Surface Water Quality Regulations[15]. The reported uses should be further investigated via DPR and the County Agricultural Commissioner's office to verify whether the reported use and sales figures are correct, and if so, whether PCOs are implementing the various mitigation measures included within DPR's regulation.

Similarly, the highest reported individual applications of bifenthrin and cyfluthrin in 2013, as described above, should be further investigated via DPR and the County Agricultural Commissioner's office to determine whether the figures are accurate, and if so, whether steps could be taken to reduce the volumes of pesticides applied in those instances, especially to impervious surfaces during the rainy season.

The monthly non-agriculture (urban) use patterns for bifenthrin and cyfluthrin during 2013 in Contra Costa County are apparently dominated by the several high values discussed above. If the high values prove to be legitimate data points, the monthly/seasonal patterns that coincide with those values could be useful in determining associated mitigation measures.

All efforts to effectively control water quality impacts from urban pesticide applications must account for the heightened water quality impacts that are attributable to applications to impervious surfaces. Additional work should be done in the two study watersheds to identify impervious surfaces, especially those that are directly coupled to constructed storm drain systems, and determine whether pesticides are typically applied to those impervious surfaces. Lessons learned from this additional research then can be used to support public education and outreach efforts aimed at business owners, residents, and PCOs that will be designed to minimize pesticide runoff from urban areas.

[15] California Department of Pesticide Regulation (DPR) (2013). Prevention of Surface Water Contamination by Pesticides - DPR Regulation No. 11-004. California Code of Regulations Division 6. Pesticides And Pest Control Operations. Sections 6000, 6970, and 6972.

# Appendix 4

## BASMAA RMC Stressor/Source Identification Studies
## Locations, Rationales, and Status (2010 – 2016)

BASMAA Regional Monitoring Coalition
2010-2016 Stressor/Source Identification (SSID) Project Locations, Rationales, Status
*Updated February 2016*

| SSID Project ID | Date Updated | County/ Program | Creek/Channel Name | Site Code(s) or alternative site ID | Primary Creek Status Indicator(s) Triggering Stressor/Source ID Project | | | | | | | | | Creek Status Indicator Result Summary | Rationale for Proposing/Selecting Project | Current Status of SSID Project |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Bioassess | General WQ | Chlorine | Temp | Water Tox | Sed Tox | Sed Chem | Pathogen Indicators | Other | | | |
| AL-1 | 3/23/15 | Alameda/ ACCWP | Castro Valley Creek | 204R00047 | X | | | | | | X | | | IBI Score = 24 (Poor); Relatively high bifenthrin (pyrethroid) in sediment; >3 chemicals exceed TECs | Triad triggers were accompanied by *Hyalella azteca* water toxicity that did not reach trigger on retest. Potential sources for investigation in small watershed include freeway and urban land use areas. | SSID Project began in 2013 with sediment sampling and watershed records review; No specific sources to local MS4 identified during 2014. Pesticides as the primary stressor are supported by additional WY 2015 sediment chemistry/toxicity results from another site higher in this watershed that also showed high Hyalella mortality in wet season water toxicity. March 2016 UCMR includes Appendix 4A summary report describing BMPs implemented and completion of the site-specific elements of this project. |
| AL-2 | 3/23/15 | Alameda/ ACCWP | Dublin Creek | 204R00084 | X | | X | | | | X | | | IBI Score = 17 (Very Poor); Relatively high bifenthrin (pyrethroid) in sediment; >3 chemicals exceed TECs | Potential sources for different triad triggers may be separable by monitoring between freeway and urban land use areas, altered vs. natural channels. | SSID Project began in 2013 with sediment sampling, watershed records review and bioassessment sampling at RMC plus a supplemental site. Bioassessment impacts were strongly associated with channel alteration and habitat quality. Review of inspection information identified no specific sources of pesticides or metals to sediment. March 2016 UCMR includes Appendix 4B progress report with schedule for review of land use inputs and freeway runoff. |
| AL-3 | 3/23/15 | Alameda/ ACCWP | Crow Creek | 204CRW030 | | X | | | | | | | | 67% of DO results < 7 mg/L in September | Potentially significant stressor on COLD beneficial use; Potential source for investigation from lake discharge or nutrient sources. | SSID Project began in 2013 with DO and water sampling; initial hypothesis regarding reservoir runoff not supported by first year's special study. Further monitoring in WY 2014 and 2015 indicated there may have been episodic contributions from urban runoff to low DO incidents observed in WY2014 but not during WY2015. March 2016 UCMR includes Appendix 4C progress report with updated WY2016 monitoring plan to evaluate summer inflows using continuous monitoring of conductivity as well as temperature. |

| SSID Project ID | Date Updated | County/ Program | Creek/Channel Name | Site Code(s) or alternative site ID | Primary Creek Status Indicator(s) Triggering Stressor/Source ID Project | | | | | | | | | Creek Status Indicator Result Summary | Rationale for Proposing/Selecting Project | Current Status of SSID Project |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Bioassess | General WQ | Chlorine | Temp | Water Tox | Sed Tox | Sed Chem | Pathogen Indicators | Other | | | |
| CC-1 | 1/7/16 | Contra Costa/ CCCWP | Grayson Creek | 207R00011 | X | | | | X | X | X | | | 32% survival of *Hyalella azteca* in water during spring of 2012; 43.8% survival of *Hyalella azteca* in sediment during summer 2012; relatively high bifenthrin in sediment; IBI Score = 13 (Very Poor). Water toxicity confirmed by retest, 2013. | Evidence of water and sediment toxicity to *Hyalella azteca*, with concurrent high concentration of bifenthrin in sediment. Recent publications by CASQA and others indicate pyrethroid pesticide-caused toxicity is a pervasive problem in urban areas of CA. Investigation of sources and solutions could be widely beneficial. | SSID Project Part A completed, WY 2014, including testing of water and sediments from sites upstream and downstream of original Grayson Creek site. Only water samples were toxic to *Hyalella*. Water TIE and concurrent chemistry point to pyrethroid pesticides as likely causes of Hyalella toxicity in waters of Grayson Creek. SSID Project Part B completed, WY 2015, computing urban use amounts for six pyrethroid pesticides detected in Part A monitoring. Based on the compiled pesticide use data from 2009-2013, it appears that uses of the most toxic and impactful pyrethroids (bifenthrin and cyfluthrin) have increased in urban areas in Contra Costa County in recent years. Urban uses account for most of the annual use amounts for those six pyrethroids in Contra Costa County. |
| CC-2 | 1/7/16 | Contra Costa/ CCCWP | Dry Creek | 544R00025 | X | | X | | X | X | X | | | 60% survival of *Hyalella azteca* in sediment during summer, 2012; 0% survival of *Hyalella azteca* in water during spring of 2012; relatively high bifenthrin in sediment; IBI Score = 3 (Very Poor). Water toxicity confirmed by retest, 2013. | Evidence of water and sediment toxicity to *Hyalella azteca*, with concurrent high concentration of bifenthrin in sediment. Recent publications by CASQA and others indicate pyrethroid pesticide-caused toxicity is a pervasive problem in urban areas of CA. Investigation of sources and solutions could be widely beneficial. | SSID Project Part A completed, WY 2014, including testing of water and sediments from sites upstream and downstream of original Dry Creek site. All samples were toxic to *Hyalella*. Water and sediment TIEs and concurrent chemistry point to pyrethroid pesticides as likely causes of Hyalella toxicity in water and sediments of Dry Creek. SSID Project Part B completed, WY 2015, computing urban use amounts for six pyrethroid pesticides detected in Part A monitoring. Based on the compiled pesticide use data from 2009-2013, it appears that uses of the most toxic and impactful pyrethroids (bifenthrin and cyfluthrin) have increased in urban areas in Contra Costa County in recent years. Urban uses account for most of the annual use amounts for those six pyrethroids in Contra Costa County. |

BASMAA Regional Monitoring Coalition
2010-2016 Stressor/Source Identification (SSID) Project Locations, Rationales, Status
*Updated February 2016*

| SSID Project ID | Date Updated | County/ Program | Creek/Channel Name | Site Code(s) or alternative site ID | Primary Creek Status Indicator(s) Triggering Stressor/Source ID Project | | | | | | | | | Creek Status Indicator Result Summary | Rationale for Proposing/Selecting Project | Current Status of SSID Project |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Bioassess | General WQ | Chlorine | Temp | Water Tox | Sed Tox | Sed Chem | Pathogen Indicators | Other | | | |
| CC-1 | 3/17/15 | Contra Costa/ CCCWP | Grayson Creek | 207R00011 | X | | | | X | X | X | | | 32% survival of *Hyalella azteca* in water during spring of 2012; 43.8% survival of *Hyalella azteca* in sediment during summer 2012; relatively high bifenthrin in sediment; IBI Score = 13 (Very Poor). Water toxicity confirmed by retest, 2013. | Evidence of water and sediment toxicity to *Hyalella azteca*, with concurrent high concentration of bifenthrin in sediment. Recent publications by CASQA and others indicate pyrethroid pesticide-caused toxicity is a pervasive problem in urban areas of CA. Investigation of sources and solutions could be widely beneficial. | SSID Project Part A completed, WY 2014, including testing of water and sediments from sites upstream and downstream of original Grayson Creek site. Only water samples were toxic to *Hyalella*. Water TIE and concurrent chemistry point to pyrethroid pesticides as likely causes of Hyalella toxicity in waters of Grayson Creek. |
| CC-2 | 3/17/15 | Contra Costa/ CCCWP | Dry Creek | 544R00025 | X | | X | | X | X | X | | | 60% survival of *Hyalella azteca* in sediment during summer, 2012; 0% survival of *Hyalella azteca* in water during spring of 2012; relatively high bifenthrin in sediment; IBI Score = 3 (Very Poor). Water toxicity confirmed by retest, 2013. | Evidence of water and sediment toxicity to *Hyalella azteca*, with concurrent high concentration of bifenthrin in sediment. Recent publications by CASQA and others indicate pyrethroid pesticide-caused toxicity is a pervasive problem in urban areas of CA. Investigation of sources and solutions could be widely beneficial. | SSID Project Part A completed, WY 2014, including testing of water and sediments from sites upstream and downstream of original Dry Creek site. All samples were toxic to *Hyalella*. Water and sediment TIEs and concurrent chemistry point to pyrethroid pesticides as likely causes of Hyalella toxicity in water and sediments of Dry Creek. |
| SC-1 | 5/11/15 | Santa Clara/ SCVURPPP | Coyote Creek | 205COY235 (Coyote Cr. - Watson Park to Julian St.) | | X | | | | | | | | 100% < 5mg/L D.O. in spring and summer periods 2012; and Pre-MRP Data | Coyote Creek supports a productive fish community and the project reach exhibits depressed dissolved oxygen that could cause biological impacts. | Project began in 2011 and was completed in 2013. Summary report was submitted in March 2014 as Appendix B1 in Part A of the Integrated Monitoring Report. |
| SC-2 | 5/11/15 | Santa Clara/ SCVURPPP | Guadalupe River (and Alviso Slough) | | | | | | | | | | X | Fish kills observed in 2008, 2009 & 2010. | The Guadalupe River supports a productive fish community and the project reaches exhibited fish kills that are a concern to local agencies. | Project began in 2011 and was completed in 2013. Summary report was submitted in March 2014 as Appendix B2 in Part A of the Integrated Monitoring Report. |

BASMAA Regional Monitoring Coalition

2010-2016 Stressor/Source Identification (SSID) Project Locations, Rationales, Status

*Updated February 2016*

| SSID Project ID | Date Updated | County/ Program | Creek/Channel Name | Site Code(s) or alternative site ID | Primary Creek Status Indicator(s) Triggering Stressor/Source ID Project | | | | | | | | | Creek Status Indicator Result Summary | Rationale for Proposing/Selecting Project | Current Status of SSID Project |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Bioassess | General WQ | Chlorine | Temp | Water Tox | Sed Tox | Sed Chem | Pathogen Indicators | Other | | | |
| SC-3 | 5/11/15 | Santa Clara/ SCVURPPP | Upper Penitencia Creek | 205R00035 | X | | | | | | | | | IBI Score = 23 (Poor) | Upper Penitencia Creeks supports one of the most productive steelhead communities in the Santa Clara Valley. Poor biological integrity scores may indicate impacts to steelhead and other biological communities. | Work plan was developed to assess existing data sources for potential causes for low biological condition and identify future monitoring actions. Work plan was submitted in March 2015 as Appendix B of the Urban Creeks Monitoring Report. Monitoring activities have been delayed due to the drought. Monitoring will begin in spring season of 2016. |
| SM-1 | 2/10/16 | San Mateo/ SMCWPPP | San Mateo Creek | 204SMA059 | | X | | | | | | | | Pre-MRP data demonstrating temperatures > 19°C and DO < 7mg/L. WY2013 creek status data confirmed DO < 7 mg/L at 204SMA059 but not at 204SMA122 located approximately 4 miles upstream. Temperatures in WY2013 rarely exceeded the 19°C threshold. | San Mateo Creek is one of two creeks on the Bay-side of San Mateo County that supports a productive coldwater community. Warm temperatures and/or low DO levels may impact this valuable community. | WY2014 monitoring was conducted to investigate spatial and temporal extent of low DO. Monitoring consisted of sonde installments and a creek walk. Low DO was not observed in WY2014. Review of flow data at USGS gage below Crystal Springs Reservoir confirmed higher dry season flows in WY2014 compared to WY2013. The higher flows were the result of a new SFPUC release schedule following dam improvements that will continue into perpetuity. It appears that higher dry season flows result in reduced water temperatures and higher DO levels. Confirmation monitoring conducted in WY2015 supported the findings. Final Project Report was submitted to RWQCB staff on 7/9/15 and with the WY2015 UCMR. |
| SM-2 | 2/10/16 | San Mateo/ SMCWPPP | San Mateo Creek | 204SMA060 | | | | | | | | X | | Pre-MRP data and WY2012 creek status grab samples had pathogen indicator (fecal coliform) densities exceeding the REC-1 WQO. | San Mateo Creek is a perennial creek with two Creekside parks. It flows through residential and commercial areas and discharges to San Francisco Bay just north of Marina Lagoon which is 303(d)-listed for bacteria. | WY2014 monitoring was conducted to investigate the magnitude and seasonal variability pathogen indicator densities. Microbial source tracking methodologies (i.e., Bacteroidales) were employed to investigate whether human and/or dog markers were present in the samples. Final Project Report submitted with the WY2015 UCMR. |

# Appendix 5

## Pollutants of Concern Status Report

# Pollutants of concern (POC) reconnaissance monitoring draft final progress report, water year (WY) 2015

**Prepared by**

**Lester McKee, Alicia Gilbreath, Don Yee and Jennifer Hunt**

**San Francisco Estuary Institute, Richmond, California**

**On**

**February 29, 2016**

**For**

**Regional Monitoring Program for Water Quality in San Francisco Bay (RMP)**
**Sources Pathways and Loadings Workgroup (SPLWG)**
**Small Tributaries Loading Strategy (STLS)**

## Preface

WY 2015 reconnaissance monitoring was completed with funding provided by the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP). This report is designed to be updated each year until completion of the study (at least two winter monitoring seasons: Water Year (WY) 2015 and WY 2016). This version of the report was submitted to BASMAA in support of materials being submitted on or before March 31st 2016 in compliance with the Municipal Regional Stormwater Permit (MRP) Order No. R2-2015-0049. Possible further changes may be made in response to SPLWG and TRC review comments before a final version is submitted to the RMP Steering Committee for approval.

## Acknowledgements

We appreciate the support and guidance from members of the Sources, Pathways and Loadings Workgroup of the Regional Monitoring Program for Water Quality in San Francisco Bay. The detailed work plan behind this work was developed through the Small Tributaries Loading Strategy (STLS) during a series of meetings in the summer of 2014. Local members on the STLS at that time were Arleen Feng (for the Alameda Countywide Clean Water Program), Bonnie de Berry (for the San Mateo Countywide Water Pollution Prevention Program), Lucile Paquette (for the Contra Costa Clean Water Program) and Chris Sommers (for the Santa Clara Valley Urban Runoff Pollution Prevention Program); and Richard Looker, and Jan O'Hara (for the Regional Water Board). San Francisco Estuary Institute (SFEI) field and logistical support over the first year of the project was provided by Patrick Kim, Carolyn Doehring and Phil Trowbridge. SFEI's data management team is acknowledged for their diligent delivery of quality assured well-managed data. Over the first year of this project, this team included: Cristina Grosso, Amy Franz, John Ross, Don Yee, Adam Wong, and Michael Weaver. Arleen Feng, Kristine Corneillie, Bonnie de Berry, and Chris Sommers provided helpful written reviews of this report.

Suggested citation:

McKee, L.J., Gilbreath, A.N., Yee, D., and Hunt, J.A., 2016. Pollutants of concern (POC) reconnaissance monitoring draft final progress report, water year (WY) 2015. A technical report prepared for the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP), Sources, Pathways and Loadings Workgroup (SPLWG), Small Tributaries Loading Strategy (STLS). Contribution No. xxx. San Francisco Estuary Institute, Richmond, California.

# Executive Summary

The San Francisco Bay mercury and PCB TMDLs called for implementation of control measures to reduce PCB and mercury loads entering the Bay via stormwater. Subsequently, the San Francisco Bay Regional Water Quality Control Board (Regional Water Board) issued the first combined Municipal Regional Stormwater Permit (MRP). This first MRP contained provisions aimed at improving information on stormwater pollutant loads in selected watersheds (Provision C.8.) and piloted a number of management techniques to reduce PCB and Hg loading entering the Bay from smaller urbanized tributaries (Provisions C.11. and C.12.). In November 2015, the Regional Water Board issued the second MRP. "MRP 2.0" places an increased focus on finding watersheds, sources areas, and source properties that are potentially more polluted and are therefore more likely to be cost effective areas for addressing load reduction requirements through implementation of control measures.

To support this increased focus, a stormwater characterization monitoring program was developed and implemented beginning in Water Year (WY) 2015. This same design is being implemented in the winter of WY 2016 by the RMP and the San Mateo Countywide Water Pollution Prevention Program and the Santa Clara Valley Urban Runoff Pollution Prevention Program. In addition, the RMP is piloting a project to explore the use of alternative un-manned "remote" suspended sediment samplers. During WY 2015, composite stormwater samples were collected from 20 watershed locations. At three of these locations, data were also collected using two remote suspended sediment sampler devices both of which are designed to enhance settling and capture of suspended sediment particles from the water column. This report summarizes and provides a preliminary interpretation of data collected during WY 2015. The data collected is contributing to a broader based effort to identify potential management areas. The report is designed to be updated in subsequent years as more data are collected.

Total PCB concentrations measured in the composite water samples collected from the 20 sites varied 27-fold between 2,033-55,503 pg/L. When normalized by suspended sediment concentrations (SSC) to generate particle ratios, the three sites with highest particle ratios were the Outfall to Lower Silver Creek in San Jose (783 ng/g), Ridder Park Drive Storm Drain in San Jose (488 ng/g) and Line-3A-M at Line 3A-D in Hayward (337 ng/g). Particle ratios of this magnitude are relatively elevated but lower than some of the previous highest observations made during the reconnaissance study of WY 2011 (Santa Fe Channel (1,403 ng/g), Pulgas Creek Pump Station-North (1,050 ng/g), Ettie St. Pump Station (745 ng/g))[1].

Total Hg (HgT) concentrations in composite water samples ranged 6-fold between sites from 13.7-85.9 ng/L. The greatest HgT concentrations were observed in Line-3A-M at Line 3A-D in Hayward, East Gish Rd Storm Drain in San Jose, and Meeker Slough in Richmond. When the data were normalized by SSC, the three most highly ranked sites were Meeker Slough in Richmond (1.3 μg/g), Line-3A-M at Line 3A-D in Hayward (1.2 μg/g), and Rock Springs Drive Storm Drain in San Jose (0.93 μg/g). Particle ratios of this magnitude are similar to the upper range of those observed previously (mainly in WY 2011). The six

[1] Note the concentrations and particle ratios for these three sites have been modified slightly since publication in 2011 to reflect a new method of computing the central tendency of the data (see the methods section in this report: Derivations of central tendency for comparisons with past data).

highest ranking sites for PCBs based on particle ratios only ranked 12th, 16th, 2nd, 7th, 14th, and 8th respectively in relation to HgT.

Both of the remote suspended sediment sampler types generally characterized sites similarly to the composite stormwater sampling methods (higher concentrations matching higher and lower matching lower), but further testing is needed to determine the overall reliability and practicality of deploying these instruments instead of or to augment manual composite stormwater sampling.

Based on data collated from all sampling programs completed by SFEI since WY 2003 on stormwater in the Bay Area and the use of a Spearman Rank correlation analysis, PCB particle ratios appear to positively correlate with impervious cover, old industrial land use, and HgT. PCBs inversely correlate with watershed area and the other trace metals analyzed (As, Cu, Cd, Pb, and Zn). Total mercury does not appear to correlate with any of the other trace metals and showed similar but weaker relationships to impervious cover, old industrial land use, and watershed area than did PCBs. In contrast, the trace metals all appear to correlate with each other more generally. Overall, the data collected to date do not support the use of any of the trace metals analyzed as a tracer for either PCB or HgT pollution sources.

Climatic conditions may affect the interpretations of relative ranking between watersheds. WY 2015 was a drier than average year. This challenge accepted, a total of 45 sites have so far been sampled for PCBs and HgT in stormwater by SFEI during various field sampling efforts since WY 2003. About 19.2% of the old industrial land use in the region has been sampled to date. The largest sample size so far has occurred in Santa Clara County (61% of this land use has been sampled), followed by Alameda County (17%), San Mateo County (9%), and Contra Costa County (3%). The disproportional coverage in Santa Clara County is due to a number of larger watersheds being sampled and because there were older industrial areas of land use further upstream in the Coyote Creek and Guadalupe River watersheds. Of the remaining older industrial land use yet to be sampled, 48% of it lies within 1 km of the Bay and 65% of it is within 2 km of the Bay. These areas are more likely to be tidal, likely to include heavy industrial areas that were historically serviced by rail and ship based transport, and are often very difficult to sample due to a lack of public right of ways. A different sampling strategy may be needed to effectively determine what pollution might be associated with these areas.

# Contents

# Introduction

The San Francisco Bay mercury and polychlorinated biphenyl (PCB) total maximum daily load plans (TMDLs) (SFBRWQCB, 2006; 2007) called for implementation of control measures to reduce stormwater PCB loads from about 20 kg to 2 kg by 2030 and to reduce stormwater total mercury (HgT) loads from about 160 kg down to 80 kg by 2028 with an interim milestone of 120 kg by 2018. Subsequently, the San Francisco Bay Regional Water Quality Control Board (Regional Water Board) issued the first combined Municipal Regional Stormwater Permit (MRP) for MS4 phase I stormwater agencies (SFBRWQCB, 2009; 2011(update)). MRP 1.0, as it came to be known, contained provisions aimed at improving information on stormwater loads in selected watersheds (Provision C.8.) and piloting a number of management techniques to reduce PCB and Hg loading entering the Bay from smaller urbanized tributaries (Provisions C.11. and C.12.). To help address these information needs, a Small Tributaries Loading Strategy (STLS) was developed that outlined four key management questions (MQs) about loadings and a general plan to address these questions (SFEI, 2009). These questions were developed to be consistent with Provision C.8.e of MRP 1.0.

MQ1. Which Bay tributaries (including stormwater conveyances) contribute most to Bay impairment from pollutants of concern (POCs);

MQ2. What are the annual loads or concentrations of POCs from tributaries to the Bay;

MQ3. What are the decadal-scale loading or concentration trends of POCs from small tributaries to the Bay; and,

MQ4. 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.

During the first term of the MRP (2009-15) for MS4 Phase I stormwater permittees[2], expenditure of RMP funds continued to focus on refining pollutant loadings but with additional emphasis on finding and prioritizing potential “high leverage” watersheds and subwatersheds (those with disproportionally high concentrations or loads with connections to sensitive Bay margins). These efforts included

1. a 2009/2010 study to explore relationships between watershed characteristics (Greenfield et al., 2010),
2. a 2009/2010 study to explore optimal sampling design for loads and trends (Melwani et al., 2010),
3. a reconnaissance study in water year 2011 to characterize concentrations during winter storms at 17 locations (McKee et al., 2012),
4. the completion of a number of “pollutant profiles” describing what is known about the sources and release processes for each pollutant (McKee et al., 2014),

[2] For a full list of permittees that included cities and special districts, the reader is referred to the individual countywide program websites or the MRP (SFRWQCB, 2009).

5. the development and operation of a loads monitoring program at six fixed station locations for water years 2012-2014 (Gilbreath et al., 2015a), and
6. further refinement of geographic information about land uses and source areas of PCBs and Hg and the development of a regional watershed spreadsheet model (2010-present) (Wu et al., 2016).

These efforts were consistent with implementation plans outlined in the PCBs and Hg policy documents. As a result, sufficient pollutant data have been collected at sites with discharge measurements to make computations of pollutant loads of varying degrees of certainty at Mallard Island on the Sacramento River and 11 urban sites (McKee et al. 2015) and the a reasonable calibration of the regional watershed spreadsheet model (RWSM) has been achieved for water, Cu, and PCBs (Wu et al., 2016)[3].

Discussions between the Bay Area Stormwater Management Agencies Association (BASMAA)[4] and the SFBRWQCB regarding the second term of the MRP, and parallel discussions at the October 2013 and May 2014 Sources Pathways and Loadings Workgroup (SPLWG) meetings, highlighted the need for an increasing focus on finding watersheds and land areas within watersheds that have relatively higher unit area load production or higher particle ratios or sediment pollutant concentrations at a scale paralleling management efforts (areas as small as subwatersheds, areas of old industrial land use, or source properties). This changing focus is consistent with the management trajectory outlined in the Fact Sheet (MRP Appendix I) issued with the November 2011 revision of the October 2009 MRP (SFRWQCB, 2009; 2011). The Fact Sheet described a transition from pilot-testing in a few specific locations during the first MRP term to a greater amount of focused implementation in areas where benefits would be most likely to accrue in the second MRP term.

During 2014 and early 2015, the SPLWG and Small Tributaries Loadings Strategy (STLS) Team discussed alternative monitoring designs that can address this focus and discussion is still ongoing through the development of a STLS Trend Strategy. In November 2015, the Regional Water Board issued the second MRP (Water Board, 2016). “MRP 2.0” places an increased focus on finding watersheds, source areas, and source properties that are potentially more polluted and located upstream from sensitive Bay margin areas (potential high leverage). Specifically the permit states that effort should be made to better understand contributions to Bay impairment by identifying watershed source areas that contribute most to the impairment of San Francisco Bay beneficial uses (due to source intensity and sensitivity of discharge location). To help support this focus, the Sources Pathways and Loadings Workgroup (SPLWG) and the STLS local team developed and implemented a stormwater characterization monitoring program in Water Year (WY) 2015. The methods employed were modified from those first proposed at the October 2004 SPLWG meeting (study proposal #2), discussed again by the workgroup in 2005/06 as an alternative option to a loading study at Zone 4 Line A in Hayward, Alameda County, and implemented for the first time in WY 2011 (McKee et al., 2012). The nimble design implemented during the winter of WY 2015 benefited from lessons learned during the WY 2011 effort and provides data primarily to support identification of potential high leverage areas as part of multiple

[3] The calibration of the RWSM for Hg still remains a challenge. Work in early 2016 may help to resolve this.
[4] BASMAA is made up of a number of programs which represent Permittees and other local agencies

lines of evidence being considered by the stormwater programs. The data also support improved calibration of the RWSM being developed to estimate regional scale watershed loads. This same design is being implemented in the winter of WY 2016 by the RMP, the San Mateo Countywide Water Pollution Prevention Program, and the Santa Clara Valley Urban Runoff Pollution Prevention Program.

In parallel, the STLS team is designing a sampling program for monitoring stormwater loading trends in response to management efforts. Data collected using the characterization design may also help to provide baseline data for observing concentration or particle ratio trends through time if the trends monitoring design effort provides evidence of suitability for that purpose.

This report summarizes and provides a preliminary interpretation of data collected during WY 2015. The data collected and presented here is contributing to a broader based effort to identify potential management areas. The report is designed to be updated annually in subsequent years as more data are collected.

# Sampling methods

## Methods selection

Water Year 2014 saw the conclusion of three years of pollutant loads monitoring at six fixed locations near the Bay margins for suspended sediment, total organic carbon (TOC), PCBs, HgT, total methylmercury (MeHgT), nitrate ($NO_3$), phosphate ($PO_4$)[5], and total phosphorus (TP). In addition, a fewer number of samples were gathered at the loading sites to characterize polybrominated diphenyl ether (PBDEs), polyaromatic hydrocarbons (PAHs), toxicity, pyrethroid pesticides, copper (Cu), and selenium (Se) (Gilbreath et al., 2015a). With the increasing focus of management efforts to identify areas of elevated PCBs (and mercury), a new monitoring design was needed to broaden the spatial coverage of information gathering and allow for relative comparisons of PCB and mercury concentrations across the region. In order to collect this information, a reconnaissance design was selected. This type of design is efficient, cost-effective, allows for a larger number of sites monitored, and can be used on a relative scale for identifying drainages with high PCB and mercury concentrations (McKee et al., 2012; SPLWG, May 2014; McKee et al., 2015).

The WY 2015 design was based on a previous monitoring design (WY 2011) in which multiple sites were visited during 1-2 storm events and stormwater samples were collected for a number of POCs. Based on discussions at the May 2014, SPLWG meeting, modifications were made to the WY 2011 design to increase cost-effectiveness. At the SPLWG meeting an analysis of previously collected stormwater sample data from both reconnaissance and fixed station monitoring was presented. An analysis of three sampling designs (1, 2, and 4 storms: functionally 4, 8, and 16 discrete samples) showed that, for Guadalupe River at Hwy 101, PCB particle ratios could vary from 45-287 ng/g (1 storm design), 59-257 ng/g (2 storm design), and 74-183 ng/g (4 storm design). Although the Guadalupe River at Hwy 101 represents a more extreme example of variability due to larger storms causing runoff from the upper

[5] Is also often referred to as dissolved orthophosphate or dissolved reactive phosphorous (DRP) or dissolved inorganic phosphorous (DIP). All these terms are functionally equivalent and refer to a sample that is filtered before analysis and analysis is completed using the ascorbic acid + molybdate blue reagents.

cleaner areas of the watershed, this analysis was used to imply that the number of storms sampled for a given system would have had quite a large influence on the resulting particle ratio and the potential relative ranking among sites. A similar analysis was then presented for the other fixed loads monitoring sites (Pulgas Creek Pump Station-South, Sunnyvale East Channel, North Richmond Pump Station, San Leandro Creek, Zone 4 Line A, and Lower Marsh Creek) to explore the relative ranking based on a random 1-storm composite or 2-storm composite design. This analysis highlighted the potential for a false negative that could occur due to a lower number of sampled storms in Sunnyvale East Channel (3 of the 8 storms represented were < 200 ng/g which would have ranked it only slightly more polluted than San Leandro Creek, Zone 4 Line A or Guadalupe River at Hwy 101). This further highlighted the tradeoff between generating information about water quality at fewer sites with more certainty or more sites with less certainty. The SPLWG agreed that a 1-storm composite per site design was preferable since the design has the flexibility to return to a site if the initial results did not make sense (either because the storm intensity was low or other information suggested potential sources).

In addition to collection of stormwater composites, a pilot study exploring in-line suspended sediment samplers based on enhanced water column settling was designed and implemented. Four sampler types were initially considered (single-stage siphon sampler, the CLAM sampler, the Hamlin sampler, and the Walling tube). After SPLWG discussion, the single-stage siphon sampler was dropped from consideration because it allowed for collection of only a single stormwater sample at a single time point, which offers no advantage over collecting a single manual stormwater sample, yet would require more effort and expense to set up. The CLAM sampler also has some limitations that affect interpretation of the data, primarily the lack of ability to estimate the volumes of water passing through the filters and the lack of performance tests in high turbidity environments. The remaining two sampler types (the Hamlin sampler and the Walling tube) were selected for the pilot study based on previous studies showing use of these devices in similar systems (velocities and analytes). However, there was a lot of discussion about how to analyze the samples and how to ensure their comparability to the composite water sample design. To test the comparability of sampling methods, the SPLWG Science Advisors recommended piloting the samplers at 12 locations[6] where manual water composites would be collected in parallel.

## Watershed physiography and sampling locations

In the May 2014 SPLWG meeting, sample site selection rationale was discussed. The potential site selection rationales fall into four basic categories.

1. Identifying potential high leverage watersheds and subwatersheds (distributed across Phase I permittees)
    a. Watersheds with suspected high pollution
    b. Sites with ongoing or planned management actions
    c. Identifying sources within a larger watershed of known concern (nested sampling design)

[6] Note that only 3 locations could be sampled during WY 2015 due to climatic constraints. The remaining nine samples are planned for WY 2016.

2. Sampling strategic large watersheds with USGS gauges to provide first order loading estimates and to support calibration of the RWSM
3. Validating unexpected low (potential false negative) concentrations (to address the possibility of a single storm composite poorly characterizing a sampling location)
4. Filling gaps along environmental gradients or source areas (to support the RWSM)

It was agreed that the majority of samples each year (60-70% of the effort) would be dedicated to identifying potential high leverage watersheds and subwatersheds. The remaining resources would be allocated to addressing the other three rationales. In order to address this focus, SFEI worked with the respective Countywide Clean Water Programs to identify priority drainages including storm drains, ditches/culverts, tidally influenced areas, and natural areas for monitoring. A larger pool of sites was visited during summer 2014 to survey each for safety, logistical constraints, and identification of feasible drainage line entry points. From this larger set, a final set of 25 sites were identified for monitoring during WY 2015. Of these 25 sites, 20 sites were sampled despite climatic constraints (Figure 1; Table 1). The remaining five sites were carried over for possible sampling in WY 2016.

It is seen, from Figure 1 and Table 1, that watershed sites with a wide variety of characteristics were sampled in WY 2015. In total, eight sites were sampled in Santa Clara County, six sites in San Mateo County, five sites in Alameda County, and just one site in Contra Costa County[7]. Areas upstream from sample locations ranged between 0.11 $km^2$ and 11.50 $km^2$ and were characterized by a high degree of imperviousness (53%-85%: mean = 74%). The percentage of the watersheds designated as old industrial[8] range between 2% and 78% and average 30%. Although the sites were mainly selected to address site selection rationale number one (identifying potential high leverage watersheds and subwatersheds), Lower Penitencia Creek represents an example of a site that was previously sampled and where the resulting concentrations appeared to be surprisingly low and therefore warranting re-sampling. In addition, the wide variety of imperviousness and industrial characteristics of these watersheds will help to broaden the environmental gradient of watershed characteristics that will potentially support an improved calibration of the RWSM (Wu et al., 2016). A matrix of site characteristics for potentially sampling strategic larger watersheds was also developed (Table 2). However, none of these could be sampled during WY 2015 because climatic conditions for rainfall and flow were not met.

# Field methods

## Mobilization and preparing to sample

Based on a minimum rainfall weather forecast for at least a quarter inch[9] over six hours, sampling teams were deployed to each of the sampling sites, ideally reaching the sampling site about one hour before

[7] Two additional sites in Contra Costa County had been identified for WY 2015 but were not sampled because they are tidally influenced with only short sampling windows. Storms in WY 2015 did not align with these short periods.
[8] Note the definition of "old Industrial" land use used here is based on definitions developed by the Santa Clara Valley Urban Run-off Pollution Prevention Program (SCVURPPP) building on GIS development work completed during the development of the RWSM (Wu et al., 2016).
[9] Note, this was relaxed due to a lack of larger storms. Ideally, mobilization would only proceeded with a 0.5" forecast.

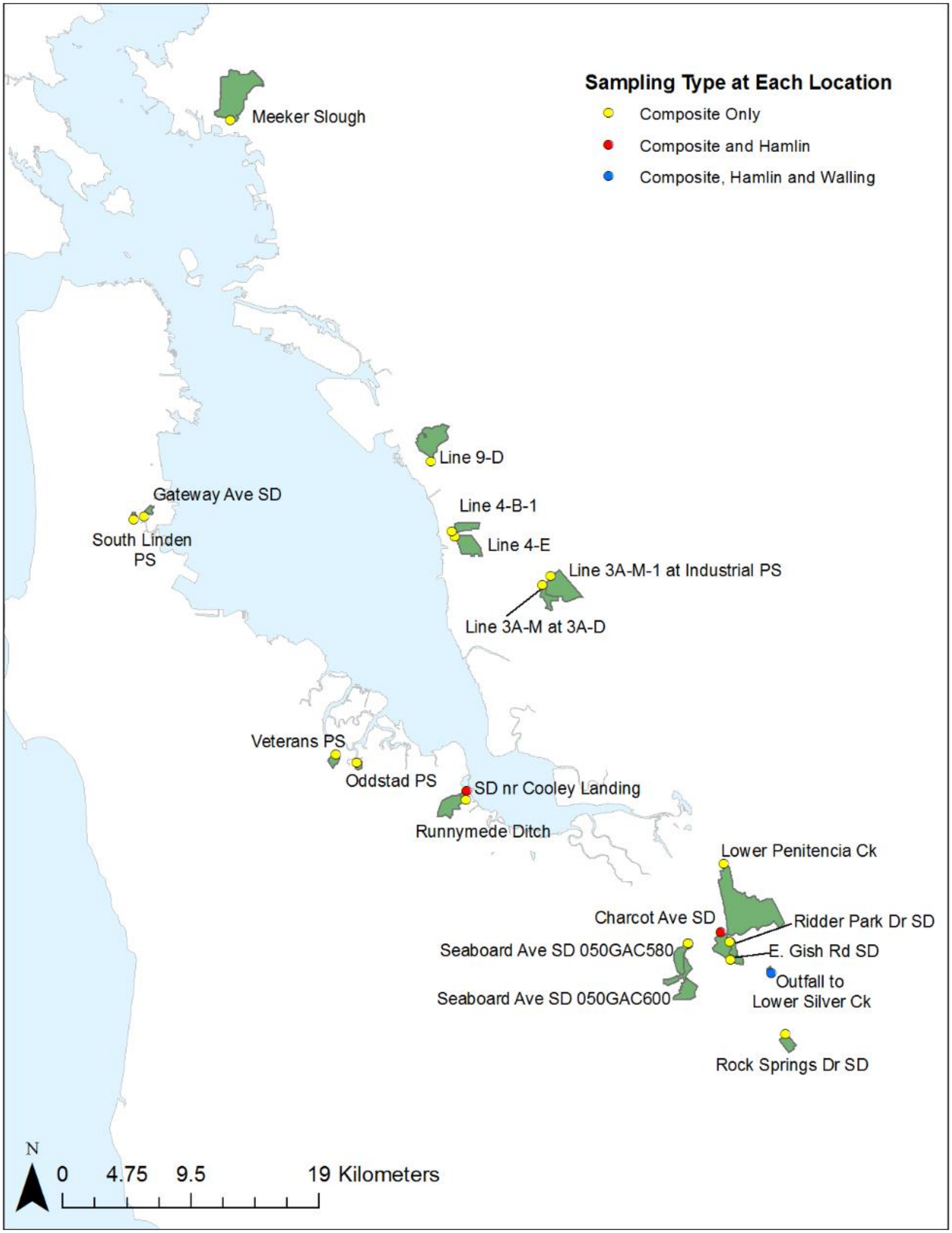



Figure 1. Sampling locations (marked by the dots), watershed boundaries (shown in green) and sampler type (color of the dots).

Table 1. Key characteristics of WY 2015 sampling locations.

| County Program | City | Watershed name | Catchment Code | Latitude | Longitude | Year Sampled | Watershed area (sq km) | Impervious cover (%) | Old Industrial (%) |
|---|---|---|---|---|---|---|---|---|---|
| Alameda | Hayward | Line3A-M-1 at Industrial PS | AC-Line3A-M-1 | 37.618933 | -122.05949 | WY 2015 | 3.44 | 78% | 26% |
| Alameda | Hayward | Line-3A-M at 3A-D | AC-Line-3A-M | 37.612853 | -122.06629 | WY 2015 | 0.88 | 73% | 12% |
| Alameda | Hayward | Line4-B-1 | AC-Line4-B-1 | 37.647519 | -122.14362 | WY 2015 | 0.96 | 85% | 28% |
| Alameda | Hayward | Line4-E | AC-Line4-E | 37.64415 | -122.14127 | WY 2015 | 2.00 | 81% | 27% |
| Alameda | San Leandro | Line9-D | AC-Line9-D | 37.693833 | -122.16248 | WY 2015 | 3.59 | 78% | 46% |
| Contra Costa | Richmond | Meeker Slough | Meeker Slough | 37.917861 | -122.33838 | WY 2015 | 7.34 | 64% | 6% |
| Santa Clara | Milpitas | Lower Penitencia Ck | Lower Penitencia | 37.429853 | -121.90913 | WY 2011, 2015 | 11.50 | 65% | 2% |
| Santa Clara | Santa Clara | Seabord Ave SD SC-050GAC580 | SC-050GAC580 | 37.376367 | -121.93793 | WY 2015 | 1.35 | 81% | 68% |
| Santa Clara | Santa Clara | Seabord Ave SD SC-050GAC600 | SC-050GAC600 | 37.376356 | -121.93767 | WY 2015 | 2.80 | 62% | 18% |
| Santa Clara | San Jose | Charcot Ave SD | SC-051CTC275 | 37.384128 | -121.91076 | WY 2015 | 1.79 | 79% | 25% |
| Santa Clara | San Jose | Ridder Park Dr SD | SC-051CTC400 | 37.377836 | -121.90302 | WY 2015 | 0.50 | 72% | 57% |
| Santa Clara | San Jose | E. Gish Rd SD | SC-066GAC550 | 37.366322 | -121.90203 | WY 2015 | 0.44 | 84% | 71% |
| Santa Clara | San Jose | Outfall to Lower Silver Ck | SC-067SCL080 | 37.357889 | -121.86741 | WY 2015 | 0.17 | 79% | 78% |
| Santa Clara | San Jose | Rock Springs Dr SD | SC-084CTC625 | 37.317511 | -121.85459 | WY 2015 | 0.83 | 80% | 10% |
| San Mateo | Redwood City | Oddstad PS | SM-267 | 37.491722 | -122.21886 | WY 2015 | 0.28 | 74% | 11% |
| San Mateo | South San Francisco | Gateway Ave SD | SM-293 | 37.652444 | -122.40257 | WY 2015 | 0.36 | 69% | 52% |
| San Mateo | South San Francisco | South Linden PS | SM-306 | 37.650175 | -122.41127 | WY 2015 | 0.14 | 83% | 22% |
| San Mateo | Redwood City | Veterans PS | SM-337 | 37.497231 | -122.23693 | WY 2015 | 0.52 | 67% | 7% |
| San Mateo | East Palo Alto | Runnymede Ditch | SM-70 | 37.468828 | -122.12701 | WY 2015 | 2.05 | 53% | 2% |
| San Mateo | East Palo Alto | SD near Cooley Landing | SM-72 | 37.474922 | -122.1264 | WY 2015 | 0.11 | 73% | 39% |

Table 2. Characteristics of larger watersheds to be monitored, proposed sampling location, and proposed sampling trigger. None of these watersheds could be sampled during WY 2015 because climatic conditions for flow and rainfall were not met.

| **Proposed sampling location** | | | | | | | **Relevant USGS gauge for 1st order loads computations** | |
|---|---|---|---|---|---|---|---|---|
| **Watershed system** | **Watershed area (sq mi)** | **Impervious surface (%)** | **Industrial (%)** | **Sampling objective** | **Commentary** | **Proposed sampling triggers** | **Gauge number** | **Area at USGS gauge (sq mi)** |
| Alameda Creek at EBRPD Bridge at Quarry Lakes | 352 | 8.5 | 0.4 | 2, 4 | Operating flow and sediment gauge at Niles just upstream will allow the computation of 1st order loads to support the calibration of the RWSM for a large, urbanizing type watershed. | 7” of antecedent rainfall in Livermore (reliable web published rain gauge), after at least an annual storm has already occurred (~2000 cfs at the Niles gauge), and a decent forecast for the East Bay interior valley's (2-3” over 12 hrs). | 11179000 | 633 |
| Dry Creek at Arizona Street (Purposely downstream from historic industrial influences) | 9.8 | 3.5 | 0.2 | 2, 4 | Operating flow gauge at Union City just upstream will allow the computation of 1st order loads to support the calibration of the RWSM for mostly undeveloped land use type watersheds. | 7” of antecedent rainfall in Union City, after at least a common annual storm has already occurred (~200 cfs at the Union City gauge), and a decent forecast for the East Bay Hills (2-3” over 12 hrs). | 11180500 | 9.39 |
| San Francisquito Creek at University Avenue (as far down as possible to capture urban influence upstream from tide) | 42.7 | 6.9 | 0.3 | 2, 4 | Operating flow gauge at Stanford upstream will allow the computation of 1st order loads to support the calibration of the RWSM for larger mixed land use type watersheds. | 7” of antecedent rainfall in Palo Alto, after at least a common annual storm has already occurred (~1000 cfs at the Stanford gauge), and a decent forecast for the Peninsula Hills (3-4” over 12 hrs). | 11164500 | 37.4 |
| Matadero Creek at Waverly Street (purposely downstream from the railroad) | 9.8 | 22.4 | 3.3 | 2, 4 | Operating flow gauge at Palo Alto upstream will allow the computation of 1st order loads to support the calibration of the RWSM for mixed land use type watersheds. Sample pair with San Francisquito Ck. | 7” of antecedent rainfall in Palo Alto, after at least a common annual storm has already occurred (~200 cfs at the Palo Alto gauge), and a decent forecast for the Peninsula Hills (3-4” over 12 hrs). | 11166000 | 7.26 |
| Colma Creek at West Orange Avenue (location strategically downstream from historic industrial influence but still upstream from tide) | 10.6 | 38 | 0.5 | 2, 4 (possibly 1) | Historic flow gauge (ending 1996) in the park a few hundred feet upstream will allow the computation of 1st order loads estimates to support the calibration of the RWSM for mixed land use type watersheds. | Since this is a very urban watershed, precursor conditions more relaxed: 4” of antecedent rainfall, and a decent forecast (2-3” over 12 hrs). Measurement of discharge and manual staff plate readings during sampling will verify the historic rating. | 11162720 | 10.8 |

**Key for sampling objectives**: 1. Identify potential high leverage watersheds; 2. Strategic watersheds with USGS gauges for loads computations and RWSM model calibration/verification; 3. Validating false negative finding or unexpected concentrations; 4. Filling gaps along environmental gradients or source areas.

the onset of rainfall[10]. When possible, one team sampled two sites in close proximity to one another to increase sample capture efficiency and decrease staffing costs to the program. Once arriving on site, the team worked together to assemble the equipment and carry out final safety checks. Sampling equipment varied between sites depending on the characteristics of the access point to the drainage line. Some sites were sampled by attaching laboratory prepared trace metal clean Teflon sampling tubing to a painters pole and a peristaltic pump (also installed with lab cleaned silicone pump roller tubing) (Figure 2a). During sampling, the tube was dipped into the channel or drainage line aiming for mid-channel mid-depth (if shallow) or depth integrating if the depth was more than about 0.5 m. In other cases, a DH 84 (Teflon) sampler was used that had also been cleaned prior to sampling, also aiming for mid-channel, mid-depth, or depth integrated depending on channel conditions.

### Manual time-paced composite stormwater sampling procedures

At each site, a time-paced composite sample was collected comprising a variable number of sub-samples, or aliquots. Depending on the weather forecast, the prevailing on site conditions, and radar imagery, staff estimated the duration of the storm and selected the aliquot size and number to ensure that the minimum volume requirements for each analyte would be reached before the storm's end (Table 3). Because the minimum volume requirements were less than the size of the sample bottle, there was flexibility built into the sub-sampling program to add aliquots in the event that the storm ended up longer than predicted (e.g., minimally 5 aliquots but up to 10 aliquots could be collected; Table 3). The final decision on the aliquot volume was made just before the first aliquot was taken and remained fixed for the rest of the event. The ultimate number of aliquots, as along as the minimum volume was reached, was usually adjusted depending upon how the rain event progressed. All aliquots for the sample were collected into the same bottle throughout the storm, which was kept in a cooler on ice.

### Remote suspended sediment sedimentation sampling procedures

The Hamlin and Walling tube remote suspended sediment samplers were deployed approximately mid-channel/ storm drain. The Hamlin sampler sat flush with the bed of either the stormdrain or concrete channel[11], and was weighted down to the bed either by itself (the sampler weighs approximately 25 lbs) or additionally using Olympic weights bungee-corded to the sampler (see Figure 2b). The Walling tube could not be deployed in storm drains due to its size and requirement for staying horizontal, but was secured in open channels either by being weighted down to a concrete bed using hose clamps to secure Olympic weights, or secured to a natural bed using hose clamps attached to temporarily installed rebar. To minimize the chances of sampler loss, both samplers were additionally secured via a stainless steel cord attached on one end to the sampler and on the other end to a temporary rebar anchor or another object such as a tree or fence post.

[10] Antecedent dry-weather was not considered prior to deployment. Although this would likely have a bearing on the concentration of certain build-up/wash-off pollutants like metals and perhaps even mercury, for PCBs, atmospheric and other ongoing sources are less important than the mobilization of in-situ legacy sources.
[11] In future years, if the Hamlin is deployed within a natural bed channel, elevating the sampler off the bed may be necessary but was not the case in WY 2015.


Figure 2. Sampling equipment used in the field. (a) Painters pole, Teflon tubing and an ISCO used as a slave pump; alternatively a Teflon bottle is attached to the end of a painters pole (DH84) and used for sample water collection as opposed to using an ISCO as a pump (b) Hamlin suspended sediment sampler; and (c) the Walling tube suspended sediment sampler.

The suspended sediment sedimentation samplers were deployed for the duration of the manual water quality sampling (Table 4 for site list and success rate). At the end of water quality sampling at a site with a remote sampler, the remote sedimentation sampler was removed from the channel bed /storm drain bottom at approximately the same time as the last water quality sample aliquot. Water and sediments collected into the sedimentation sampler were decanted into one or two large glass bottles. Staff flushed all sediments into the collection bottles. When additional water was needed to flush the settled sediments from the remote samplers into the collection bottles, site water from the sampled channel was used. The samples were taken back to SFEI and refrigerated upon arrival until processing. Samples were split and placed into laboratory containers and then shipped to the laboratory for analysis. Three samples were analyzed as whole water samples and one was analyzed as separated dissolved and sediment fractions.

## Laboratory analytical methods

All samples were labeled, placed on ice, transferred back to SFEI, and refrigerated at 4 °C until transport to the laboratory for analysis, except for TOC/DOC. DOC has a 24-hour hold time for filtration. Samples were mostly dropped to the analytical laboratory within the 24-hour filtration hold time. In those cases where the laboratory was not open during the 24-hour hold time window, SFEI staff filtered DOC samples using a Hamilton 50 mm glass syringe with a 25 mm, 0.45 um filter. Laboratory methods shown in Table 5 were used to ensure the optimal combination of method detection limits, accuracy and precision, and costs (BASMAA, 2011; 2012) (Table 5).

Table 3. Sub-sample sizes in relation to analytes and sample container volumes.

| **Analyte** | **Bottle size (L)** | **Minimum volume (L)** | **Aliquots (sub-samples) (minimum to maximum number, and required volumes in milliliters (mL)** | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | **3 to 6** | **4 to 8** | **5 to 10** | **6 to 12** | **7 to 14** | **8 to 16** |
| HgT/ trace metals | 2 | 0.25 | 333 | 250 | 200 | 167 | 143 | 125 |
| SSC | 1 | 0.3 | 167 | 125 | 100 | 83 | 71 | 63 |
| PCBs | 2.5 | 1 | 333 | 250 | 200 | 167 | 143 | 125 |
| Grain size | 2 | 1 | 333 | 250 | 200 | 167 | 143 | 125 |
| TOC | 1 | 0.25 | 167 | 125 | 100 | 83 | 71 | 63 |

Table 4. Locations where remote sediment samplers were pilot tested.

| Site | Date | Sampler(s) deployed | Comments |
|---|---|---|---|
| Meeker Slough | 11/2015 | Hamlin and Walling | Sampling effort was unsuccessful due to very high velocities. Both samplers washed downstream because they were not weighted down enough and debris caught on the securing lines. |
| Outfall to Lower Silver Creek | 2/06/15 | Hamlin and Walling | Sampling effort was successful. This sample was analyzed as a water sample. |
| Charcot Ave Storm Drain | 4/07/15 | Hamlin | Sampling effort was successful. This sample was analyzed as separate dissolved and sediment (particulate) samples. |
| Cooley Landing Storm Drain | 2/06/15 | Hamlin | Sampling effort was successful. This sample was analyzed as a water sample. |

Table 5. Laboratory analysis methods for 2015 samples.

| Analysis | Matrix | Analytical Method | Lab | Filtered | Field preservation | Contract Lab / Preservation hold time |
|---|---|---|---|---|---|---|
| PCBs (40)-Dissolved | Water | EPA 1668 | AXYS | Yes | NA | NA |
| PCBs (40)-Total | Water | EPA 1668 | AXYS | No | NA | NA |
| PCBs (40)-Particulate | Water | EPA 1668 | AXYS | Yes | NA | NA |
| SSC | Water | ASTM D3977 | USGS | No | NA | NA |
| Grain size | Water | USGS GS method | USGS | No | NA | NA |
| Mercury-Total | Water | EPA 1631E | BRL | No | BrCl | BRL preservation within 28 days |
| Metals-Total (As, Cd, Pb, Cu, Zn) | Water | EPA 1638 mod | BRL | No | $HNO_3$ | BRL preservation with Nitric acid within 14 days |
| Mercury-Dissolved | Water | EPA 1631E | BRL | Yes | BrCl | BRL preservation within 28 days |
| Mercury-Particulate | Water | EPA 1631E | BRL | Yes | BrCl | BRL preservation within 28 days |
| Organic carbon-Total | Water | 5310 C | EB mud | No | HCL | NA |
| Organic carbon-Dissolved | Water | 5310 C | EB mud | Yes | HCL | NA |
| Mercury | Sediment | EPA 1631E, Appendix | BRL | NA | NA | |
| PCBs | Sediment | EPA 1668 | AXYS | NA | NA | NA |

# Interpretive methods

## Particle normalized concentrations

It has previously been shown that stormwater concentrations tend to vary more at a site than particle ratios, depending on storm characteristics. Since each site was only monitored at the characterization level and there was no averaging of data for a site across many storm events and suspended sediment erosion and concentrations in stormwater vary greatly between sites, it was argued that the particle ratio from a single sample is likely a better summary of water quality of a site than a single water concentration (McKee et al., 2012). But even so, it is noted that, in addition to sediment variability, climatic conditions can influence the interpretations of relative ranking between watersheds although the absolute nature of that influence may differ between watershed locations. For example, for some watersheds, dry years or lower storm intensity might cause a greater particle ratio if transport of the sources of polluted sediments are activated and entrained into runoff but overall less diluted by lower erosion rates of cleaner particles from other parts of the watershed. For other watersheds, the source may be a remote patch of polluted soil that can only be eroded and transported when antecedent conditions and/ or rainfall intensity reach some threshold. In this instance, a false negative could occur during a dry year. Only with many years of data during many types of storms could such processes be teased out. WY 2015 was a drier than average year. For example, the San Francisco gauge (047772) recorded 18.2 in or 82% of the 40 year (1976-2015) normal. However, most of this rainfall (11.7 in) fell in December. In contrast, WY 2011 (when the last spatially intensive sampling occurred) was a wetter year with 130% of the 40 year San Francisco normal. These climatic challenges acknowledged, the particle ratio (PR) (mass of a given pollutant of concern in relation to mass of suspended sediment) was computed for each composite water sample collected for each analyte at each site by taking the water concentration (mass per unit volume) and dividing it by its suspended sediment concentration pair (mass of suspended sediment per unit volume) (Equation 1).

Equation 1 (example PCBs):

$$PR\ (\frac{ng}{mg}) = \frac{PCB\ (\frac{ng}{L})}{SSC\ (\frac{mg}{L})}$$

These ratios where then used as the primary method for comparisons between sites without regard to climate or rainfall intensity. Such comparisons are assumed valid for providing evidence to differentiate a group of sites with higher pollutant concentrations from a contrasting group with lower pollutant concentrations. To generate information on the absolute relative ranking between individual sites, a much more rigorous sampling campaign sampling many storms over many years would be required (c.f. the Guadalupe River study: McKee et al., 2006, or the Zone 4 Line A study: Gilbreath et al., 2012a).

### Derivations of central tendency for comparisons with past data

As commonly discussed in water quality literature, mean, median, geomean, or flow-weighted mean can be used measures of central tendency of a dataset. In the Bay Area, the average or median of water concentrations at a site had sometimes been used, or the average or median of the particle ratios (McKee et al., 2012; McKee et al., 2014; Wu et al., 2016). To best compare WY 2015 results with past data (always collected as discrete stormwater samples rather than composite samples), a different technique was used to estimate the central tendency than had been done in the past. It was reasoned that a water composite collected over a single storm is equivalent to taking several discrete samples collected over multiple storms and mixing them all into a single bottle for analysis. In order to calculate the equivalent of a single storm composite particle ratio for an analyte, for previous studies that resulted in multiple stormwater samples, all of the water concentration samples were summed together for the analyte and divided that by the sum of all the suspended sediment concentrations for the site (note: this method is mathematically not equivalent to averaging together the particle ratios of each discrete sample paired with its SSC). Due to the use of this alternate method for estimating the central tendency of the data for a site, particle ratios reported here will differ slightly from those reported previously for the same site (e.g. McKee et al., 2012; McKee et al., 2014; Wu et al., 2016).

# Quality assurance

The sections below reports on WY 2015 data only. The data were reviewed using the quality assurance (QA) program developed for the San Francisco Bay Regional Monitoring Program for Water Quality (Yee et al., 2015). Yee et al. (2015) describes how RMP data are reviewed for concerns in relation to hold times, sensitivity, blank contamination, precision, accuracy, comparison of dissolved and total phases, magnitude of concentrations versus concentrations from previous years, other similar local studies or studies described from elsewhere in peer-reviewed literature, and PCB (or other organics) fingerprinting. Data handling procedures and acceptance criteria differ among programs, however, the underlying data were never discarded. The results for “censored” data were maintained so the impacts of applying different QA protocols can be assessed by a future analyst if desired. Quality assurance (QA) summary tables can be found in Appendix A in addition to the following narrative.

## Suspended Sediment Concentration and Particle Size Distribution

The SSC and particle size distribution (PSD)[12] data from USGS-PCMSC were acceptable. Samples were all analyzed within hold time. Minimum detection limits (MDLs) were generally sufficient with <20% non-detects reported for SSC and the more abundant Clay, Silt, and Very Fine Sand fractions. Extensive non-detects (>50% NDs) were generally reported for the coarser fractions, with 100% NDs for the coarsest (Granule + Pebble/2.0 to <64 mm) fraction. Method blanks and spiked samples are not typically reported for SSC and PSD. The blind field replicate sample was used to evaluate precision in the absence of any other replicates. Particle size fractions had average relative standard deviation (RSD) ranging from 12% for Silt to 62% for Fine Sand. Although both SSC and some individual fractions had average percent difference (RPD) or RSDs >40%, suspended sediments in runoff (and particle size distributions within that SSC) can be highly variable even separated by minutes, so results were flagged as estimated values, rather than rejected. Fines represented the largest proportion (~85%) of the results. Average results could not be compared to previous years, except for SSC, because particle size has not been measured before in POC water samples. Excluding three results from Hamlin (suspended sediment trap) samplers, the mean SSC concentration was 102 mg/L, 78% of the average concentration of the 2012-2014 POC water samples, suggesting similar flow regimes and/or sediment sources.

## Total Organic Carbon and Dissolved Organic Carbon

Reported TOC and DOC data from EBMUD were acceptable. TOC samples were field acidified on collection, DOC samples field or lab filtered as soon as practical (usually within a day) and acidified after, so were generally within the recommended 24-hour holding time. MDLs were sufficient with no non-detects reported for any field samples. TOC was detected in only one method blank (0.026 mg/L), just above the MDL (0.024 mg/L), but the average blank concentration (0.013 mg/L) was still below the MDL, so results were not flagged. Matrix spike samples were used to evaluate accuracy, although many were not spiked at high enough concentrations (at least 2x) the parent sample to evaluate. Recoveries in the remaining matrix spikes for DOC were generally good, with an average 9% error, below the 10% target measurement quality objective (MQO). TOC averaged 14% error, above the 10% MQO, and was therefore qualified but not censored. Lab replicate samples were used to evaluate precision, with average RSD of 2% for DOC and TOC, well within the target MQO (10%). RSDs even including field replicates remained below the target MQO of 10% (RSDs were 3% and 9% for DOC and TOC, respectively), so no precision qualifiers were needed. TOC samples averaged 82% of the average for 2012-2014 POC water samples. DOC was not measured in previous POC project water samples so could not be compared.

[12] Data of particle size was captured for % Clay (<0.0039 mm), % Silt (0.0039 to <0.0625 mm), % V. Fine Sand (0.0625 to <0.125 mm), % Fine Sand (0.125 to <0.25 mm), % Medium Sand (0.25 to <0.5 mm), % Coarse Sand (0.5 to <1.0 mm), % V. Coarse Sand (1.0 to <2.0 mm), and % Granule + Pebble (>2.0 mm). The raw data can be found in appendix B.

## PCBs in Water and Sediment

Overall the water (whole water and dissolved) and sediment (separately analyzed particulate) PCB data from AXYS were acceptable. EPA 1668 methods for PCBs recommend analysis within a year, and all samples were analyzed well within that time (maximum 64 days). MDLs were sufficient with no non-detects reported for any of the PCB congeners measured. Some blank contamination was found in method blanks for about 20 of the more abundant congeners, with only two PCB 008 water results censored for blank contamination exceeding 1/3 the concentration in field samples. Many of the same congeners were detected in the field blank, but at concentrations <1% the average found in the field samples. Three target analytes, PCB 105, 118, and 156, and numerous non-RMP 40 congeners were reported in laboratory control samples (LCS) to evaluate accuracy, with good recovery (average error on target compounds always <16%, well within the target MQO of 35%). A laboratory control material (modified NIST 1493) was also reported, with error 22% or better for all congeners. Average RSDs for congeners in the field replicate were all <18%, within the MQO target of 35%, and LCS RSDs were ~2% or getter. PCB concentrations have not been analyzed in remote sediment sampler sediments for previous POC studies, so no direct comparison could be made. PCB concentrations in water samples were similar to previous years (2012-2014) ranging from 25% to 323% of previous averages, depending on the congener. Ratios of congeners generally followed expected abundances in the environment.

## Trace Elements in Water

Overall the water trace elements (As, Cd, Pb, Cu, Zn, Hg) data from Brooks Rand Labs (BRL) were acceptable. MDLs were sufficient with no non-detects reported for any field samples. Arsenic was detected in one method blank, and mercury in 4 method blanks, but the results were blank corrected, and blank variation was <MDL. Also, no analytes were detected in the field blank. Recoveries in certified reference materials (CRMs) were good, averaging 2% error for mercury up to 5% for zinc, all well below the target MQOs (35% for arsenic and mercury; 25% for all others). Matrix spike and LCS sample errors all averaged below 10%, well within the accuracy MQOs. Precision was evaluated in lab replicates, except for mercury which was evaluated in certified reference material replicates (no mercury lab replicates were analyzed). RSDs on lab replicates ranged from <1% for zinc up to 4% for arsenic, well within target MQOs (35% for arsenic and mercury; 25% for all the other analytes). Mercury CRM replicate RSD was 1%, also well within the target MQO. Matrix spike and laboratory control sample replicates similarly had average RSDs well within their respective target MQOs. Even including the field heterogeneity from blind field replicates, precision MQOs were easily met. Average concentrations were up to 12 times higher than the average concentrations of 2012-2014 POC water samples, but whole water composite samples were in a similar range as previous years.

## Trace Elements in Sediment

A single sediment sample was obtained from fractionating one Hamlin sampler and analyzing for As, Cd, Pb, Cu, Zn, and Hg concentration on sediment. Overall the data were acceptable. MDLs were sufficient with no non-detects for any analytes in field samples. Arsenic was detected in one method blank (0.08 mg/kg dw) just above the MDL (0.06 mg/kg dw), but results were blank corrected and the blank standard deviation was less than the MDL so results were not blank flagged. All other analytes were not detected in method blanks. CRM recoveries showed average errors ranging from 1% for copper to 24%

for mercury, all within their target MQOs (35% for arsenic and mercury; 25% for others). Matrix spike and LCS average recoveries were also within target MQOs when spiked at least 2x the native concentrations. Lab replicate RSDs were good, averaging from <1% for zinc to 5% for arsenic, all well within the target MQOs (35% for arsenic and mercury; 25% for others). Matrix spike RSDs were all 5% or less, also well within target MQOs. Average results ranged from 1 to 14 times higher than the average concentrations for the RMP Status and Trend sediment samples (2009-2014), which might be expected given runoff samples' likely greater proximity to terrestrial anthropogenic metal sources.

# Results and Discussion

This section presents the data in the context of two key questions.

a) What are the concentrations and particle ratios observed at each of the sites based on the composite water samples?
b) How do the particle ratios observed at each of the sites based on the composite water samples compare to particle ratios derived from the remote sedimentation based samplers?

The reader is reminded that the data collected and presented here is contributing to a broader based effort to identify potential management areas. The rankings provided here based on either stormwater concentration or particle ratios are part of a weight of evidence approach being used for locating and managing areas in the landscape that may be disproportionally impacting downstream water quality.

## Suspended Sediment Concentrations

Concentrations of suspended sediments ranged between 29-265 mg/L (Table 6). Concentrations of this magnitude are typical of urban stormwater runoff in the Bay Area. For example, concentrations of between 1.4-2,700 mg/L with a flow-weighted mean concentration of 160 mg/L have been observed in Zone 4 Line A, a small urban drainage in Hayward (Gilbreath et al. 2012a). McKee et al. (2012) reported mean concentrations of 38.4-484 mg/L for 14 out of 16 urban tributaries in the Bay Area (excluding Marsh Creek and Walnut Creek that exhibited high concentrations associated with rural areas). McKee et al. (2015) reported flow-weighted mean concentrations (FWMC) of 34 mg/L, 28 mg/L, 171 mg/L, and 66 mg/L for North Richmond Pump Station, San Leandro Creek, Sunnyvale East Channel, and Pulgas Creek Pump Station-South, respectively.

## Total Organic Carbon and Dissolved Organic Carbon

TOC ranged from 3.1-20 mg/L. At all but three sites, TOC was composed of more than 90% dissolved phase (DOC). The three exceptions were Ridder Park Dr Storm Drain (88%), Line4-E (78%), and Meeker Slough (83%). On average, TOC was 98% transported in dissolved phase, functionally DOC. These concentrations are also similar to those observed previously. For example, McKee et al., (2012) observed a range of 2.1-13 mg/L for 16 tributaries around the Bay Area. FWMCs for TOC of 9.7 mg/L, 6.4 mg/L, 7.6 mg/L, and 9.4 mg/L have been observed for North Richmond Pump Station, San Leandro Creek, Sunnyvale East Channel, and Pulgas Creek Pump Station-South respectively (McKee et al., 2015). There was no correlation between SSC and TOC, probably due to the high proportion in the dissolved phase but also perhaps because the production of organic carbon in an urban landscape is

Table 6. Concentrations of total mercury, sum of PCBs (RMP 40), selected trace metals, and ancillary constituents measured at each of the sites during winter storms of water year 2015. Both the sum of PCBs and total mercury are also expressed at a particle ratio (mass of pollutant divided by mass of suspended sediment). The table was sorted from high to low based on PCB particle ratios.

| | SSC (mg/L) | DOC (mg/L) | TOC (mg/L) | PCBs | | | | Total Hg | | | | As (µg/L) | Cd (µg/L) | Cu (µg/L) | Pb (µg/L) | Zn (µg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (pg/L) | Rank | (ng/g) | Rank | (ng/L) | Rank | (µg/g) | Rank | | | | | |
| Outfall to Lower Silver Ck | 57.0 | 8.6 | 8.3 | 44,643 | 2 | 783 | 1 | 24.1 | 17 | 0.423 | 12 | 2.11 | 0.267 | 21.8 | 5.43 | 337 |
| Ridder Park Dr SD | 114 | 7.7 | 8.8 | 55,503 | 1 | 488 | 2 | 37.1 | 12 | 0.326 | 16 | 2.66 | 0.335 | 19.6 | 11.0 | 116 |
| Line-3A-M at 3A-D | 73.6 | 9.5 | 7.3 | 24,791 | 5 | 337 | 3 | 85.9 | 1 | 1.17 | 2 | 2.08 | 0.423 | 19.9 | 17.3 | 118 |
| Seabord Ave SD SC-050GAC580 | 84.5 | 9.5 | 10 | 19,915 | 6 | 236 | 4 | 46.7 | 8 | 0.553 | 7 | 1.29 | 0.295 | 27.6 | 10.2 | 168 |
| Line4-E | 170 | 2.8 | 3.6 | 37,350 | 3 | 219 | 5 | 59.0 | 5 | 0.346 | 14 | 2.12 | 0.246 | 20.6 | 13.3 | 144 |
| Seabord Ave SD SC-050GAC600 | 72.5 | 7.9 | 8.6 | 13,472 | 9 | 186 | 6 | 38.3 | 10 | 0.528 | 8 | 1.11 | 0.187 | 21.0 | 8.76 | 132 |
| South Linden PS | 43.0 | 7.4 | 7.4 | 7,814 | 15 | 182 | 7 | 29.2 | 15 | 0.679 | 4 | 0.792 | 0.145 | 16.7 | 3.98 | 141 |
| Line9-D | 68.5 | 5.0 | 4.6 | 10,451 | 10 | 153 | 8 | 16.6 | 19 | 0.242 | 18 | 0.470 | 0.0530 | 6.24 | 0.910 | 67.0 |
| Meeker Slough | 60.3 | 4.4 | 5.3 | 8,560 | 14 | 142 | 9 | 76.4 | 3 | 1.27 | 1 | 1.75 | 0.152 | 13.6 | 14.0 | 85.1 |
| Rock Springs Dr SD | 41.0 | 11 | 11 | 5,252 | 17 | 128 | 10 | 38.0 | 11 | 0.927 | 3 | 0.749 | 0.0960 | 20.4 | 2.14 | 99.2 |
| Charcot Ave SD | 121 | 20 | 20 | 14,927 | 7 | 123 | 11 | 67.4 | 4 | 0.557 | 6 | 0.623 | 0.0825 | 16.1 | 2.02 | 115 |
| Veterans PS | 29.2 | 5.9 | 6.3 | 3,520 | 19 | 121 | 12 | 13.7 | 20 | 0.469 | 9 | 1.32 | 0.0930 | 8.83 | 3.86 | 41.7 |
| Gateway Ave SD | 45.0 | 9.9 | 10 | 5,244 | 18 | 117 | 13 | 19.6 | 18 | 0.436 | 10 | 1.18 | 0.0530 | 24.3 | 1.04 | 78.8 |
| Runnymede Ditch | 265 | 16 | 16 | 28,549 | 4 | 108 | 14 | 51.5 | 7 | 0.194 | 20 | 1.84 | 0.202 | 52.7 | 21.3 | 128 |
| E. Gish Rd SD | 145 | 12 | 13 | 14,365 | 8 | 99.2 | 15 | 84.7 | 2 | 0.585 | 5 | 1.52 | 0.552 | 23.3 | 19.4 | 152 |
| Line3A-M-1 at Industrial PS | 93.1 | 4.2 | 4.5 | 8,923 | 12 | 95.8 | 16 | 31.2 | 14 | 0.335 | 15 | 1.07 | 0.176 | 14.8 | 7.78 | 105 |
| SD near Cooley Landing | 82.0 | 13 | 13 | 6,473 | 16 | 78.9 | 17 | 35.0 | 13 | 0.427 | 11 | 1.74 | 0.100 | 9.66 | 1.94 | 48.4 |
| Oddstad PS | 148 | 8.0 | 7.5 | 9,204 | 11 | 62.4 | 18 | 54.8 | 6 | 0.372 | 13 | 2.45 | 0.205 | 23.8 | 5.65 | 117 |
| Line4-B-1 | 152 | 2.8 | 3.1 | 8,674 | 13 | 57.0 | 19 | 43.0 | 9 | 0.282 | 17 | 1.46 | 0.225 | 17.7 | 8.95 | 108 |
| Lower Penitencia Ck | 144 | 5.9 | 6.1 | 2,033 | 20 | 14.1 | 20 | 29.0 | 16 | 0.202 | 19 | 2.39 | 0.113 | 16.4 | 4.71 | 64.6 |
| | | | | | | | | | | | | | | | | |
| Minimum | 29 | 2.8 | 3.1 | 2,033 | | 14.1 | | 13.7 | | 0.194 | | 0.470 | 0.053 | 6.24 | 0.910 | 41.7 |
| Maximum | 265 | 20 | 20 | 55,503 | | 783 | | 85.9 | | 1.27 | | 2.66 | 0.552 | 52.7 | 21.3 | 337 |

likely complex and associated with vegetation debris, pet wastes, soot carbon from combustion of fossil fuels, and the organic components of human derived trash rather than from erosion of low carbon soils (<10%) which would be more typical of rural soils and watersheds of the Bay area.

## PCBs Concentrations and Particle Ratios

Total PCB concentrations measured in the composite water samples across the 20 watershed sampling sites ranged 27-fold from 2,033-55,503 pg/L (Table 6). The highest concentration was observed in Ridder Park Dr. Storm Drain in San Jose, a site with 57% of its estimated drainage area in old industrial land use. This concentration was relatively high in relation to previous observations in the Bay Area (e.g., Zone 4 Line A FWMC = 14,500 pg/L: Gilbreath et al., 2012a; Ettie Street Pump Station mean = 59,000 pg/L; Pulgas Creek Pump Station-North: 60,300 pg/L: McKee et al., 2012). When normalized to SSC to generate particle ratios, the three highest ranking sites were the Outfall to Lower Silver Creek in San Jose (783 ng/g) (78% old industrial), Ridder Park Drive Storm Drain in San Jose (488 ng/g) (57% old industrial), and Line-3A-M at 3A-D in Hayward (337 ng/g) (12% old industrial). Particle ratios of this magnitude are relatively elevated but lower than some of the more extreme examples in the Bay Area that have been previously sampled (Santa Fe Channel (1,403 ng/g) (3% old industrial), Pulgas Creek Pump Station-North (1,050 ng/g) (52% old industrial), Pulgas Creek Pump Station-South (906 ng/g) (54% old industrial), Ettie St. Pump Station (745 ng/g) (22% old industrial): McKee et al., 2012)[13]. Line 4-B-1 in Hayward and Lower Penitencia Creek in Milpitas were ranked the lowest using PCB particle ratios. The sample taken in Lower Penitencia Creek corroborates a similar finding that was previously reported (McKee et al., 2012). In general, on average, the particle ratios for the WY 2015 sampling effort were greater than those from WY 2011 (McKee et al., 2012). This likely resulted from a much greater average imperviousness and proportion of old industrial land use in the catchment areas of the WY 2015 sites.

## Mercury Concentrations and Particle Ratios

Total Hg concentrations in composite water samples varied 6-fold between the 20 watershed sampling sites from 14-86 ng/L (Table 6). This relatively small variation between sites is quite a change from the previous reconnaissance effort in WY 2011 when mean HgT concentrations were observed to vary by 36-fold between sites (McKee et al., 2012). This lower variation at least in part reflects the lower variation in SSC between sites (36-fold for sites observed in WY 2011 and just 9-fold for WY 2015 sites). The greatest HgT concentrations were observed in Line-3A-M at 3A-D in Hayward (12% old industrial), E. Gish Rd Storm Drain in San Jose (71% old industrial), and Meeker Slough in Richmond (6% old industrial). This helps to illustrate that mercury concentrations don't appear to follow a strong relationship with old industrial land use. When the data were normalized to SSC, the five most highly ranked sites were Meeker Slough in Richmond (6% old industrial), Line-3A-M at 3A-D in Hayward (12% old industrial), Rock Springs Dr. Storm Drain in San Jose (10% old industrial), South Linden Pump Station in South San Francisco (22% old industrial), and E. Gish Rd Storm Drain in San Jose (71% old industrial). Particle ratios at these sites were 1.3, 1.3, 0.93, 0.68, and 0.59 µg/g, respectively. Particle ratios of this magnitude are

[13] Note, these particle ratios do not match those in Table 8 of this report because of the slightly different method of computing the central tendency of the data (see the methods section of this report above) and, in the case of Pulgas Creek Pump Station – South, because of the extensive additional sampling that has occurred since McKee et al. (2012) reported the reconnaissance results from the WY 2011 field season.

similar to the upper range of those observed during the WY 2011 sampling campaign (Pulgas Creek Pump Station-South: 0.83 µg/g, San Leandro Creek: 0.80 µg/g, Ettie Street Pump Station: 0.78 µg/g, and Santa Fe Channel: 0.68 µg/g) (McKee et al., 2012).[see footnote 12 above]

Since there was much lower variation in SSC among the sites, the choice of ranking method for both PCBs and HgT was less important within the WY 2015 dataset than it was when interpreting the 2011 data set (McKee et al., 2012). But as will be discussed further below, when making comparisons between all the data collected in the Bay Area to date, the particle ratio method of normalization remains the most reliable tool for ranking sites in relation to potential management follow-up. In general there was only a weak but positive relationship between observed PCB and HgT concentrations. The six highest ranking sites for PCBs based on particle ratios ranked 12th, 16th, 2nd, 7th, 14th, and 8th, respectively, for HgT. This observation contrasts with the conclusions drawn from the WY 2011 dataset where there appeared to be more of a general correlation (McKee et al., 2012). This might reflect a stronger focus on PCBs during the WY 2015 site selection process and the resulting focus on smaller watersheds with higher imperviousness and old industrial land use, or perhaps it might be an artifact of small datasets. This observation will be explored further below.

## Trace metal (As, Cd, Cu, Pb, and Zn) Concentrations

Concentrations of As, Cd, Cu, Pb, and Zn ranged between 0.47-2.7 µg/L, 0.053-0.55 µg/L, 6.2-53 µg/L, 0.91-21 µg/L, and 42-337 µg/L respectively (Table 6). Total As concentrations of this magnitude have been measured in the Bay Area before (Guadalupe River at Hwy 101: mean=1.9 µg/L; Zone 4 Line A: mean=1.6 µg/L) but appear much lower than were observed in North Richmond Pump Station (mean=11 µg/L) (see Appendix A3 in McKee et al., 2015). The Cd concentrations observed at sites during the WY 2015 effort also appear similar to mean concentrations of Cd measured in Guadalupe River at Hwy 101 (0.23 µg/L), North Richmond Pump Station (0.32 µg/L), and Zone 4 Line A (0.25 µg/L) (see Appendix A3 in McKee et al., 2015). Similarly the Cu and Pb concentrations observed during the WY 2015 sampling effort also appear typical of other Bay Area watersheds (Guadalupe River at Hwy 101: Cu 19 µg/L, Pb 14 µg/L; Lower Marsh Creek: Cu 14 µg/L; North Richmond Pump Station: Cu 16 µg/L, Pb 1.8 µg/L; Pulgas Creek Pump Station-South: Cu 44 µg/L; San Leandro Creek: Cu 16 µg/L; Sunnyvale East Channel: Cu 18 µg/L; and Zone 4 Line A: Cu 16 µg/L, Pb 12 µg/L) (see Appendix A3 in McKee et al., 2015). In contrast, Zn measurements at 12 of the sites measured during the WY 2015 sampling effort exceeded the greatest mean concentration observed in the Bay Area previously (Zone 4 Line A: 105 µg/L) (Gilbreath et al., 2012a; see Appendix A3 in McKee et al., 2015). The sites exhibiting the highest Zn concentrations in order from higher to lower were the Outfall to Lower Silver Creek in San Jose (79% imperviousness; 78% old industrial), the Seabord Ave Storm Drain in San Jose (81% imperviousness; 68% old industrial), the E. Gish Rd Storm Drain in San Jose (84% imperviousness; 71% old industrial), the Line4-E in Hayward (81% imperviousness; 27% old industrial). These sites ranked 2nd, 6th, 8th and 3rd using PCB concentrations, 1st, 4th, 5th and 15th using PCB particle ratios, 17th, 8th, 5th and 2nd using HgT concentrations, and 12th, 7th, 14th and 5th using HgT particle ratios. It is not clear from these comparisons what might be the cause of the elevated Zn concentrations in these watersheds.

## Comparisons between Composite Water and Remote Sediment Sampling Methods

The four results from remote (primarily suspended sediment trapping) sedimentation samplers that were successfully gathered in WY 2015 were compared to the results from water composite samples collected in parallel at those sites for the same storm events. Results for the remote samplers are all compared on a particle ratio basis, whether analyzed as whole water or separate dissolved and sediment fractions. Although most of the remotely collected samples included reported suspended sediment concentrations, these are not environmentally linked SSCs, but rather the total mass of sediment collected and slurried in an arbitrary volume of water needed to wash the sediment into a collection jar. However, due to the arbitrary volume of water used to slurry the sample, rather than SSC, a more environmentally linkable measure in remote samplers is the total mass of sediment collected. A first order metric of the effectiveness of the remote sampler sediment collection is the volume of composite water that would need to be filtered to generate the same collected sediment mass. These are inexact estimates due to the possibility of different grain sizes captured by the remote sampler and composite stormwater samples, but differences between the Hamlin and Walling are qualitatively consistent with their different cross sectional areas at the sample entry points. Table 7 shows the site water composite SSC, and the total mass of sediment (dry weight (dw) basis) collected in the remote sampler, and the water volume equivalent that the remote sampler sediment represents.

Table 7. Remote sampler collected sediment mass and volume equivalent (relative to composite).

| Sampler | Site | Composite SSC (mg/L) | Remote sediment mass (g) | Remote volume equivalent (liters (L)) |
|---|---|---|---|---|
| Hamlin | Charcot Ave Storm Drain | 121 | 93.3 | 771 |
| Hamlin | Storm Drain near Cooley Landing | 82 | 53.9 | 657 |
| Hamlin | Outfall to Lower Silver Creek | 57 | 5.9 | 104 |
| Walling | Outfall to Lower Silver Creek | 57 | 0.48 | 8.4 |

For the Hamlin samplers, higher SSC in the separately collected composite stormwater samples consistently translated to larger masses of sediment collected, but in a non-linear fashion. Some of the differences may be related to deployment site geometry, as well as the particle size distribution of sediment carried in the flow. The composite samples, whether collected via peristaltic pump or using a DH-81, could only sample ~5 cm or more above the channel bed, and attempts were made for integrated collection throughout the water column. In contrast, the Hamlin samplers sat directly on the channel bed, or slightly elevated (~3 cm) when attached atop a weighted plate. The Hamlin samples therefore would be more likely than the composited stormwater samples to capture coarser grained near-bed or bedload sediment. Similarly, although the inlet for the Walling tube would be above the channel bed (~5 cm minimum, much like the DH-81), rather than integrating throughout the water column, it would remain fixed at that depth throughout the collection, and thus more of the flow passing through the sampler would be nearer to the bed than the flow captured by the composite water sampling techniques. In addition, the finest grained sediments would likely remain suspended within and wash out from both Hamlin and Walling samplers, leading to samples that could disproportionately over-sample coarser sediments and under-sample finer grained sediments. The remote sampler from one site (Charcot Ave SD) had large amounts of coarse grained material, but whether that was appreciably different from that seen in composite water samples (~15% sand) was not visually determinable. Future collections using remote samplers will measure grainsize in the laboratory to verify these hypotheses.

Figure 4 shows remote sampler particle ratio results for PCBs and mercury plotted versus particle ratios for composited stormwater samples. The data generally show some correlation, i.e., higher remote sampler particle ratios occur for sites with higher particle ratios obtained from composite stormwater samples, although based on the small number of samples, the correlation for PCBs is not quite significant ($p \sim 0.09$) at $\alpha = 0.05$. Both figures show a 1:1 line, which would occur if all the contaminant in composite water samples occurred in the sediment phase for those sites.

Results for PCBs showed that most of the composited stormwater samples had lower particle ratios than those obtained from remote samplers. Prior settling experiments using collected runoff (Yee and McKee, 2010) showed a majority of PCBs in a sediment phase settled out of a 30 cm water column within 20 minutes or less in contrast to the results for HgT which showed generally lower settling rates. If this trend holds true for other systems in the Bay Area, PCB results would therefore generally be less influenced by a bias of including the dissolved phase in calculating particle ratios for composited stormwater samples with lower suspended sediments. Secondly, remote samplers affixed to the bed of discharge channels would preferentially sample heavier and larger particles near-bed load, compared to composited stormwater samples that represent more of the entire water column. Thus the results might be conceptually reasonable. Three of the four remote samplers showed PCB particle ratios higher than those from corresponding composited stormwater samples. The exception (from a Hamlin sampler at Cooley Landing) showed only a modest excursion in the opposite direction, with a particle ratio 13% lower than that in the composited stormwater sample from that site. Overall, the differences between remotely collected and composited stormwater samples was generally small for PCBs, with particle ratios differing by <20% except for one pair differing 2-fold. These preliminary interpretations are only initial hypotheses being used to help refine the sampling and analytical program. Care must be taken when interpreting general patterns with such a small number of samples.

In contrast, the results for mercury showed that some of the composited stormwater water samples had greater particle ratios than those obtained from remote samplers. For mercury, the highest particle ratios occurred in the samples collected from Charcot Avenue Storm Drain in San Jose for both the composite of stormwater samples as well as a sample analyzed as sediment collected with a Hamlin sampler. Interestingly, results for Charcot ran counter to our general expectations and results for other sites, namely that the mercury particle ratios for the remote samplers would be lower than those for composited stormwater samples collected at the same sites. This latter pattern would be expected at most sites because the particle ratio includes any dissolved phase mercury measured. Composited stormwater samples would be expected to show higher particle ratios than from remote samplers, due

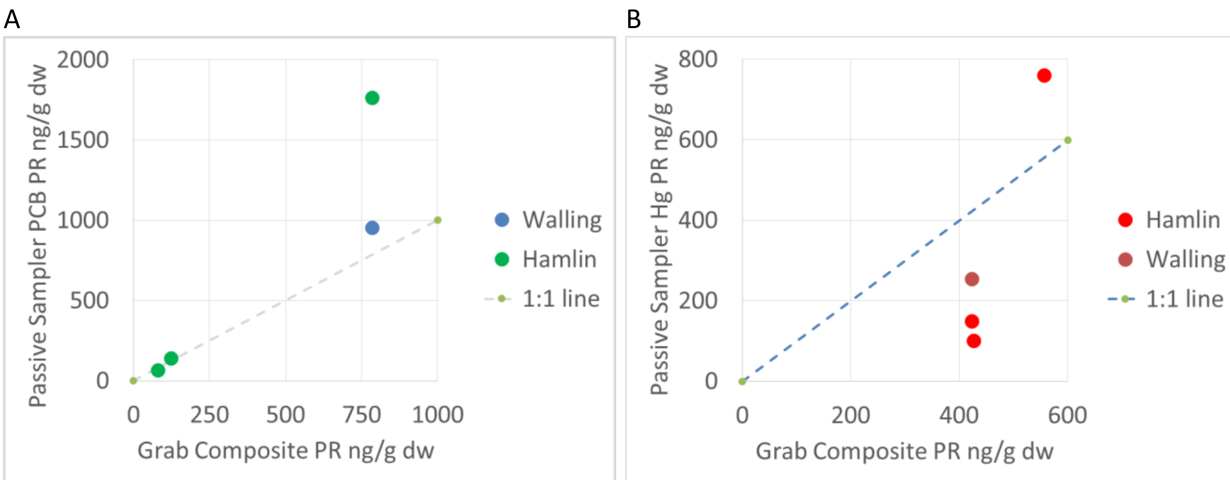



Figure 4. Particle Ratio (PR) comparisons between remote (sediment) versus composite (water) samples for A) PCBs and B) total mercury.

to lower sediment content and thus a greater relative proportion of mercury in the dissolved phase or on fine particles biasing the calculated particle ratio higher. Even if the Charcot Avenue Storm Drain composite sample contained high suspended solids, a similar but smaller high bias (nearer the 1:1 line) would still be accepted. Although conclusions are hard to draw based on data from just three sites, the contrary results for the Charcot Avenue Storm Drain sample could be either associated with differing sources or environmental processes for mercury at that site at least for this one event, or alternatively, greater variability in the subsampling of its composite water sample (e.g., if the composite subsample analyzed for SSC contained more sediment than that for mercury, a lower apparent particle ratio would result). The differences in particle ratio were lowest for Charcot Avenue (25%), which is similar to a plausible degree of subsampling and analytical variation. The particle ratios for other sites differed up to 4-fold (as noted previously, with the composited stormwater samples biased higher). This difference cannot be accounted for through sub-sampling or analytical errors and the representativeness of the composite sample (time paced with a limited number of sub-samples) is ruled out by the Hg results from the remote samplers being lower than 1:1. Also, the Charcot Avenue Storm Drain composite water sample contained 15% sand, versus the other two sites with primarily clays and silts and little sand (<0.1%). This may have also influenced the comparison, as water samples with higher sand content are more difficult to subsample uniformly; if the field sampling crew or the analytical labs biased differently in the fraction of sand captured in mercury versus SSC analyses, random variations in particle ratio (either up or down) could result. The possibility of a coarse sediment associated mercury source (similar to the case for most sites for PCBs) also cannot be totally ruled out but is counter to the hypothesis put forward previously by Yee and McKee (2010) that mercury is more dominantly transported on finer particles than PCBs.

Although only a limited number of samples were able to be collected using the remote samplers during the WY 2015 sampling effort, the results obtained thus far show some promise at least as a qualitative site ranking tool. For both PCBs and mercury, the samples with the highest particle ratios for composited stormwater samples were also the highest in the remote samplers. For PCBs, the site with the lowest particle ratio for a composited stormwater sample also had the lowest for a remote sampler. The remaining mercury results were more difficult to distinguish, with particle ratios in the composited stormwater samples nearly identical (differing ~1%), while results for remotely collected samples differed from the composited stormwater samples by 1.7- to 4-fold (including differences for paired Hamlin (2.8x) and Walling (1.7x) samplers at Lower Silver Creek).

These variable results indicate some challenges in interpretation of data collected by composite versus remote methods. The composited stormwater water samples conflate some dissolved load in the indicator (particle ratio) where concentrations based on whole water samples were normalized to suspended sediment. In addition, the composite water collection method likely either did not sample or at least under-sampled near-bed transport of sediment and pollutants. Although no samples were collected for different events at any site, the differences among sites for the composited and remote particle ratios suggest the potential for large differences among events even within a site, depending on storm event and site characteristics. These differences also present some challenges in applications beyond ranking and prioritization. Partly due to a small data set so far, there was no consistent direction of bias between the manual stormwater composite and remote methods, and even within PCBs (the more consistent analyte), for the Hamlin sampler, the particle ratio ranged from 87% to 230% of the composite sample result. The ability to find differences among sites or within a site with less than a two-fold difference would therefore seem unlikely at this point. Although this is also true for the water composite methodology, there is always going to be more certainty that the sample for water composites better represents transport through the majority of a sample site cross section. The other challenge with samples gathered using the remote samplers is that the data cannot be used to estimate loads without corresponding sediment load estimates. Since sediment loads are not readily available for individual watersheds and, after failures to calibrate the RWSM for suspended sediments, or for PCB and HgT using a sediment model as the basis (McKee et al., 2014), the RWSM is now being calibrated with some success using flow and water-based stormwater concentrations (Wu et al., 2016). Although perhaps cheaper to deploy or logistically possible to deploy in situations where staffing a site is not possible due to logistical constraints, the data derived from the sediment remote samplers are overall less versatile and more challenging to interpret.

With these concerns raised, the sampling program for WY 2016 will continue to build out the dataset for comparing samples derived from composite and remote suspended sediment sampling methods. Based on a full set of a further nine planned sample pairs, better confidence maybe be obtained about how to characterize the range of differences and biases among the methods, as well as to identify some causes of these artifacts, either generally or specific to certain site (land use) or/and event characteristics (storm intensity, duration, sample grain size, organic carbon). The data obtained to date from remote samplers show some promise as relative ranking or prioritization tools; if the data from additional planned sample pairs continue to show similar relationships to stormwater composite samples, future monitoring strategies could be envisioned, first using remote samplers as a low-cost screening and ranking tool, to be followed up by site occupation and active water sampling for the highest priority locations. In the event that after the pilot study is completed and a total of 12 samples have been collected and data still does not show reasonable comparability or explainable differences between the stormwater composite and suspended sediment remote sampler methods, future efforts to further improve these methods might need to consider additional factors such as inter-storm variation, site cross-sectional variation, and relative contributions of near-bed load to total pollutant discharge.

## What is the cost/benefit and pros/cons of all sampling methods including remote samplers practiced to date?

The pilot study to assess effectiveness of remote samplers is still in the early stages. Due to a low number of storm events during WY 2015, these devices were only successfully deployed at three locations. A more comprehensive analysis of effectiveness and cost versus benefit of this method will be completed after the sampling effort for the winter of WY 2016 is completed. Generally speaking, it is anticipated that non-manual sampling methods will be more cost-effective. Conceptually, this method will allow multiple sites to be monitored during a single storm event where devices are deployed prior to the storm and retrieved after the storm. There will be initial capital costs to purchase the equipment and labor will be required to deploy and process samples. In addition, there will always be logistical constraints (such as turbulence or tidal influences) that negate the use of the remote settling devices and cause the need for manual monitoring at a particular site, and as mentioned above, the data derived from the remote sampling methodologies will be less easy to interpret and overall will have less versatility for other uses outside ranking sites for relative pollution, for example loadings estimates. But used as a companion to manual monitoring methods, costs will most likely be reduced and data suitable for other purposes will continue to be collected. Factoring in the more limited data uses in the cost-effectiveness analysis will be challenging.

## Preliminary site rankings based on all available data

The PCB and HgT load allocations of 2 and 80 kg respectively translate to a mean concentration of 1.33 ng/L (PCBs) and 53 ng/L (HgT) (assuming an annual average flow from small tributaries of 1.5 $km^3$ (Lent et al., 2012)) and mean annual particle ratio of 1.4 ng/g (PCBs) and 0.058 µg/g (HgT) (assuming an average annual suspended sediment load of 1.4 million metric tons) (McKee et al., 2013). Keeping in mind that the estimates of regional flow and regional sediment loads are subject to change is further interpretations are completed, only one sampling location (Gellert Park bioretention influent stormwater) observed to date has a composite averaged PCB concentration of < 1.33 ng/L (Table 8) and none out of 45 sampling locations have composite averaged PCB particle ratios <1.4 ng/g (Table 8; Figure 5 and 6). The elevated PCB concentrations and particle ratios measured in WY 2015 may be due, in part, to the site selection process which focused on finding potential higher leverage areas for PCBs. The lowest observed PCB particle ratio to date was at Marsh Creek (2.9 ng/g).

Although there are always challenges associated with interpreting data in relation to highly variable climate including antecedent conditions, storm specific rainfall intensity, and watershed specific source-release-transport processes, the objective here is to provide evidence to help differentiate watersheds

Table 8. PCB and HgT concentrations and particle ratios observed in the Bay area based on all data collected in stormwater since WY 2003 that focused on urban sources (45 sites in total for PCBs and HgT). Data for both PCBs and HgT were sorted high to low based on particle ratio to provide preliminary information on potential leverage.

| Watershed/ Catchment | County | Water Year sampled | Area (km²) | Impervious cover (%) | Old Industrial land use (%) | Polychlorinated biphenyls (PCBs) | | | | Total Mercury (HgT) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Particle Ratio | | Composite /mean water concentration | | Particle Ratio | Rank (HgT PR) | Composite /mean water concentration | |
| | | | | | | (ng/g) | Rank | (pg/L) | Rank | (µg/g) | Rank | (ng/L) | Rank |
| Pulgas Creek Pump Station-South | San Mateo | 2011-2014 | 0.584 | 87% | 54% | 8222 | 1 | 447984 | 1 | 0.35 | 24 | 19 | 40 |
| Santa Fe Channel | Contra Costa | 2011 | 3.26 | 69% | 3% | 1295 | 2 | 197923 | 2 | 0.57 | 14 | 86 | 7 |
| Pulgas Creek Pump Station-North | San Mateo | 2011 | 0.552 | 84% | 52% | 893 | 3 | 60320 | 4 | 0.40 | 22 | 24 | 36 |
| Outfall to Lower Silver Creek | Santa Clara | 2015 | 0.171 | 79% | 78% | 783 | 4 | 44643 | 7 | 0.42 | 21 | 24 | 37 |
| Ettie Street Pump Station | Alameda | 2011 | 4.03 | 75% | 22% | 759 | 5 | 58951 | 5 | 0.69 | 10 | 55 | 19 |
| Ridder Park Dr Storm Drain | Santa Clara | 2015 | 0.497 | 72% | 57% | 488 | 6 | 55503 | 6 | 0.33 | 27 | 37 | 30 |
| El Cerrito Bioretention Influent | Contra Costa | 2011 | 0.00408 | 74% | 0% | 442 | 7 | 37690 | 8 | 0.19 | 37 | 16 | 43 |
| Sunnyvale East Channel | Santa Clara | 2011 | 14.5 | 59% | 4% | 343 | 8 | 96572 | 3 | 0.20 | 35 | 50 | 22 |
| Line-3A-M at 3A-D | Alameda | 2015 | 0.881 | 73% | 12% | 337 | 9 | 24791 | 12 | 1.17 | 4 | 86 | 8 |
| North Richmond Pump Station | Contra Costa | 2011-2014 | 1.96 | 62% | 18% | 241 | 10 | 13226 | 20 | 0.81 | 9 | 47 | 23 |
| Seabord Ave Storm Drain SC-050GAC580 | Santa Clara | 2015 | 1.35 | 81% | 68% | 236 | 11 | 19915 | 15 | 0.55 | 16 | 47 | 24 |
| Line4-E | Alameda | 2015 | 2.00 | 81% | 27% | 219 | 12 | 37350 | 9 | 0.35 | 25 | 59 | 14 |
| Glen Echo Creek | Alameda | 2011 | 5.45 | 39% | 0% | 191 | 13 | 31078 | 10 | 0.21 | 34 | 73 | 12 |
| Seabord Ave Storm Drain SC-050GAC600 | Santa Clara | 2015 | 2.80 | 62% | 18% | 186 | 14 | 13472 | 19 | 0.53 | 17 | 38 | 28 |
| South Linden Pump Station | San Mateo | 2015 | 0.137 | 83% | 22% | 182 | 15 | 7814 | 31 | 0.68 | 11 | 29 | 35 |
| Line 9-D | Alameda | 2015 | 3.59 | 78% | 46% | 153 | 16 | 10451 | 23 | 0.24 | 30 | 17 | 42 |

| Watershed/ Catchment | County | Water Year sampled | Area ($km^2$) | Impervious cover (%) | Old Industrial land use (%) | Polychlorinated biphenyls (PCBs) | | | | Total Mercury (HgT) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Particle Ratio | | Composite /mean water concentration | | Particle Ratio | Rank (HgT PR) | Composite /mean water concentration | |
| | | | | | | (ng/g) | Rank | (pg/L) | Rank | (µg/g) | Rank | (ng/L) | Rank |
| Meeker Slough | Contra Costa | 2015 | 7.34 | 64% | 6% | 142 | 17 | 8560 | 29 | 1.27 | 3 | 76 | 11 |
| Rock Springs Dr Storm Drain | Santa Clara | 2015 | 0.829 | 80% | 10% | 128 | 18 | 5252 | 34 | 0.93 | 7 | 38 | 29 |
| Charcot Ave Storm Drain | Santa Clara | 2015 | 1.84 | 79% | 24% | 123 | 19 | 14927 | 17 | 0.56 | 15 | 67 | 13 |
| Veterans Pump Station | San Mateo | 2015 | 0.522 | 67% | 7% | 121 | 20 | 3520 | 38 | 0.47 | 18 | 14 | 44 |
| Gateway Ave Storm Drain | San Mateo | 2015 | 0.356 | 69% | 52% | 117 | 21 | 5244 | 35 | 0.44 | 19 | 20 | 39 |
| Guadalupe River at Hwy 101 | Santa Clara | 2003-2006, 2010, 2012-2014 | 233 | 39% | 3% | 115 | 22 | 23736 | 13 | 3.60 | 2 | 603 | 1 |
| Runnymede Ditch | San Mateo | 2015 | 2.05 | 53% | 2% | 108 | 23 | 28549 | 11 | 0.19 | 36 | 52 | 21 |
| E. Gish Rd Storm Drain | Santa Clara | 2015 | 0.447 | 84% | 70% | 99 | 24 | 14365 | 18 | 0.59 | 12 | 85 | 9 |
| Line 3A-M-1 at Industrial Pump Station | Alameda | 2015 | 3.44 | 78% | 26% | 96 | 25 | 8923 | 25 | 0.34 | 26 | 31 | 33 |
| Zone 4 Line A | Alameda | 2007-2010 | 4.17 | 68% | 12% | 82 | 26 | 18442 | 16 | 0.17 | 39 | 30 | 34 |
| Storm Drain near Cooley Landing | San Mateo | 2015 | 0.108 | 73% | 39% | 79 | 27 | 6473 | 32 | 0.43 | 20 | 35 | 31 |
| San Leandro Creek | Alameda | 2011-2014 | 8.94 | 38% | 0% | 66 | 28 | 8614 | 28 | 0.86 | 8 | 117 | 5 |
| Oddstad Pump Station | San Mateo | 2015 | 0.280 | 74% | 11% | 62 | 29 | 9204 | 24 | 0.37 | 23 | 55 | 18 |
| Line 4-B-1 | Alameda | 2015 | 0.963 | 85% | 28% | 57 | 30 | 8674 | 27 | 0.28 | 29 | 43 | 26 |
| Fremont Osgood Road Bioretention Influent | Alameda | 2012, 2013 | 0.000804 | 76% | 0% | 45 | 31 | 2906 | 40 | 0.12 | 43 | 10 | 45 |
| Gellert Park Daly City Library Bioretention Influent | San Mateo | 2009 | 0.0153 | 40% | 0% | 36 | 32 | 725 | 44 | 1.01 | 6 | 22 | 38 |
| Lower Coyote Creek | Santa Clara | 2005 | 327 | 22% | 1% | 30 | 33 | 4576 | 36 | 0.24 | 31 | 34 | 32 |

| Watershed/ Catchment | County | Water Year sampled | Area (km²) | Impervious cover (%) | Old Industrial land use (%) | Polychlorinated biphenyls (PCBs) | | | | Total Mercury (HgT) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Particle Ratio | | Composite /mean water concentration | | Particle Ratio | Rank (HgT PR) | Composite /mean water concentration | |
| | | | | | | (ng/g) | Rank | (pg/L) | Rank | (µg/g) | Rank | (ng/L) | Rank |
| Calabazas Creek | Santa Clara | 2011 | 50.1 | 44% | 3% | 29 | 34 | 11493 | 22 | 0.15 | 42 | 59 | 15 |
| San Lorenzo Creek | Alameda | 2011 | 125 | 13% | 0% | 25 | 35 | 12870 | 21 | 0.18 | 38 | 41 | 27 |
| Stevens Creek | Santa Clara | 2011 | 26.0 | 38% | 1% | 23 | 36 | 8160 | 30 | 0.22 | 33 | 77 | 10 |
| Guadalupe River at Foxworthy Road/ Almaden Expressway | Santa Clara | 2010 | 107 | 22% | 0% | 19 | 37 | 3120 | 39 | 4.09 | 1 | 529 | 2 |
| Lower Penitencia Creek | Santa Clara | 2011, 2015 | 11.5 | 65% | 2% | 16 | 38 | 1588 | 42 | 0.16 | 41 | 17 | 41 |
| Borel Creek | San Mateo | 2011 | 3.23 | 31% | 0% | 15 | 39 | 6129 | 33 | 0.16 | 40 | 58 | 17 |
| San Tomas Creek | Santa Clara | 2011 | 108 | 33% | 0% | 14 | 40 | 2825 | 41 | 0.28 | 28 | 59 | 16 |
| Zone 5 Line M | Alameda | 2011 | 8.05 | 34% | 5% | 13 | 41 | 21120 | 14 | 0.57 | 13 | 505 | 3 |
| Belmont Creek | San Mateo | 2011 | 7.22 | 27% | 0% | 13 | 42 | 3599 | 37 | 0.22 | 32 | 53 | 20 |
| Walnut Creek | Contra Costa | 2011 | 232 | 15% | 0% | 7 | 43 | 8830 | 26 | 0.07 | 45 | 94 | 6 |
| Lower Marsh Creek | Contra Costa | 2011-2014 | 83.6 | 10% | 0% | 3 | 44 | 1445 | 43 | 0.11 | 44 | 44 | 25 |
| San Pedro Storm Drain | Santa Clara | 2006 | 1.27 | 72% | 16% | No data | | | | 1.12 | 5 | 160 | 4 |

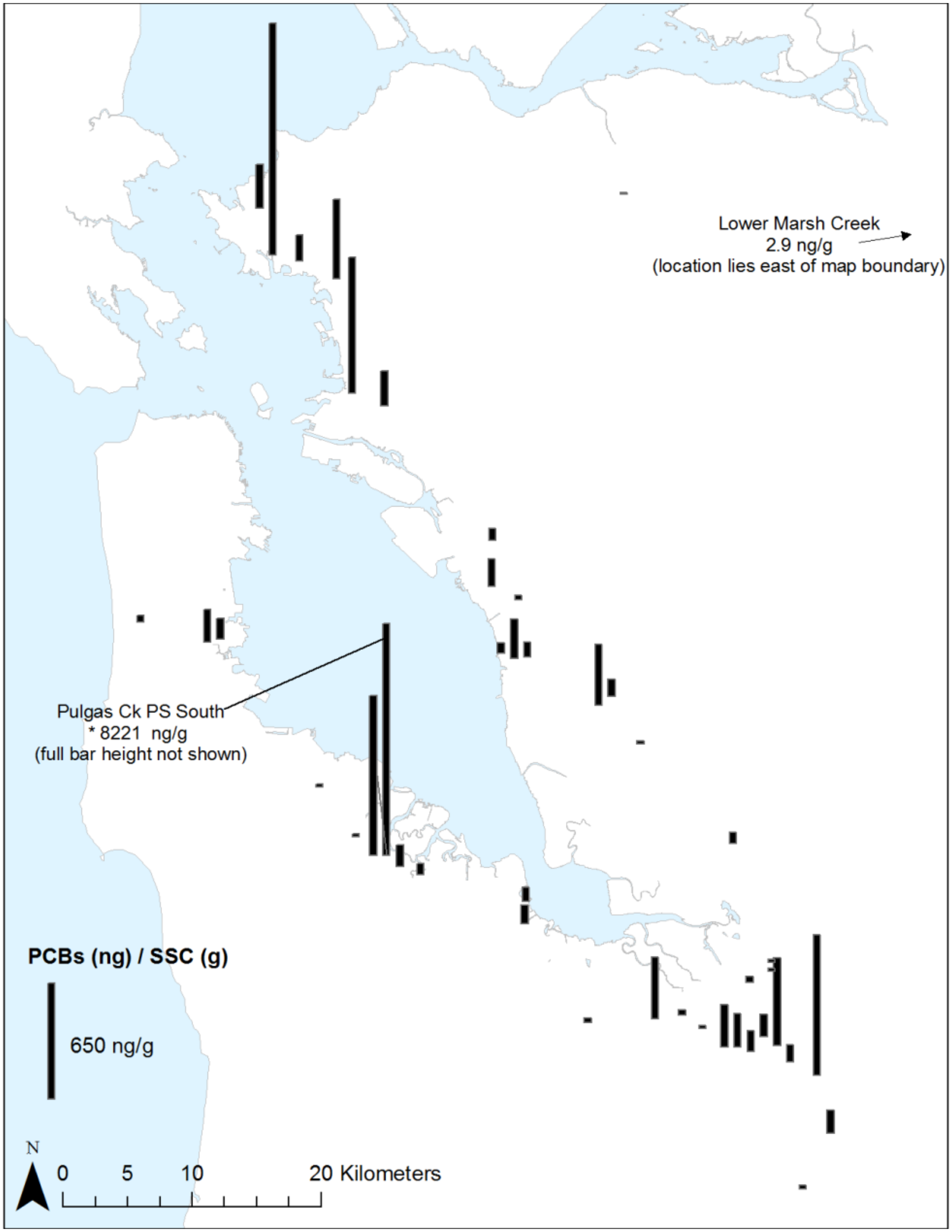



Figure 5. Regional distribution of particle ratios of polychlorinated biphenyl (PCB) in stormwater samples collected to date.

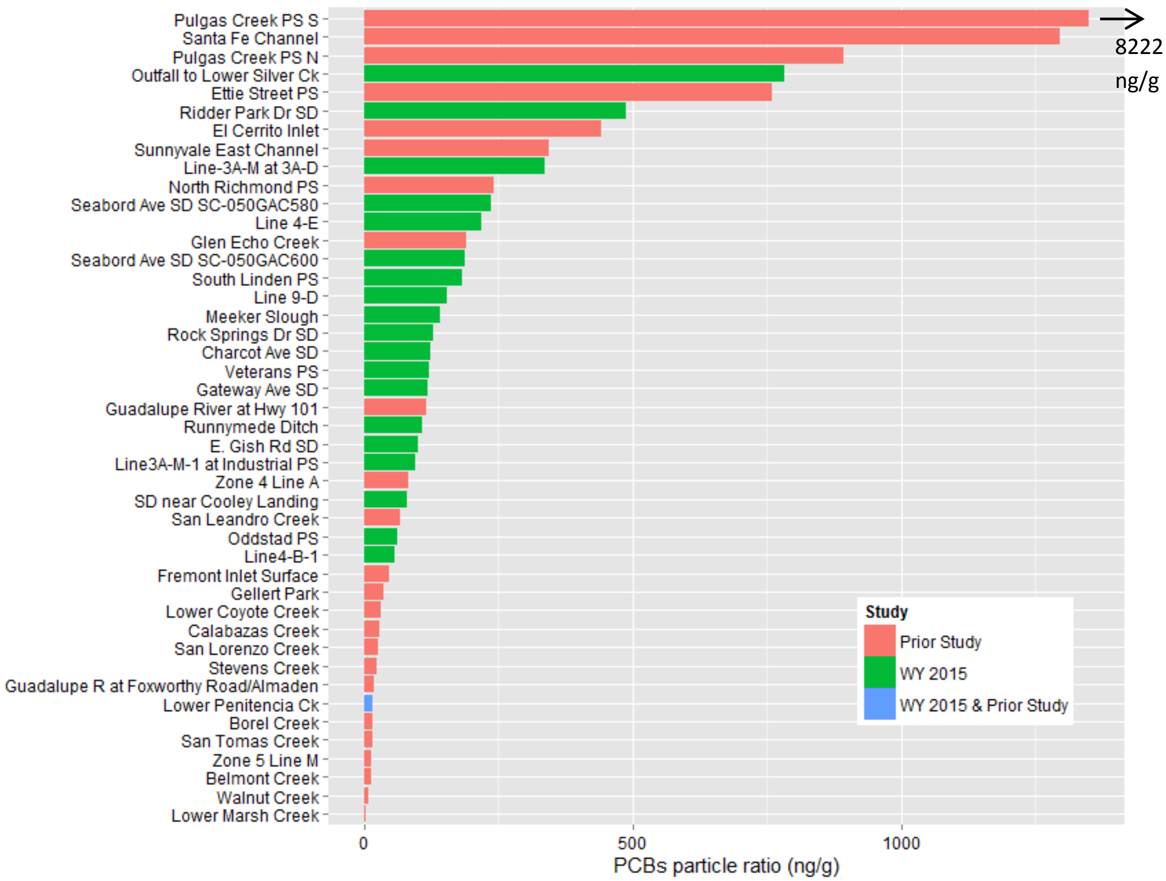



Figure 6. All watershed sampling locations measured to date ranked using PCB particle ratios. Note Pulgas Creek Pump Station-South is beyond the extent of this graph at 8,222 ng/g.

that might be disproportionately elevated in PCB or Hg concentrations or particle ratios from those with lower pollutant signatures. Given the nature of the reconnaissance sampling design, the absolute rank is much less certain. With these caveats in mind, the relative ranking was generated for PCBs and Hg based on both water concentrations and particle ratios for all the available data most of which was collected during WYs 2011 (a slightly wetter than average year) and WY 2015 (a slightly drier than average year).

Based on water composite concentrations for all available data, the ten most polluted sites for PCBs appear to be (in order from higher to lower): Pulgas Creek Pump Station-South, Santa Fe Channel, Sunnyvale East Channel, Pulgas Creek Pump Station-North, Ettie Street Pump Station, Ridder Park Dr Storm Drain, Outfall to Lower Silver Creek, Line4-E , Glen Echo Creek, and Runnymede Ditch (Figure 6). Using PCB particle ratios, the ten most polluted sites appear to be: Pulgas Creek Pump Station-South, Santa Fe Channel, Pulgas Creek Pump Station-North, Outfall to Lower Silver Ck, Ettie Street Pump Station, Ridder Park Dr Storm Drain, Sunnyvale East Channel, Line-3A-M at 3A-D, North Richmond Pump

Station and Seabord Ave Storm Drain. Seven of these locations were similarly selected based on water concentrations but three of the sites with elevated water concentrations dropped to lower rank due to high sediment production and three new sites were ranked in the top ten based on the relative nature of PCB mass in the water and lower suspended sediment mass (Line-3A-M at 3A-D, North Richmond Pump Station, and Seabord Ave Storm Drain). In addition to identification of four new top-10 ranked PCB particle ratio sites, the WY 2015 stormwater sampling effort also identified a large number of sites with moderate particle ratios (Figure 6). This additional large cohort of sites with moderately elevated particle ratios was likely a result of the site selection process that targeted watershed areas with greater imperviousness and older industrial influences.

Comparisons between the ranking methodologies provide a hint as to the main vector for transport at each of the sites (contaminated soil erosion versus emulsion of liquid PCBs). For example, a high ranking for water concentration but low ranking for particle ratio can indicate high rates of erosion of relatively clean sediment, which is more typical of a larger watershed, but in a small watershed, when coupled with low suspended sediment concentrations, it would indicate sediment is not the dominant vector for transport and that PCB emulsions are possibly in transport. Conversely, a lower ranking for concentration coupled with a higher ranking for particle ratio can indicate erosion of highly contaminated particles. If this occurs in a smaller watershed, this would indicate sediment transport is the main vector. Therefore, at smaller site scales, these hints could be instructive for helping to consider main source areas and release processes.

There are a number of watersheds that appear to show relatively low Hg concentrations. In contrast to PCBs, 26 out of 45 sampling locations have composite averaged HgT water concentrations less than 53 ng/L (Table 8), the regionally averaged concentration derived from the TMDL target. These lower ranking sites based on water concentrations ranged in impervious cover between 10-87% with a median of 72%. However, none of the locations sampled to date have composite averaged HgT particle ratios <0.058 µg/g (the regionally averaged particle ratio based on the TMDL target combined with estimated average annual regional total suspended sediment loads[14]); the lowest observation so far has been Walnut Creek at 0.073 µg/g (0.07 mg/kg) (Table 8; Figure 7). But 16 sites measured to-date (Line9-D , Lower Coyote Creek, Belmont Creek, Stevens Creek, Glen Echo Creek, Sunnyvale East Channel, Runnymede Ditch, El Cerrito Inlet, San Lorenzo Creek, Zone 4 Line A Storm Drain, Fremont tree Well Filter Inlet, Borel Creek, Lower Penitencia Creek, Calabazas Creek, Lower Marsh Creek, and Walnut Creek) do have particle ratios <0.25 µg/g that, given error bars of 25% around our measurements, could be considered equivalent to or less than 0.2 µg/g of Hg on suspended solids (the particulate Hg concentration that was specified in the Bay and Guadalupe River TMDLs) (SFRWQCB, 2006; 2008).

There have been several studies in the Bay Area on atmospheric deposition rates for HgT (Tsai and Hoenicke, 2001; Steding and Flegal, 2002). These studies measured very similar wet deposition rates of

[14] Again the reader is reminded that these regional estimates total suspended sediment loads are subject to change if future interpretations are completed.

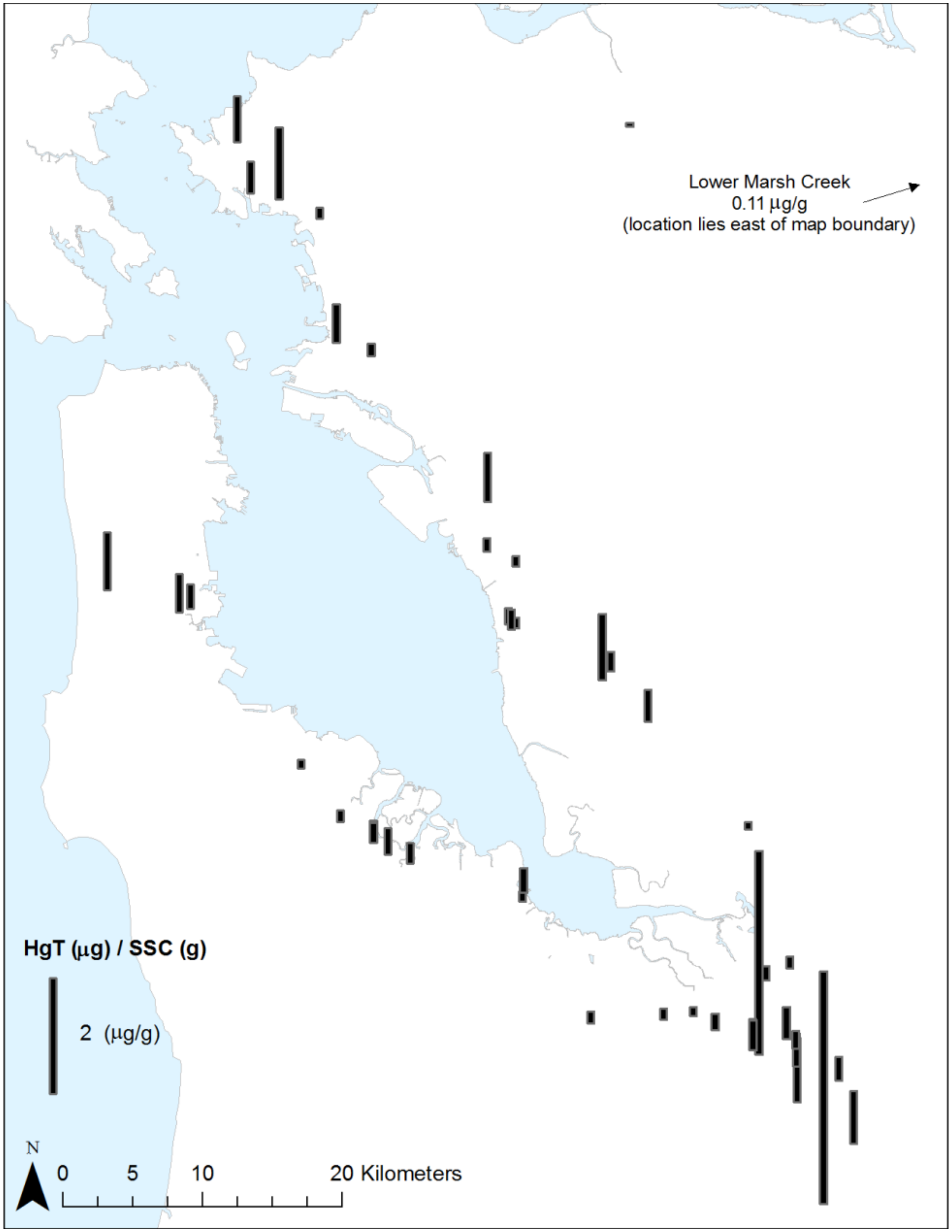



Figure 7. Regional distribution of sites and particle ratios of total mercury (HgT) in stormwater samples collected to date.

4.2 µg/m$^2$/y (Tsai and Hoenicke, 2001) and 4.4 µg/m$^2$/y (Steding and Flegal, 2002) with Tsai and Hoenicke reporting a total (wet + dry) deposition rate of 18-21 µg/m$^2$/y. Tsai and Hoenicke observed volume-weighted average mercury concentrations in precipitation based on 59 samples collected across the Bay Area of 8.0 ng/L. They reported that wet deposition comprised 18% of total annual deposition thus scaled to volume of runoff, an equivalent stormwater concentration of 44 ng/L can be derived. If a runoff coefficient (the proportion of rainfall that manifests as runoff) equivalent to the impervious cover of a watershed is assumed, it can be hypothesized that all of the runoff from the sites exhibiting composite averaged concentration of <53 ng/L could be accounted for by atmospheric deposition alone; indeed a high proportion of the runoff from any watershed exhibiting concentrations in stormwater of, for example, < 100 ng/L could also be atmospherically derived. This is not to say that there are no other sources in these watersheds, but rather that loads from any other sources are diluted out by cleaner runoff sustained by relatively low but relatively constant atmospheric deposition rates. Thus, a number of watersheds have been sampled for Hg that show relatively low concentrations and will likely continue to do so in alignment with atmospheric deposition. Given the data set now amassed, it is likely that many future sampling locations would show similar outcomes. However, this may not be the case for methylmercury, where in situ production in anoxic saturated zones may provide additional input not directly correlating to atmospheric loads.

On the other end of the spectrum, there are some watersheds that display elevated HgT concentrations that, if the sources could be found and treated, would help to reduce HgT loads entering the Bay (Table 8). Based on composite averaged HgT water concentrations, the ten most polluted sites (ranked in order from high to lower) would include the Guadalupe River mainstem, Zone 5 Line M, San Pedro Storm Drain, San Leandro Creek, Walnut Creek, Santa Fe Channel (also ranked high for PCB concentrations in composite averaged stormwater), Line-3A-M at 3A-D, E. Gish Rd SD, Stevens Creek, and Meeker Slough.

As discussed above and introduced by McKee et al. (2012), given the atmospheric sources of Hg and highly variable sediment erosion in Bay Area watersheds, it is possible to get very elevated HgT stormwater concentrations but very low particle ratios. The best example of this is Walnut Creek that was ranked 5$^{th}$ highest in terms of stormwater composite averaged concentrations but lowest (45$^{th}$ out of 45 watershed locations) in terms of particle ratios. Thus, much more care is needed when ranking the sites for HgT than for PCBs (for which the atmospheric pathway plays less of a role in dispersion). This is consistent with the relative results from the most recent calibration of the RWSM based on the hydrology where a better calibration for PCBs than for Hg has been achieved (Wu et al., 2016); a sediment model basis may be more appropriate for Hg.

Based on particle ratios (the preferred method), the 10 most polluted sites appear to be (in addition to the two Guadalupe River mainstem sites) Meeker Slough, Line-3A-M at 3A-D, San Pedro Storm Drain, Gellert Park bioretention inlet, Rock Springs Dr Storm Drain, San Leandro Creek, North Richmond Pump Station, Ettie Street Pump Station, South Linden Pump Station, and E. Gish Rd Storm Drain (Table 8; Figure 8). Management in these watersheds might be most cost effective for HgT. The Daly City library bioretention demonstration project appears to have been placed (quite by accident) in a cost effective manner and appears to be functioning reasonably well for HgT removal, however, there were some

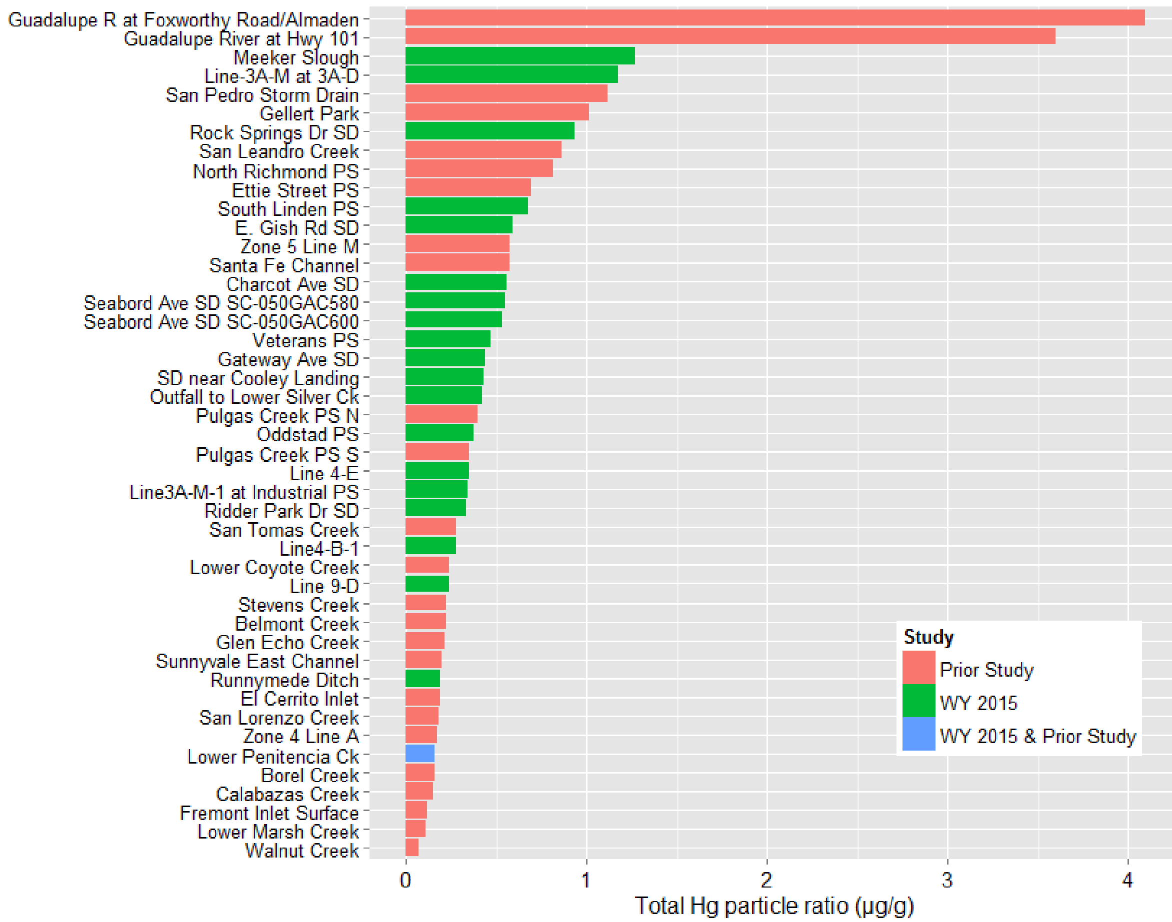



Figure 8. All watershed sampling locations measured to data ranked using total mercury (HgT) particle ratios.

concerns about methylmercury production (David et al., 2015). Three of these locations were also identified as elevated for PCB particle ratios (Ettie Street Pump Station, Line-3A-M at 3A-D, North Richmond Pump Station) providing the opportunity for multiple benefits. Thus the reconnaissance sampling methods coupled with the use of particle ratio in the interpretative process has indicated a number of watersheds with elevated HgT.

## Relationships between PCBs and Hg and other trace substances and land cover attributes

The data can be used to explore relationships between pollutants and with landscape attributes. Beginning in WY 2003, a number of sites have been evaluated for not only PCB and HgT concentrations in stormwater but also for a range of trace elements. These sites have included the fixed station loads monitoring sites on Guadalupe River at Hwy 101 (McKee et al., 2006), Zone 4 Line A (Gilbreath et al., 2012a), North Richmond Pump Station (Hunt et al., 2012) and for Cu only (Lower Marsh Creek, San

Leandro Creek, Pulgas Creek Pump Station-South, and Sunnyvale East Channel) (Gilbreath et al., 2015a). Copper data have also been collected at the inlets to several pilot performance studies for bioretention (El Cerrito: Gilbreath et al., 2012b); Fremont: Gilbreath et al., 2015b) and Cu, Cd, Pb, and Zn data were collected at the Daly City Library Gellert Park demonstration bioretention site (David et al., 2015). In addition, during WY 2015, trace element data were collected at an additional 20 locations (See Table 6 earlier in this report). All these data (n=30 sites for Cu; n=24 for Cd, Pb, and Zn; n=23 for As) were pooled to complete an analysis of relationships between observed particle ratios of PCBs and HgT, trace elements, and impervious land cover and old industrial land use using a Spearman Rank correlation analysis (Table 9). In the case of Guadalupe River, the HgT data were removed from the analysis due the historic mining influence in that watershed[15]. Particle ratios were chosen for this analysis for the same reasons as described above and in McKee et al. (2012); the influence of variable sediment production across Bay Area watersheds is best normalized out so that variations in the influence of pollutant sources and mobilization can be more easily observed between sites.

A variety of relationships have been found but the relationships to trace metals are weak for both PCBs and Hg. Based on the available appropriate data and the particle ratio method, PCBs appear to positively correlate with impervious cover, old industrial land use and HgT. PCBs appear to inversely correlate with watershed area. These observations are consistent with previous analysis (McKee et al., 2012) and make conceptual sense given larger watersheds tend to have mixed land use and thus a lower proportional amount of PCB source areas. The positive but relatively weak correlation between PCBs and HgT also makes sense given the general relationships with impervious cover and old industrial land use but the larger role of atmospheric recirculation in the mercury cycle. PCBs appear to inversely correlate with all the trace metals analyzed (As, Cu, Cd, Pb, and Zn) since these also inversely correlate with impervious cover and old industrial land use. Total mercury does not appear to correlate with any of the other trace metals and shows similar but weaker relationships to impervious cover, old industrial land use, and watershed area than does PCBs. In contrast, the trace metals all appear to correlate with each other more generally. The strongest correlations appear to be between Cu and Zn perhaps because they are both vehicular related (see discussion in McKee et al., 2012) and between Pb and Cd perhaps because of the strong atmospheric pathway of these two metals (Davis et al., 2001). Overall, based on this analysis using the available pooled data, there is no support for the use of these trace metals as a tracer for either PCB or HgT pollution sources.

## Sampling progress in relation to data uses

Sampling completed in older industrial areas can be used as an indicator of progress towards identifying areas for potential management. It has been argued previously (McKee et al., 2012; McKee et al., 2015) that old industrial land use and the specific source areas found within or in association with older industrial areas are likely to exhibit higher concentrations and loads with respect to PCBs and HgT. A total of 45 sites have been sampled for PCBs and HgT during various field sampling efforts since WY

[15] Historic mining in the Guadalupe River watershed is known to cause a unique positive relationship between Hg, Cr, and Ni and it is known that there are unique inverse correlations between Hg and other typical urban metals such as Cu and Pb (McKee et al., 2005).

Table 9. Spearman Rank correlation matrix based on stormwater samples collected in the Bay Area since WY 2003 (see text for data source and exclusions).

| | PCBs (ng/g) | HgT (µg/g) | Arsenic (µg/mg) | Cadmium (µg/mg) | Copper (µg/mg) | Lead (µg/mg) | Zinc (µg/mg) | Area ($km^2$) | % Impervious cover | % Old Industrial land use | % Clay (<0.004 mm) | % Silt (0.004 to <0.0625 mm) | % Sands (0.0625 to <2.0 mm) | TOC (mg/mg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PCBs (ng/g) | 1.00 | | | | | | | | | | | | | |
| HgT (µg/g) | 0.44 | 1.00 | | | | | | | | | | | | |
| Arsenic (µg/mg) | -0.61 | -0.13 | 1.00 | | | | | | | | | | | |
| Cadmium (µg/mg) | -0.38 | 0.12 | 0.75 | 1.00 | | | | | | | | | | |
| Copper (µg/mg) | -0.15 | 0.05 | 0.71 | 0.67 | 1.00 | | | | | | | | | |
| Lead (µg/mg) | -0.37 | 0.04 | 0.73 | 0.89 | 0.60 | 1.00 | | | | | | | | |
| Zinc (µg/mg) | -0.37 | 0.19 | 0.47 | 0.65 | 0.88 | 0.55 | 1.00 | | | | | | | |
| Area ($km^2$) | -0.47 | -0.38 | 0.06 | -0.06 | -0.33 | 0.17 | -0.26 | 1.00 | | | | | | |
| % Impervious cover | 0.64 | 0.36 | -0.28 | -0.13 | 0.10 | -0.27 | 0.18 | -0.71 | 1.00 | | | | | |
| % Old Industrial land use | 0.58 | 0.40 | -0.34 | -0.28 | -0.29 | -0.41 | -0.14 | -0.43 | 0.75 | 1.00 | | | | |
| % Clay (<0.004 mm) | 0.47 | 0.16 | -0.28 | -0.05 | -0.40 | -0.16 | -0.40 | -0.31 | 0.11 | 0.41 | 1.00 | | | |
| % Silt (0.004 to <0.0625 mm) | -0.03 | 0.22 | -0.04 | -0.12 | 0.39 | 0.03 | 0.36 | 0.29 | -0.12 | -0.19 | -0.02 | 1.00 | | |
| % Sands (0.0625 to <2.0 mm) | 0.06 | 0.08 | 0.17 | -0.07 | -0.10 | 0.06 | 0.06 | -0.21 | 0.36 | 0.35 | -0.80 | -0.34 | 1.00 | |
| TOC (mg/mg) | 0.28 | 0.32 | 0.59 | 0.44 | 0.86 | 0.30 | 0.66 | -0.48 | 0.45 | 0.26 | -0.50 | 0.31 | 0.28 | 1.00 |

2003. The sampling locations have been selected to help answer a variety of questions, in some cases to make measurements of loads to the Bay from selected watersheds and in other cases to help characterize concentrations of PCBs, HgT and other trace pollutants in stormwater. Although land redevelopment is occurring at a rapid pace, the currently available old industrial land use layer that was based on the overlay of ABAG, 2005 industrial land use and an older urban land use coverage from 1968 (e.g. Wu et al., 2016) was used to evaluate the proportion of old industrial land use within each sampled watershed in relation to the regional and county based totals. In this way, progress towards characterizing concentrations in these areas was evaluated. This analysis (which excluded nested sampling sites) showed that about 19.2% of the so defined old industrial land use in the region has been sampled to date. The best effort so far has occurred in Santa Clara County (where 61% of this land use has been sampled), followed by Alameda County (17%), San Mateo County (9%), and Contra Costa County (3%). The disproportional coverage in Santa Clara County is due to a number of larger watersheds being sampled (Lower Penitencia Creek, Lower Coyote Creek, Guadalupe River at Hwy 101, Sunnyvale East Channel, Stevens Creek, and San Tomas Creek) and also because there were older industrial land use areas further upstream in the Coyote Creek and Guadalupe River watersheds. Of the remaining older industrial land use yet to be sampled, 48% of it lies within 1 km of the Bay and 65% of it is within 2 km of the Bay. These areas are more likely to be tidal, likely to include heavy industrial areas that were historically serviced by rail and ship based transport, and military areas, and are often very difficult to sample due to a lack of public right of ways. A different sampling strategy may be needed to effectively determine what pollution might be associated with these areas to further progress towards identifying areas for potential management.

Data collected will also be used to calibrate the Regional Watershed Spreadsheet Model (RWSM) (Wu et al., 2016). The present version of the model was calibrated using data from 22 watershed areas. Parameterization of the model is currently limited because many of the key source areas are not present in sufficient amounts within the calibration watersheds to strongly influence the calibration procedures. For example, various forms of waste recycling (general waste, metals, auto, drum) only produce an estimated <1% of the runoff within the calibration watersheds and were present in <10 of the 22 watersheds (Wu et al., 2016). Based on the extended dataset (now 45 watersheds), the number of watersheds where these types of source areas are present has increased (Table 10) compared to data available mainly reported by McKee et al., (2010). For example, waste-recycle was present in just nine watersheds, auto-recycle was present in just 10 watersheds, and metals recycle was present in just 5 watersheds within the 22 sample sites previously available for model calibration; these numbers have now increased to 16, 19, and 11 respectively (Table 10). In addition, many of the new watersheds characterized in WY 2015 (described for the first time in this current report) are much smaller in size (0.108-7.34 $km^2$) compared to previous characterization or loading based sampling efforts (0.552-327 $km^2$) and as such are less heterogeneous in relation to land uses and source areas. This may also help the model to calibrate better by placing stronger constraints on the calibration process for key source areas. Thus, apart from the use of the data to support watershed characterization in relation to pollution sources and higher potential leverage (along with other evidence being generated by the stormwater programs), another use of the data is for improving the calibration of the RWSM and by extension improved estimates of regional scale watershed loads.

Table 10. Land uses and source areas sampled in relation to potential use for calibration of the Regional Watershed Spreadsheet Model (RWSM) (Wu et al., 2016).

| Land use or source area | % volume contribution | Number of watersheds | Conceptual largest influence (Combined rank) | Potential use in the RWSM |
|---|---|---|---|---|
| LU Open | 36% | 33 | 1189 | Likely high calibration influence. Can likely be used as either a single or group parameter |
| LU Old Transportation | 20% | 38 | 750 | |
| LU Old Residential | 15% | 35 | 540 | |
| LU Old Commercial | 9.6% | 37 | 354 | |
| LU Old Industrial | 2.8% | 33 | 93 | |
| LU New Industrial | 2.5% | 35 | 87 | |
| LU New Transportation | 4.9% | 16 | 79 | |
| SA TranspRail | 1.8% | 29 | 51 | |
| LU New Residential | 4.3% | 11 | 48 | |
| LU New Commercial | 2.4% | 15 | 37 | |
| SA RecycWaste | 1.2% | 16 | 19 | Likely moderate calibration influence. Can best be used in a grouped parameter |
| LU Agriculture | 1.7% | 8 | 13 | |
| SA ManufMetals | 0.2% | 21 | 5.2 | |
| SA RecycAuto | 0.2% | 19 | 4.3 | |
| SA ElectricTransf | 0.1% | 16 | 0.94 | Likely low calibration influence but could be grouped with other source areas as part of a global parameter that would not influence the calibration but could influence the regional loads estimates |
| SA RecycMetals | 0.1% | 11 | 0.81 | |
| SA TranspAir | 0.3% | 2 | 0.59 | |
| SA ElectricPower | 0.1% | 3 | 0.25 | |
| SA RecycDrums | 0.0% | 3 | 0.024 | |
| SA Military | 0.0% | 1 | 0.0016 | |

# Summary and Recommendations for Improved Sampling Design

Despite climatically challenging conditions resulting in a limited number of storms of appropriate magnitude for sample capture, a total of 20 additional sites were sampled during WY 2015. At these sites, 20 composite water samples collected during one storm event were analyzed for PCBs, HgT, SSC, selected trace metals, organic carbon, and grain size. Sampling efficiency was increased by sampling two sites during a single storm that had similar runoff characteristics and were near enough to each other to allow safe and rapid transport and reoccupation repeatedly during a rain event. At three of these locations, simultaneous samples were also collected using a Hamlin remote suspended sediment sampler and at one site a third method (the Walling tube remote suspended sediment sampler) was also trialed successfully. Based on this dataset, a number of sites with elevated PCB and Hg concentrations and particle ratios were successfully identified, in part based on an improved effort of site selection focusing on older industrial and highly impervious landscapes. With careful selection of sample timing relative to tides, some success even occurred at tidal sties, but overall, tidal sites remain the most challenging to sample. Although optimism remains about future applications, the remote suspended sediment samplers that were trialed showed mixed results and need further testing.

Based on the WY 2015 results, the following recommendations were made:

- Continue to select sites based on the four main selection rationales (Section 2.2). The majority of the samples should be devoted to identifying areas of potential high leverage (indicated by high unit areas loads or particle ratios/ concentrations relative to other sites) with a smaller number of sites allocated to sampling potentially cleaner and variably-sized watersheds to help broaden the dataset for regional model calibration and to inform consideration of cleanup potential. The method of selection of sites of potentially higher leverage focusing on older industrial and highly impervious landscapes appears successful and should continue.

- Continue to use the composite water sampling design as developed and applied during WY 2015 with no further modifications. In the event of a higher rainfall wet season, greater success may even occur at sites influenced by tidal processes since, with more storms to choose from, there will be a greater likelihood that more storm events will fall within the needed tidal windows.
- Continue to trial both the Hamlin and Walling remote suspended sediment samplers to amass a full dataset of 12 side-by-side sample pairs for comparison to the composite water column sampling design with the objective of evaluating usefulness and comparability of the data obtained in relation to the management questions.

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# Appendices

## Appendix A – Detailed QA information

Table A1: Summary of QA data at all sites.

| Analyte | Unit | Average Lab Blank | Detection Limit (MDL) (range; mean) | Average Reporting Limit (RL) | RSD of Lab Duplicates (% range; % mean) | RSD of Field Duplicates (% range; % mean) | Percent Recovery of CRM (% range; % mean) | Percent Recovery of Matrix Spike (% range; % mean) |
|---|---|---|---|---|---|---|---|---|
| SSC | mg/L | - | 0.5-0.5; 0.5 | 1 | NA | 5.16-5.16; 5.16 | NA | NA |
| DOC | µg/L | 0 | 52-520; 256 | NA | 0.00-6.02; 1.91 | 0.00-10.13; 3.97 | NA | 100.00-112.50; 107.18 |
| TOC | mg/L | 0.00289 | 0.096-0.48; 0.129 | NA | 0.00-3.93; 2.16 | 0.00-35.79; 11.89 | NA | 100.00-141.25; 107.49 |
| Total Arsenic | µg/L | 0.00358 | 0.013-0.013; 0.013 | 0.032 | 2.74-2.74; 2.74 | 1.81-4.04; 2.89 | 96.32-101.76; 98.32 | 91.56-102.34; 93.65 |
| Total Cadmium | µg/L | 0 | 0.007-0.037; 0.0118 | 0.0344 | 1.89-4.29; 3.09 | 0.93-8.00; 3.74 | 99.90-105.59; 102.66 | 80.27-101.05; 95.83 |
| Total Cu | µg/L | 0 | 0.042-0.211; 0.116 | 0.349 | 0.87-1.04; 0.95 | 0.75-1.36; 1.06 | 100.28-104.55; 103.00 | 91.83-103.60; 95.98 |
| Total Hg | µg/L | 0.000129 | 0.00253-0.00263; 0.00258 | 0.0103 | NA | 16.66-16.66; 16.66 | 100.58-103.34; 101.77 | 93.75-103.82; 98.54 |
| Total Lead | µg/L | 0 | 0.006-0.032; 0.0174 | 0.0726 | 0.00-1.75; 0.82 | 0.00-7.85; 2.93 | 99.00-104.12; 101.92 | 97.21-101.10; 99.33 |
| Total Zinc | µg/L | 0 | 0.06-0.32; 0.174 | 0.58 | 0.31-0.59; 0.48 | 0.05-2.64; 0.97 | 101.11-108.34; 105.43 | 86.35-101.14; 92.89 |

| Analyte | Unit | Average Lab Blank | Detection Limit (MDL) (range; mean) | Average Reporting Limit (RL) | RSD of Lab Duplicates (% range; % mean) | RSD of Field Duplicates (% range; % mean) | Percent Recovery of CRM (% range; % mean) | Percent Recovery of Matrix Spike (% range; % mean) |
|---|---|---|---|---|---|---|---|---|
| Dissolved PCB 008 | ng/L | - | 0.000814-0.000814; 0.000814 | NA | NA | NA | NA | NA |
| Dissolved PCB 018 | ng/L | - | 0.000528-0.000528; 0.000528 | NA | NA | NA | NA | NA |
| Dissolved PCB 028 | ng/L | - | 0.00599-0.00599; 0.00599 | NA | NA | NA | NA | NA |
| Dissolved PCB 031 | ng/L | - | 0.00535-0.00535; 0.00535 | NA | NA | NA | NA | NA |
| Dissolved PCB 033 | ng/L | - | 0.00546-0.00546; 0.00546 | NA | NA | NA | NA | NA |
| Dissolved PCB 044 | ng/L | - | 0.000907-0.000907; 0.000907 | NA | NA | NA | NA | NA |
| Dissolved PCB 049 | ng/L | - | 0.000823-0.000823; 0.000823 | NA | NA | NA | NA | NA |
| Dissolved PCB 052 | ng/L | - | 0.00102-0.00102; 0.00102 | NA | NA | NA | NA | NA |
| Dissolved PCB 056 | ng/L | - | 0.0084-0.0084; 0.0084 | NA | NA | NA | NA | NA |
| Dissolved PCB 060 | ng/L | - | 0.0083-0.0083; 0.0083 | NA | NA | NA | NA | NA |
| Dissolved PCB 066 | ng/L | - | 0.00759-0.00759; 0.00759 | NA | NA | NA | NA | NA |
| Dissolved PCB 070 | ng/L | - | 0.00776-0.00776; 0.00776 | NA | NA | NA | NA | NA |
| Dissolved PCB 087 | ng/L | - | 0.00236-0.00236; 0.00236 | NA | NA | NA | NA | NA |

| Analyte | Unit | Average Lab Blank | Detection Limit (MDL) (range; mean) | Average Reporting Limit (RL) | RSD of Lab Duplicates (% range; % mean) | RSD of Field Duplicates (% range; % mean) | Percent Recovery of CRM (% range; % mean) | Percent Recovery of Matrix Spike (% range; % mean) |
|---|---|---|---|---|---|---|---|---|
| Dissolved PCB 095 | ng/L | - | 0.00267-0.00267; 0.00267 | NA | NA | NA | NA | NA |
| Dissolved PCB 099 | ng/L | - | 0.00291-0.00291; 0.00291 | NA | NA | NA | NA | NA |
| Dissolved PCB 101 | ng/L | - | 0.00238-0.00238; 0.00238 | NA | NA | NA | NA | NA |
| Dissolved PCB 105 | ng/L | - | 0.0311-0.0311; 0.0311 | NA | NA | NA | NA | NA |
| Dissolved PCB 110 | ng/L | - | 0.00196-0.00196; 0.00196 | NA | NA | NA | NA | NA |
| Dissolved PCB 118 | ng/L | - | 0.0238-0.0238; 0.0238 | NA | NA | NA | NA | NA |
| Dissolved PCB 128 | ng/L | - | 0.0152-0.0152; 0.0152 | NA | NA | NA | NA | NA |
| Dissolved PCB 132 | ng/L | - | 0.0198-0.0198; 0.0198 | NA | NA | NA | NA | NA |
| Dissolved PCB 138 | ng/L | - | 0.0152-0.0152; 0.0152 | NA | NA | NA | NA | NA |
| Dissolved PCB 141 | ng/L | - | 0.0171-0.0171; 0.0171 | NA | NA | NA | NA | NA |
| Dissolved PCB 149 | ng/L | - | 0.0172-0.0172; 0.0172 | NA | NA | NA | NA | NA |
| Dissolved PCB 151 | ng/L | - | 0.000869-0.000869; 0.000869 | NA | NA | NA | NA | NA |
| Dissolved PCB 153 | ng/L | - | 0.014-0.014; 0.014 | NA | NA | NA | NA | NA |

| Analyte | Unit | Average Lab Blank | Detection Limit (MDL) (range; mean) | Average Reporting Limit (RL) | RSD of Lab Duplicates (% range; % mean) | RSD of Field Duplicates (% range; % mean) | Percent Recovery of CRM (% range; % mean) | Percent Recovery of Matrix Spike (% range; % mean) |
|---|---|---|---|---|---|---|---|---|
| Dissolved PCB 156 | ng/L | - | 0.0138-0.0138; 0.0138 | NA | NA | NA | NA | NA |
| Dissolved PCB 158 | ng/L | - | 0.0118-0.0118; 0.0118 | NA | NA | NA | NA | NA |
| Dissolved PCB 170 | ng/L | - | 0.00157-0.00157; 0.00157 | NA | NA | NA | NA | NA |
| Dissolved PCB 174 | ng/L | - | 0.0013-0.0013; 0.0013 | NA | NA | NA | NA | NA |
| Dissolved PCB 177 | ng/L | - | 0.00143-0.00143; 0.00143 | NA | NA | NA | NA | NA |
| Dissolved PCB 180 | ng/L | - | 0.00117-0.00117; 0.00117 | NA | NA | NA | NA | NA |
| Dissolved PCB 183 | ng/L | - | 0.00138-0.00138; 0.00138 | NA | NA | NA | NA | NA |
| Dissolved PCB 187 | ng/L | - | 0.00131-0.00131; 0.00131 | NA | NA | NA | NA | NA |
| Dissolved PCB 194 | ng/L | - | 0.00327-0.00327; 0.00327 | NA | NA | NA | NA | NA |
| Dissolved PCB 195 | ng/L | - | 0.0036-0.0036; 0.0036 | NA | NA | NA | NA | NA |
| Dissolved PCB 201 | ng/L | - | 0.000686-0.000686; 0.000686 | NA | NA | NA | NA | NA |
| Dissolved PCB 203 | ng/L | - | 0.000843-0.000843; 0.000843 | NA | NA | NA | NA | NA |
| Total PCB 008 | ng/L | 0.00248 | 0.000282-0.00212; 0.000883 | NA | NA | NA | NA | NA |

| Analyte | Unit | Average Lab Blank | Detection Limit (MDL) (range; mean) | Average Reporting Limit (RL) | RSD of Lab Duplicates (% range; % mean) | RSD of Field Duplicates (% range; % mean) | Percent Recovery of CRM (% range; % mean) | Percent Recovery of Matrix Spike (% range; % mean) |
|---|---|---|---|---|---|---|---|---|
| Total PCB 018 | ng/L | 0.0022 | 0.000282-0.000782; 0.000447 | NA | NA | NA | NA | NA |
| Total PCB 028 | ng/L | 0.00389 | 0.000319-0.0323; 0.00212 | NA | NA | NA | NA | NA |
| Total PCB 031 | ng/L | 0.00206 | 0.000319-0.03; 0.00198 | NA | NA | NA | NA | NA |
| Total PCB 033 | ng/L | 0.000879 | 0.000319-0.0302; 0.00201 | NA | NA | NA | NA | NA |
| Total PCB 044 | ng/L | 0.00221 | 0.000282-0.00215; 0.00055 | NA | NA | NA | NA | NA |
| Total PCB 049 | ng/L | 0.00149 | 0.000282-0.00196; 0.000524 | NA | NA | NA | NA | NA |
| Total PCB 052 | ng/L | 0.00831 | 0.000282-0.00225; 0.000558 | NA | NA | NA | NA | NA |
| Total PCB 056 | ng/L | 0 | 0.000319-0.0846; 0.00644 | NA | NA | NA | NA | NA |
| Total PCB 060 | ng/L | 0 | 0.000319-0.085; 0.00646 | NA | NA | NA | NA | NA |
| Total PCB 066 | ng/L | 0.000589 | 0.000319-0.0824; 0.00623 | NA | NA | NA | NA | NA |
| Total PCB 070 | ng/L | 0.00319 | 0.000319-0.157; 0.00916 | NA | NA | NA | NA | NA |
| Total PCB 087 | ng/L | 0.00097 | 0.000319-0.0511; 0.00466 | NA | NA | NA | NA | NA |
| Total PCB 095 | ng/L | 0.00353 | 0.000344-0.0391; 0.00447 | NA | NA | NA | NA | NA |

| Analyte | Unit | Average Lab Blank | Detection Limit (MDL) (range; mean) | Average Reporting Limit (RL) | RSD of Lab Duplicates (% range; % mean) | RSD of Field Duplicates (% range; % mean) | Percent Recovery of CRM (% range; % mean) | Percent Recovery of Matrix Spike (% range; % mean) |
|---|---|---|---|---|---|---|---|---|
| Total PCB 099 | ng/L | 0.000725 | 0.000354-0.0425; 0.0048 | NA | NA | NA | NA | NA |
| Total PCB 101 | ng/L | 0.00122 | 0.000319-0.0533; 0.0048 | NA | NA | NA | NA | NA |
| Total PCB 105 | ng/L | 0.00128 | 0.000601-0.63; 0.0362 | NA | NA | NA | NA | NA |
| Total PCB 110 | ng/L | 0.00123 | 0.000319-0.0442; 0.004 | NA | NA | NA | NA | NA |
| Total PCB 118 | ng/L | 0.00135 | 0.000555-0.554; 0.0321 | NA | NA | NA | NA | NA |
| Total PCB 128 | ng/L | 0.000236 | 0.000475-0.29; 0.0241 | NA | NA | NA | NA | NA |
| Total PCB 132 | ng/L | 0 | 0.000608-0.365; 0.0303 | NA | NA | NA | NA | NA |
| Total PCB 138 | ng/L | 0.00116 | 0.000476-0.317; 0.0252 | NA | NA | NA | NA | NA |
| Total PCB 141 | ng/L | 0.000241 | 0.00054-0.328; 0.0272 | NA | NA | NA | NA | NA |
| Total PCB 149 | ng/L | 0.00226 | 0.000528-0.313; 0.0259 | NA | NA | NA | NA | NA |
| Total PCB 151 | ng/L | 0.000853 | 0.000282-0.00454; 0.000844 | NA | NA | NA | NA | NA |
| Total PCB 153 | ng/L | 0.000882 | 0.000426-0.259; 0.0214 | NA | NA | NA | NA | NA |
| Total PCB 156 | ng/L | 0 | 0.000517-0.301; 0.0243 | NA | NA | NA | NA | NA |

| Analyte | Unit | Average Lab Blank | Detection Limit (MDL) (range; mean) | Average Reporting Limit (RL) | RSD of Lab Duplicates (% range; % mean) | RSD of Field Duplicates (% range; % mean) | Percent Recovery of CRM (% range; % mean) | Percent Recovery of Matrix Spike (% range; % mean) |
|---|---|---|---|---|---|---|---|---|
| Total PCB 158 | ng/L | 0 | 0.000373-0.226; 0.0188 | NA | NA | NA | NA | NA |
| Total PCB 170 | ng/L | 0 | 0.000299-0.00696; 0.00124 | NA | NA | NA | NA | NA |
| Total PCB 174 | ng/L | 0 | 0.000302-0.00624; 0.00112 | NA | NA | NA | NA | NA |
| Total PCB 177 | ng/L | 0 | 0.000311-0.00651; 0.00117 | NA | NA | NA | NA | NA |
| Total PCB 180 | ng/L | 0.000357 | 0.000282-0.00549; 0.00099 | NA | NA | NA | NA | NA |
| Total PCB 183 | ng/L | 0 | 0.00029-0.00608; 0.00109 | NA | NA | NA | NA | NA |
| Total PCB 187 | ng/L | 0.000353 | 0.000282-0.0058; 0.00104 | NA | NA | NA | NA | NA |
| Total PCB 194 | ng/L | 0 | 0.000446-0.013; 0.00176 | NA | NA | NA | NA | NA |
| Total PCB 195 | ng/L | 0 | 0.000483-0.0141; 0.00189 | NA | NA | NA | NA | NA |
| Total PCB 201 | ng/L | 0 | 0.000282-0.00211; 0.000657 | NA | NA | NA | NA | NA |
| Total PCB 203 | ng/L | 0 | 0.000282-0.00277; 0.000885 | NA | NA | NA | NA | NA |

Table A2: Field blank data from all sites.

| Analyte | Unit | Average MDL | RL | Minimum Field Blank | Maximum Field Blank | Average Field Blank |
|---|---|---|---|---|---|---|
| Total As | µg/L | 0.013 | 0.032 | ND | ND | ND |
| Total Cd | µg/L | 0.007 | 0.021 | ND | ND | ND |
| Total Cu | µg/L | 0.211 | 0.632 | ND | ND | ND |
| Total Hg | µg/L | 0.0001 | 4E-04 | ND | ND | ND |
| Total Pb | µg/L | 0.006 | 0.026 | ND | ND | ND |
| Total Zn | µg/L | 0.32 | 1.05 | ND | ND | ND |
| PCB 008 | ng/L | 0.000185 | - | 0.00304 | 0.00304 | 0.00304 |
| PCB 018 | ng/L | 0.000185 | - | 0.00251 | 0.00251 | 0.00251 |
| PCB 028 | ng/L | 0.000185 | - | 0.00514 | 0.00514 | 0.00514 |
| PCB 031 | ng/L | 0.000185 | - | 0.00394 | 0.00394 | 0.00394 |
| PCB 033 | ng/L | 0.000185 | - | 0.00274 | 0.00274 | 0.00274 |
| PCB 044 | ng/L | 0.000185 | - | 0.00352 | 0.00352 | 0.00352 |
| PCB 049 | ng/L | 0.000185 | - | 0.00152 | 0.00152 | 0.00152 |
| PCB 052 | ng/L | 0.000185 | - | 0.00677 | 0.00677 | 0.00677 |
| PCB 056 | ng/L | 0.000185 | - | 0.00159 | 0.00159 | 0.00159 |
| PCB 060 | ng/L | 0.000185 | - | 0.000579 | 0.000579 | 0.000579 |
| PCB 066 | ng/L | 0.000185 | - | 0.00175 | 0.00175 | 0.00175 |
| PCB 070 | ng/L | 0.000185 | - | 0.00344 | 0.00344 | 0.00344 |
| PCB 087 | ng/L | 0.000229 | - | 0.00216 | 0.00216 | 0.00216 |
| PCB 095 | ng/L | 0.000259 | - | 0.00283 | 0.00283 | 0.00283 |
| PCB 099 | ng/L | 0.000268 | - | 0.00124 | 0.00124 | 0.00124 |
| PCB 101 | ng/L | 0.000232 | - | 0.00262 | 0.00262 | 0.00262 |
| PCB 105 | ng/L | 0.000213 | - | 0.00124 | 0.00124 | 0.00124 |
| PCB 110 | ng/L | 0.000197 | - | 0.00341 | 0.00341 | 0.00341 |
| PCB 118 | ng/L | 0.000227 | - | 0.0023 | 0.0023 | 0.0023 |
| PCB 128 | ng/L | 0.000185 | - | 0.00111 | 0.00111 | 0.00111 |

Table A2 (continued): Field blank data from all sites.

| Analyte | Unit | Average MDL | RL | Minimum Field Blank | Maximum Field Blank | Average Field Blank |
|---|---|---|---|---|---|---|
| PCB 132 | ng/L | 0.000218 | - | 0.00222 | 0.00222 | 0.00222 |
| PCB 138 | ng/L | 0.000185 | - | 0.00435 | 0.00435 | 0.00435 |
| PCB 141 | ng/L | 0.000188 | - | 0.000699 | 0.000699 | 0.000699 |
| PCB 149 | ng/L | 0.000188 | - | 0.00294 | 0.00294 | 0.00294 |
| PCB 151 | ng/L | 0.000185 | - | 0.0012 | 0.0012 | 0.0012 |
| PCB 153 | ng/L | 0.000185 | - | 0.00202 | 0.00202 | 0.00202 |
| PCB 156 | ng/L | 0.000185 | - | 0.000417 | 0.000417 | 0.000417 |
| PCB 158 | ng/L | 0.000185 | - | 0.000391 | 0.000391 | 0.000391 |
| PCB 170 | ng/L | 0.000185 | - | 0.000938 | 0.000938 | 0.000938 |
| PCB 174 | ng/L | 0.000185 | - | 0.0011 | 0.0011 | 0.0011 |
| PCB 177 | ng/L | 0.000185 | - | 0.000651 | 0.000651 | 0.000651 |
| PCB 180 | ng/L | 0.000185 | - | 0.0015 | 0.0015 | 0.0015 |
| PCB 183 | ng/L | 0.000185 | - | 0.000699 | 0.000699 | 0.000699 |
| PCB 187 | ng/L | 0.000185 | - | 0.00113 | 0.00113 | 0.00113 |
| PCB 194 | ng/L | 0.000458 | - | ND | ND | ND |
| PCB 195 | ng/L | 0.000303 | - | ND | ND | ND |
| PCB 201 | ng/L | 0.000185 | - | ND | ND | ND |
| PCB 203 | ng/L | 0.000678 | - | ND | ND | ND |

Table A3: Average RSD of field and lab duplicates at each site.

| | Charcot Avenue SD SC-051CTC275 | | SD near Cooley Landing SM-72 | | Line 3A-M-1 at Industrial PS | | Line 4-B-1 | | Line 4-E | |
|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | RSD Lab | RSD Field | RSD Lab | RSD Field | RSD Lab | RSD Field | RSD Lab | RSD Field | RSD Lab | RSD Field |
| SSC | - | - | - | - | - | - | - | - | - | - |
| DOC | - | - | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | - | - |
| TOC | - | - | 0.00% | 0.00% | - | - | - | - | 3.90% | 3.90% |
| Total As | - | - | - | - | - | - | - | - | - | - |
| Total Cd | 4.30% | 4.30% | - | - | - | - | 1.90% | 1.90% | - | - |
| Total Cu | - | 0.70% | - | - | - | - | 1.00% | 1.00% | - | - |
| Total Hg | - | - | - | - | - | - | - | - | - | - |
| Total Pb | 0.00% | 0.00% | - | - | - | - | 0.70% | 0.70% | - | - |
| Total Zn | 0.30% | 0.30% | - | - | - | - | 0.60% | 0.60% | - | - |
| PCB 008 | - | - | - | - | - | - | - | - | - | - |
| PCB 018 | - | - | - | - | - | - | - | - | - | - |
| PCB 028 | - | - | - | - | - | - | - | - | - | - |
| PCB 031 | - | - | - | - | - | - | - | - | - | - |
| PCB 033 | - | - | - | - | - | - | - | - | - | - |
| PCB 044 | - | - | - | - | - | - | - | - | - | - |
| PCB 049 | - | - | - | - | - | - | - | - | - | - |
| PCB 052 | - | - | - | - | - | - | - | - | - | - |
| PCB 056 | - | - | - | - | - | - | - | - | - | - |
| PCB 060 | - | - | - | - | - | - | - | - | - | - |
| PCB 066 | - | - | - | - | - | - | - | - | - | - |
| PCB 070 | - | - | - | - | - | - | - | - | - | - |
| PCB 087 | - | - | - | - | - | - | - | - | - | - |
| PCB 095 | - | - | - | - | - | - | - | - | - | - |
| PCB 099 | - | - | - | - | - | - | - | - | - | - |
| PCB 101 | - | - | - | - | - | - | - | - | - | - |
| PCB 105 | - | - | - | - | - | - | - | - | - | - |
| PCB 110 | - | - | - | - | - | - | - | - | - | - |
| PCB 118 | - | - | - | - | - | - | - | - | - | - |
| PCB 128 | - | - | - | - | - | - | - | - | - | - |
| PCB 132 | - | - | - | - | - | - | - | - | - | - |
| PCB 138 | - | - | - | - | - | - | - | - | - | - |
| PCB 141 | - | - | - | - | - | - | - | - | - | - |
| PCB 149 | - | - | - | - | - | - | - | - | - | - |
| PCB 151 | - | - | - | - | - | - | - | - | - | - |
| PCB 153 | - | - | - | - | - | - | - | - | - | - |
| PCB 156 | - | - | - | - | - | - | - | - | - | - |
| PCB 158 | - | - | - | - | - | - | - | - | - | - |
| PCB 170 | - | - | - | - | - | - | - | - | - | - |
| PCB 174 | - | - | - | - | - | - | - | - | - | - |
| PCB 177 | - | - | - | - | - | - | - | - | - | - |
| PCB 180 | - | - | - | - | - | - | - | - | - | - |
| PCB 183 | - | - | - | - | - | - | - | - | - | - |
| PCB 187 | - | - | - | - | - | - | - | - | - | - |
| PCB 194 | - | - | - | - | - | - | - | - | - | - |
| PCB 195 | - | - | - | - | - | - | - | - | - | - |
| PCB 201 | - | - | - | - | - | - | - | - | - | - |
| PCB 203 | - | - | - | - | - | - | - | - | - | - |

Table A3 (continued): Average RSD of field and lab duplicates at each site.

| | Line 9-D | | Outfall to Lower Silver | | Meeker Slough | | Oddstad PS SM-267 | | Rock Springs Dr SD | |
|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | RSD Lab | RSD Field | RSD Lab | RSD Field | RSD Lab | RSD Field | RSD Lab | RSD Field | RSD Lab | RSD Field |
| SSC | - | 5.20% | - | - | - | - | - | - | - | - |
| DOC | 6.00% | 10.10% | - | - | - | - | 3.50% | 3.50% | - | - |
| TOC | 1.30% | 35.80% | 3.90% | 3.90% | 0.00% | 0.00% | - | - | - | - |
| Total As | - | 1.80% | - | - | - | 4.00% | - | - | 2.70% | 2.70% |
| Total Cd | - | 8.00% | - | - | - | 0.90% | - | - | - | 2.90% |
| Total Cu | - | 1.40% | - | - | - | 1.20% | - | - | 0.90% | 0.90% |
| Total Hg | - | 16.70% | - | - | - | - | - | - | - | - |
| Total Pb | - | 7.90% | - | - | - | 1.20% | - | - | 1.70% | 1.70% |
| Total Zn | - | 2.60% | - | - | - | 0.00% | - | - | 0.50% | 0.50% |
| PCB 008 | - | 6.50% | - | - | - | - | - | - | - | - |
| PCB 018 | - | 5.30% | - | - | - | - | - | - | - | - |
| PCB 028 | - | 9.00% | - | - | - | - | - | - | - | - |
| PCB 031 | - | 7.10% | - | - | - | - | - | - | - | - |
| PCB 033 | - | 7.40% | - | - | - | - | - | - | - | - |
| PCB 044 | - | 2.90% | - | - | - | - | - | - | - | - |
| PCB 049 | - | 3.40% | - | - | - | - | - | - | - | - |
| PCB 052 | - | 5.50% | - | - | - | - | - | - | - | - |
| PCB 056 | - | 7.70% | - | - | - | - | - | - | - | - |
| PCB 060 | - | 8.60% | - | - | - | - | - | - | - | - |
| PCB 066 | - | 4.50% | - | - | - | - | - | - | - | - |
| PCB 070 | - | 2.40% | - | - | - | - | - | - | - | - |
| PCB 087 | - | 4.20% | - | - | - | - | - | - | - | - |
| PCB 095 | - | 10.80% | - | - | - | - | - | - | - | - |
| PCB 099 | - | 9.00% | - | - | - | - | - | - | - | - |
| PCB 101 | - | 9.40% | - | - | - | - | - | - | - | - |
| PCB 105 | - | 9.60% | - | - | - | - | - | - | - | - |
| PCB 110 | - | 8.80% | - | - | - | - | - | - | - | - |
| PCB 118 | - | 11.30% | - | - | - | - | - | - | - | - |
| PCB 128 | - | 17.50% | - | - | - | - | - | - | - | - |
| PCB 132 | - | 5.60% | - | - | - | - | - | - | - | - |
| PCB 138 | - | 3.90% | - | - | - | - | - | - | - | - |
| PCB 141 | - | 2.80% | - | - | - | - | - | - | - | - |
| PCB 149 | - | 2.30% | - | - | - | - | - | - | - | - |
| PCB 151 | - | 0.80% | - | - | - | - | - | - | - | - |
| PCB 153 | - | 1.20% | - | - | - | - | - | - | - | - |
| PCB 156 | - | 5.70% | - | - | - | - | - | - | - | - |
| PCB 158 | - | 6.10% | - | - | - | - | - | - | - | - |
| PCB 170 | - | 4.60% | - | - | - | - | - | - | - | - |
| PCB 174 | - | 6.10% | - | - | - | - | - | - | - | - |
| PCB 177 | - | 6.80% | - | - | - | - | - | - | - | - |
| PCB 180 | - | 4.90% | - | - | - | - | - | - | - | - |
| PCB 183 | - | 9.70% | - | - | - | - | - | - | - | - |
| PCB 187 | - | 7.70% | - | - | - | - | - | - | - | - |
| PCB 194 | - | 4.70% | - | - | - | - | - | - | - | - |
| PCB 195 | - | 3.80% | - | - | - | - | - | - | - | - |
| PCB 201 | - | 10.80% | - | - | - | - | - | - | - | - |
| PCB 203 | - | 7.90% | - | - | - | - | - | - | - | - |

# Appendix B – Additional data results

Table B1. PCB congener results data appendix.

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Charcot Ave SD | PCB 008 | Dissolved | 649 | pg/L |
| Charcot Ave SD | PCB 018 | Dissolved | 1630 | pg/L |
| Charcot Ave SD | PCB 028 | Dissolved | 3170 | pg/L |
| Charcot Ave SD | PCB 031 | Dissolved | 2490 | pg/L |
| Charcot Ave SD | PCB 033 | Dissolved | 1630 | pg/L |
| Charcot Ave SD | PCB 044 | Dissolved | 3070 | pg/L |
| Charcot Ave SD | PCB 049 | Dissolved | 1770 | pg/L |
| Charcot Ave SD | PCB 052 | Dissolved | 3460 | pg/L |
| Charcot Ave SD | PCB 056 | Dissolved | 715 | pg/L |
| Charcot Ave SD | PCB 060 | Dissolved | 373 | pg/L |
| Charcot Ave SD | PCB 066 | Dissolved | 1410 | pg/L |
| Charcot Ave SD | PCB 070 | Dissolved | 2930 | pg/L |
| Charcot Ave SD | PCB 087 | Dissolved | 2340 | pg/L |
| Charcot Ave SD | PCB 095 | Dissolved | 2990 | pg/L |
| Charcot Ave SD | PCB 099 | Dissolved | 1610 | pg/L |
| Charcot Ave SD | PCB 101 | Dissolved | 3030 | pg/L |
| Charcot Ave SD | PCB 105 | Dissolved | 1240 | pg/L |
| Charcot Ave SD | PCB 110 | Dissolved | 3870 | pg/L |
| Charcot Ave SD | PCB 118 | Dissolved | 2490 | pg/L |
| Charcot Ave SD | PCB 128 | Dissolved | 747 | pg/L |
| Charcot Ave SD | PCB 132 | Dissolved | 2080 | pg/L |
| Charcot Ave SD | PCB 138 | Dissolved | 5900 | pg/L |
| Charcot Ave SD | PCB 141 | Dissolved | 1170 | pg/L |
| Charcot Ave SD | PCB 149 | Dissolved | 4890 | pg/L |
| Charcot Ave SD | PCB 151 | Dissolved | 2130 | pg/L |
| Charcot Ave SD | PCB 153 | Dissolved | 4710 | pg/L |
| Charcot Ave SD | PCB 156 | Dissolved | 566 | pg/L |
| Charcot Ave SD | PCB 158 | Dissolved | 607 | pg/L |
| Charcot Ave SD | PCB 170 | Dissolved | 2290 | pg/L |
| Charcot Ave SD | PCB 174 | Dissolved | 2740 | pg/L |
| Charcot Ave SD | PCB 177 | Dissolved | 1470 | pg/L |
| Charcot Ave SD | PCB 180 | Dissolved | 5840 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Charcot Ave SD | PCB 183 | Dissolved | 2060 | pg/L |
| Charcot Ave SD | PCB 187 | Dissolved | 2900 | pg/L |
| Charcot Ave SD | PCB 194 | Dissolved | 1880 | pg/L |
| Charcot Ave SD | PCB 195 | Dissolved | 701 | pg/L |
| Charcot Ave SD | PCB 201 | Dissolved | 348 | pg/L |
| Charcot Ave SD | PCB 203 | Dissolved | 1810 | pg/L |
| Charcot Ave SD | PCB 008 | Total | 167 | pg/L |
| Charcot Ave SD | PCB 018 | Total | 307 | pg/L |
| Charcot Ave SD | PCB 028 | Total | 600 | pg/L |
| Charcot Ave SD | PCB 031 | Total | 495 | pg/L |
| Charcot Ave SD | PCB 033 | Total | 332 | pg/L |
| Charcot Ave SD | PCB 044 | Total | 492 | pg/L |
| Charcot Ave SD | PCB 049 | Total | 277 | pg/L |
| Charcot Ave SD | PCB 052 | Total | 552 | pg/L |
| Charcot Ave SD | PCB 056 | Total | 163 | pg/L |
| Charcot Ave SD | PCB 060 | Total | 86.8 | pg/L |
| Charcot Ave SD | PCB 066 | Total | 286 | pg/L |
| Charcot Ave SD | PCB 070 | Total | 614 | pg/L |
| Charcot Ave SD | PCB 087 | Total | 516 | pg/L |
| Charcot Ave SD | PCB 095 | Total | 500 | pg/L |
| Charcot Ave SD | PCB 099 | Total | 298 | pg/L |
| Charcot Ave SD | PCB 101 | Total | 592 | pg/L |
| Charcot Ave SD | PCB 105 | Total | 292 | pg/L |
| Charcot Ave SD | PCB 110 | Total | 805 | pg/L |
| Charcot Ave SD | PCB 118 | Total | 588 | pg/L |
| Charcot Ave SD | PCB 128 | Total | 138 | pg/L |
| Charcot Ave SD | PCB 132 | Total | 359 | pg/L |
| Charcot Ave SD | PCB 138 | Total | 1100 | pg/L |
| Charcot Ave SD | PCB 141 | Total | 212 | pg/L |
| Charcot Ave SD | PCB 149 | Total | 779 | pg/L |
| Charcot Ave SD | PCB 151 | Total | 322 | pg/L |
| Charcot Ave SD | PCB 153 | Total | 834 | pg/L |
| Charcot Ave SD | PCB 156 | Total | 110 | pg/L |
| Charcot Ave SD | PCB 158 | Total | 109 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Charcot Ave SD | PCB 170 | Total | 332 | pg/L |
| Charcot Ave SD | PCB 174 | Total | 431 | pg/L |
| Charcot Ave SD | PCB 177 | Total | 212 | pg/L |
| Charcot Ave SD | PCB 180 | Total | 834 | pg/L |
| Charcot Ave SD | PCB 183 | Total | 260 | pg/L |
| Charcot Ave SD | PCB 187 | Total | 371 | pg/L |
| Charcot Ave SD | PCB 194 | Total | 238 | pg/L |
| Charcot Ave SD | PCB 195 | Total | 80.7 | pg/L |
| Charcot Ave SD | PCB 201 | Total | 38 | pg/L |
| Charcot Ave SD | PCB 203 | Total | 204 | pg/L |
| E. Gish Rd SD | PCB 008 | Total | 62.3 | pg/L |
| E. Gish Rd SD | PCB 018 | Total | 154 | pg/L |
| E. Gish Rd SD | PCB 028 | Total | 269 | pg/L |
| E. Gish Rd SD | PCB 031 | Total | 228 | pg/L |
| E. Gish Rd SD | PCB 033 | Total | 155 | pg/L |
| E. Gish Rd SD | PCB 044 | Total | 292 | pg/L |
| E. Gish Rd SD | PCB 049 | Total | 158 | pg/L |
| E. Gish Rd SD | PCB 052 | Total | 378 | pg/L |
| E. Gish Rd SD | PCB 056 | Total | 101 | pg/L |
| E. Gish Rd SD | PCB 060 | Total | 55 | pg/L |
| E. Gish Rd SD | PCB 066 | Total | 183 | pg/L |
| E. Gish Rd SD | PCB 070 | Total | 429 | pg/L |
| E. Gish Rd SD | PCB 087 | Total | 550 | pg/L |
| E. Gish Rd SD | PCB 095 | Total | 586 | pg/L |
| E. Gish Rd SD | PCB 099 | Total | 294 | pg/L |
| E. Gish Rd SD | PCB 101 | Total | 658 | pg/L |
| E. Gish Rd SD | PCB 105 | Total | 255 | pg/L |
| E. Gish Rd SD | PCB 110 | Total | 846 | pg/L |
| E. Gish Rd SD | PCB 118 | Total | 543 | pg/L |
| E. Gish Rd SD | PCB 128 | Total | 167 | pg/L |
| E. Gish Rd SD | PCB 132 | Total | 389 | pg/L |
| E. Gish Rd SD | PCB 138 | Total | 1140 | pg/L |
| E. Gish Rd SD | PCB 141 | Total | 243 | pg/L |
| E. Gish Rd SD | PCB 149 | Total | 910 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| E. Gish Rd SD | PCB 151 | Total | 407 | pg/L |
| E. Gish Rd SD | PCB 153 | Total | 936 | pg/L |
| E. Gish Rd SD | PCB 156 | Total | 122 | pg/L |
| E. Gish Rd SD | PCB 158 | Total | 114 | pg/L |
| E. Gish Rd SD | PCB 170 | Total | 360 | pg/L |
| E. Gish Rd SD | PCB 174 | Total | 463 | pg/L |
| E. Gish Rd SD | PCB 177 | Total | 239 | pg/L |
| E. Gish Rd SD | PCB 180 | Total | 1000 | pg/L |
| E. Gish Rd SD | PCB 183 | Total | 337 | pg/L |
| E. Gish Rd SD | PCB 187 | Total | 498 | pg/L |
| E. Gish Rd SD | PCB 194 | Total | 336 | pg/L |
| E. Gish Rd SD | PCB 195 | Total | 115 | pg/L |
| E. Gish Rd SD | PCB 201 | Total | 60.8 | pg/L |
| E. Gish Rd SD | PCB 203 | Total | 332 | pg/L |
| Gateway Ave SD | PCB 018 | Total | 27.5 | pg/L |
| Gateway Ave SD | PCB 028 | Total | 64.9 | pg/L |
| Gateway Ave SD | PCB 031 | Total | 48.4 | pg/L |
| Gateway Ave SD | PCB 033 | Total | 33.6 | pg/L |
| Gateway Ave SD | PCB 044 | Total | 86.9 | pg/L |
| Gateway Ave SD | PCB 049 | Total | 45.3 | pg/L |
| Gateway Ave SD | PCB 052 | Total | 126 | pg/L |
| Gateway Ave SD | PCB 056 | Total | 42.5 | pg/L |
| Gateway Ave SD | PCB 060 | Total | 22.8 | pg/L |
| Gateway Ave SD | PCB 066 | Total | 87.8 | pg/L |
| Gateway Ave SD | PCB 070 | Total | 175 | pg/L |
| Gateway Ave SD | PCB 087 | Total | 208 | pg/L |
| Gateway Ave SD | PCB 095 | Total | 214 | pg/L |
| Gateway Ave SD | PCB 099 | Total | 143 | pg/L |
| Gateway Ave SD | PCB 101 | Total | 276 | pg/L |
| Gateway Ave SD | PCB 105 | Total | 136 | pg/L |
| Gateway Ave SD | PCB 110 | Total | 386 | pg/L |
| Gateway Ave SD | PCB 118 | Total | 285 | pg/L |
| Gateway Ave SD | PCB 128 | Total | 91.5 | pg/L |
| Gateway Ave SD | PCB 132 | Total | 173 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Gateway Ave SD | PCB 138 | Total | 526 | pg/L |
| Gateway Ave SD | PCB 141 | Total | 95.9 | pg/L |
| Gateway Ave SD | PCB 149 | Total | 341 | pg/L |
| Gateway Ave SD | PCB 151 | Total | 127 | pg/L |
| Gateway Ave SD | PCB 153 | Total | 367 | pg/L |
| Gateway Ave SD | PCB 156 | Total | 61.1 | pg/L |
| Gateway Ave SD | PCB 158 | Total | 54.5 | pg/L |
| Gateway Ave SD | PCB 170 | Total | 113 | pg/L |
| Gateway Ave SD | PCB 174 | Total | 124 | pg/L |
| Gateway Ave SD | PCB 177 | Total | 66.9 | pg/L |
| Gateway Ave SD | PCB 180 | Total | 274 | pg/L |
| Gateway Ave SD | PCB 183 | Total | 86.8 | pg/L |
| Gateway Ave SD | PCB 187 | Total | 153 | pg/L |
| Gateway Ave SD | PCB 194 | Total | 80.7 | pg/L |
| Gateway Ave SD | PCB 195 | Total | 26.9 | pg/L |
| Gateway Ave SD | PCB 201 | Total | 12.5 | pg/L |
| Gateway Ave SD | PCB 203 | Total | 60.9 | pg/L |
| Line-3A-M at 3A-D | PCB 008 | Total | 145 | pg/L |
| Line-3A-M at 3A-D | PCB 018 | Total | 620 | pg/L |
| Line-3A-M at 3A-D | PCB 028 | Total | 842 | pg/L |
| Line-3A-M at 3A-D | PCB 031 | Total | 634 | pg/L |
| Line-3A-M at 3A-D | PCB 033 | Total | 386 | pg/L |
| Line-3A-M at 3A-D | PCB 044 | Total | 801 | pg/L |
| Line-3A-M at 3A-D | PCB 049 | Total | 421 | pg/L |
| Line-3A-M at 3A-D | PCB 052 | Total | 1070 | pg/L |
| Line-3A-M at 3A-D | PCB 056 | Total | 274 | pg/L |
| Line-3A-M at 3A-D | PCB 060 | Total | 156 | pg/L |
| Line-3A-M at 3A-D | PCB 066 | Total | 490 | pg/L |
| Line-3A-M at 3A-D | PCB 070 | Total | 1210 | pg/L |
| Line-3A-M at 3A-D | PCB 087 | Total | 1200 | pg/L |
| Line-3A-M at 3A-D | PCB 095 | Total | 1300 | pg/L |
| Line-3A-M at 3A-D | PCB 099 | Total | 755 | pg/L |
| Line-3A-M at 3A-D | PCB 101 | Total | 1560 | pg/L |
| Line-3A-M at 3A-D | PCB 105 | Total | 659 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Line-3A-M at 3A-D | PCB 110 | Total | 1950 | pg/L |
| Line-3A-M at 3A-D | PCB 118 | Total | 1460 | pg/L |
| Line-3A-M at 3A-D | PCB 128 | Total | 342 | pg/L |
| Line-3A-M at 3A-D | PCB 132 | Total | 670 | pg/L |
| Line-3A-M at 3A-D | PCB 138 | Total | 1920 | pg/L |
| Line-3A-M at 3A-D | PCB 141 | Total | 327 | pg/L |
| Line-3A-M at 3A-D | PCB 149 | Total | 1160 | pg/L |
| Line-3A-M at 3A-D | PCB 151 | Total | 397 | pg/L |
| Line-3A-M at 3A-D | PCB 153 | Total | 1240 | pg/L |
| Line-3A-M at 3A-D | PCB 156 | Total | 254 | pg/L |
| Line-3A-M at 3A-D | PCB 158 | Total | 210 | pg/L |
| Line-3A-M at 3A-D | PCB 170 | Total | 322 | pg/L |
| Line-3A-M at 3A-D | PCB 174 | Total | 281 | pg/L |
| Line-3A-M at 3A-D | PCB 177 | Total | 159 | pg/L |
| Line-3A-M at 3A-D | PCB 180 | Total | 663 | pg/L |
| Line-3A-M at 3A-D | PCB 183 | Total | 197 | pg/L |
| Line-3A-M at 3A-D | PCB 187 | Total | 303 | pg/L |
| Line-3A-M at 3A-D | PCB 194 | Total | 181 | pg/L |
| Line-3A-M at 3A-D | PCB 195 | Total | 58.2 | pg/L |
| Line-3A-M at 3A-D | PCB 201 | Total | 25.5 | pg/L |
| Line-3A-M at 3A-D | PCB 203 | Total | 148 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 008 | Total | 150 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 018 | Total | 368 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 028 | Total | 559 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 031 | Total | 453 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 033 | Total | 299 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 044 | Total | 542 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 049 | Total | 297 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 052 | Total | 528 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 056 | Total | 143 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 060 | Total | 78.1 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 066 | Total | 267 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 070 | Total | 514 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 087 | Total | 297 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Line3A-M-1 at Industrial PS | PCB 095 | Total | 321 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 099 | Total | 191 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 101 | Total | 354 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 105 | Total | 159 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 110 | Total | 496 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 118 | Total | 318 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 128 | Total | 85.3 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 132 | Total | 164 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 138 | Total | 484 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 141 | Total | 86.2 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 149 | Total | 309 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 151 | Total | 117 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 153 | Total | 329 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 156 | Total | 60.1 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 158 | Total | 52.2 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 170 | Total | 105 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 174 | Total | 106 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 177 | Total | 58.1 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 180 | Total | 250 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 183 | Total | 73.5 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 187 | Total | 131 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 194 | Total | 79.1 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 195 | Total | 25.1 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 201 | Total | 11.1 | pg/L |
| Line3A-M-1 at Industrial PS | PCB 203 | Total | 63.4 | pg/L |
| Line4-B-1 | PCB 008 | Total | 14.7 | pg/L |
| Line4-B-1 | PCB 018 | Total | 37.2 | pg/L |
| Line4-B-1 | PCB 028 | Total | 71.5 | pg/L |
| Line4-B-1 | PCB 031 | Total | 53.2 | pg/L |
| Line4-B-1 | PCB 033 | Total | 32.7 | pg/L |
| Line4-B-1 | PCB 044 | Total | 126 | pg/L |
| Line4-B-1 | PCB 049 | Total | 63 | pg/L |
| Line4-B-1 | PCB 052 | Total | 189 | pg/L |
| Line4-B-1 | PCB 056 | Total | 60.7 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Line4-B-1 | PCB 060 | Total | 30 | pg/L |
| Line4-B-1 | PCB 066 | Total | 105 | pg/L |
| Line4-B-1 | PCB 070 | Total | 242 | pg/L |
| Line4-B-1 | PCB 087 | Total | 339 | pg/L |
| Line4-B-1 | PCB 095 | Total | 370 | pg/L |
| Line4-B-1 | PCB 099 | Total | 217 | pg/L |
| Line4-B-1 | PCB 101 | Total | 444 | pg/L |
| Line4-B-1 | PCB 105 | Total | 192 | pg/L |
| Line4-B-1 | PCB 110 | Total | 619 | pg/L |
| Line4-B-1 | PCB 118 | Total | 412 | pg/L |
| Line4-B-1 | PCB 128 | Total | 140 | pg/L |
| Line4-B-1 | PCB 132 | Total | 285 | pg/L |
| Line4-B-1 | PCB 138 | Total | 846 | pg/L |
| Line4-B-1 | PCB 141 | Total | 164 | pg/L |
| Line4-B-1 | PCB 149 | Total | 630 | pg/L |
| Line4-B-1 | PCB 151 | Total | 248 | pg/L |
| Line4-B-1 | PCB 153 | Total | 629 | pg/L |
| Line4-B-1 | PCB 156 | Total | 90.5 | pg/L |
| Line4-B-1 | PCB 158 | Total | 84.6 | pg/L |
| Line4-B-1 | PCB 170 | Total | 215 | pg/L |
| Line4-B-1 | PCB 174 | Total | 245 | pg/L |
| Line4-B-1 | PCB 177 | Total | 142 | pg/L |
| Line4-B-1 | PCB 180 | Total | 524 | pg/L |
| Line4-B-1 | PCB 183 | Total | 173 | pg/L |
| Line4-B-1 | PCB 187 | Total | 311 | pg/L |
| Line4-B-1 | PCB 194 | Total | 133 | pg/L |
| Line4-B-1 | PCB 195 | Total | 46.9 | pg/L |
| Line4-B-1 | PCB 201 | Total | 23.3 | pg/L |
| Line4-B-1 | PCB 203 | Total | 126 | pg/L |
| Line4-E | PCB 008 | Total | 41.1 | pg/L |
| Line4-E | PCB 018 | Total | 109 | pg/L |
| Line4-E | PCB 028 | Total | 294 | pg/L |
| Line4-E | PCB 031 | Total | 106 | pg/L |
| Line4-E | PCB 033 | Total | 53.7 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Line4-E | PCB 044 | Total | 490 | pg/L |
| Line4-E | PCB 049 | Total | 282 | pg/L |
| Line4-E | PCB 052 | Total | 445 | pg/L |
| Line4-E | PCB 056 | Total | 100 | pg/L |
| Line4-E | PCB 060 | Total | 44.8 | pg/L |
| Line4-E | PCB 066 | Total | 238 | pg/L |
| Line4-E | PCB 070 | Total | 433 | pg/L |
| Line4-E | PCB 087 | Total | 508 | pg/L |
| Line4-E | PCB 095 | Total | 870 | pg/L |
| Line4-E | PCB 099 | Total | 407 | pg/L |
| Line4-E | PCB 101 | Total | 1060 | pg/L |
| Line4-E | PCB 105 | Total | 277 | pg/L |
| Line4-E | PCB 110 | Total | 975 | pg/L |
| Line4-E | PCB 118 | Total | 666 | pg/L |
| Line4-E | PCB 128 | Total | 387 | pg/L |
| Line4-E | PCB 132 | Total | 1100 | pg/L |
| Line4-E | PCB 138 | Total | 3930 | pg/L |
| Line4-E | PCB 141 | Total | 967 | pg/L |
| Line4-E | PCB 149 | Total | 3080 | pg/L |
| Line4-E | PCB 151 | Total | 1300 | pg/L |
| Line4-E | PCB 153 | Total | 3870 | pg/L |
| Line4-E | PCB 156 | Total | 281 | pg/L |
| Line4-E | PCB 158 | Total | 339 | pg/L |
| Line4-E | PCB 170 | Total | 1920 | pg/L |
| Line4-E | PCB 174 | Total | 1860 | pg/L |
| Line4-E | PCB 177 | Total | 1130 | pg/L |
| Line4-E | PCB 180 | Total | 4610 | pg/L |
| Line4-E | PCB 183 | Total | 1280 | pg/L |
| Line4-E | PCB 187 | Total | 1780 | pg/L |
| Line4-E | PCB 194 | Total | 1030 | pg/L |
| Line4-E | PCB 195 | Total | 388 | pg/L |
| Line4-E | PCB 201 | Total | 120 | pg/L |
| Line4-E | PCB 203 | Total | 578 | pg/L |
| Line9-D | PCB 008 | Total | 34.9 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Line9-D | PCB 018 | Total | 52.45 | pg/L |
| Line9-D | PCB 028 | Total | 133.5 | pg/L |
| Line9-D | PCB 031 | Total | 102.85 | pg/L |
| Line9-D | PCB 033 | Total | 78.85 | pg/L |
| Line9-D | PCB 044 | Total | 147 | pg/L |
| Line9-D | PCB 049 | Total | 74.1 | pg/L |
| Line9-D | PCB 052 | Total | 194.5 | pg/L |
| Line9-D | PCB 056 | Total | 76.25 | pg/L |
| Line9-D | PCB 060 | Total | 41.75 | pg/L |
| Line9-D | PCB 066 | Total | 127 | pg/L |
| Line9-D | PCB 070 | Total | 297 | pg/L |
| Line9-D | PCB 087 | Total | 424.5 | pg/L |
| Line9-D | PCB 095 | Total | 301 | pg/L |
| Line9-D | PCB 099 | Total | 195.5 | pg/L |
| Line9-D | PCB 101 | Total | 399.5 | pg/L |
| Line9-D | PCB 105 | Total | 183.5 | pg/L |
| Line9-D | PCB 110 | Total | 519.5 | pg/L |
| Line9-D | PCB 118 | Total | 392.5 | pg/L |
| Line9-D | PCB 128 | Total | 121 | pg/L |
| Line9-D | PCB 132 | Total | 280 | pg/L |
| Line9-D | PCB 138 | Total | 933 | pg/L |
| Line9-D | PCB 141 | Total | 203 | pg/L |
| Line9-D | PCB 149 | Total | 636.5 | pg/L |
| Line9-D | PCB 151 | Total | 258.5 | pg/L |
| Line9-D | PCB 153 | Total | 763.5 | pg/L |
| Line9-D | PCB 156 | Total | 84.8 | pg/L |
| Line9-D | PCB 158 | Total | 89.8 | pg/L |
| Line9-D | PCB 170 | Total | 380.5 | pg/L |
| Line9-D | PCB 174 | Total | 460 | pg/L |
| Line9-D | PCB 177 | Total | 237.5 | pg/L |
| Line9-D | PCB 180 | Total | 932 | pg/L |
| Line9-D | PCB 183 | Total | 263 | pg/L |
| Line9-D | PCB 187 | Total | 467.5 | pg/L |
| Line9-D | PCB 194 | Total | 253.5 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Line9-D | PCB 195 | Total | 87.85 | pg/L |
| Line9-D | PCB 201 | Total | 34.55 | pg/L |
| Line9-D | PCB 203 | Total | 188.5 | pg/L |
| Lower Penitencia Ck | PCB 008 | Total | 4.36 | pg/L |
| Lower Penitencia Ck | PCB 018 | Total | 11.3 | pg/L |
| Lower Penitencia Ck | PCB 028 | Total | 18.3 | pg/L |
| Lower Penitencia Ck | PCB 031 | Total | 13.5 | pg/L |
| Lower Penitencia Ck | PCB 033 | Total | 8.58 | pg/L |
| Lower Penitencia Ck | PCB 044 | Total | 30.4 | pg/L |
| Lower Penitencia Ck | PCB 049 | Total | 15.2 | pg/L |
| Lower Penitencia Ck | PCB 052 | Total | 43.9 | pg/L |
| Lower Penitencia Ck | PCB 056 | Total | 12 | pg/L |
| Lower Penitencia Ck | PCB 060 | Total | 6.12 | pg/L |
| Lower Penitencia Ck | PCB 066 | Total | 22 | pg/L |
| Lower Penitencia Ck | PCB 070 | Total | 50.1 | pg/L |
| Lower Penitencia Ck | PCB 087 | Total | 79.9 | pg/L |
| Lower Penitencia Ck | PCB 095 | Total | 91.5 | pg/L |
| Lower Penitencia Ck | PCB 099 | Total | 49.8 | pg/L |
| Lower Penitencia Ck | PCB 101 | Total | 106 | pg/L |
| Lower Penitencia Ck | PCB 105 | Total | 46.6 | pg/L |
| Lower Penitencia Ck | PCB 110 | Total | 152 | pg/L |
| Lower Penitencia Ck | PCB 118 | Total | 96.4 | pg/L |
| Lower Penitencia Ck | PCB 128 | Total | 35.6 | pg/L |
| Lower Penitencia Ck | PCB 132 | Total | 67.4 | pg/L |
| Lower Penitencia Ck | PCB 138 | Total | 203 | pg/L |
| Lower Penitencia Ck | PCB 141 | Total | 37 | pg/L |
| Lower Penitencia Ck | PCB 149 | Total | 140 | pg/L |
| Lower Penitencia Ck | PCB 151 | Total | 52.1 | pg/L |
| Lower Penitencia Ck | PCB 153 | Total | 142 | pg/L |
| Lower Penitencia Ck | PCB 156 | Total | 23 | pg/L |
| Lower Penitencia Ck | PCB 158 | Total | 21.6 | pg/L |
| Lower Penitencia Ck | PCB 170 | Total | 53.5 | pg/L |
| Lower Penitencia Ck | PCB 174 | Total | 54.7 | pg/L |
| Lower Penitencia Ck | PCB 177 | Total | 30.2 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Lower Penitencia Ck | PCB 180 | Total | 128 | pg/L |
| Lower Penitencia Ck | PCB 183 | Total | 36 | pg/L |
| Lower Penitencia Ck | PCB 187 | Total | 63 | pg/L |
| Lower Penitencia Ck | PCB 194 | Total | 37.9 | pg/L |
| Lower Penitencia Ck | PCB 195 | Total | 14 | pg/L |
| Lower Penitencia Ck | PCB 201 | Total | 4.97 | pg/L |
| Lower Penitencia Ck | PCB 203 | Total | 31.3 | pg/L |
| Meeker Slough | PCB 008 | Total | 7.26 | pg/L |
| Meeker Slough | PCB 018 | Total | 26.6 | pg/L |
| Meeker Slough | PCB 028 | Total | 64.8 | pg/L |
| Meeker Slough | PCB 031 | Total | 47.3 | pg/L |
| Meeker Slough | PCB 033 | Total | 23.8 | pg/L |
| Meeker Slough | PCB 044 | Total | 105 | pg/L |
| Meeker Slough | PCB 049 | Total | 56 | pg/L |
| Meeker Slough | PCB 052 | Total | 178 | pg/L |
| Meeker Slough | PCB 056 | Total | 53.6 | pg/L |
| Meeker Slough | PCB 060 | Total | 27.5 | pg/L |
| Meeker Slough | PCB 066 | Total | 95.4 | pg/L |
| Meeker Slough | PCB 070 | Total | 245 | pg/L |
| Meeker Slough | PCB 087 | Total | 349 | pg/L |
| Meeker Slough | PCB 095 | Total | 360 | pg/L |
| Meeker Slough | PCB 099 | Total | 242 | pg/L |
| Meeker Slough | PCB 101 | Total | 463 | pg/L |
| Meeker Slough | PCB 105 | Total | 244 | pg/L |
| Meeker Slough | PCB 110 | Total | 661 | pg/L |
| Meeker Slough | PCB 118 | Total | 512 | pg/L |
| Meeker Slough | PCB 128 | Total | 166 | pg/L |
| Meeker Slough | PCB 132 | Total | 280 | pg/L |
| Meeker Slough | PCB 138 | Total | 928 | pg/L |
| Meeker Slough | PCB 141 | Total | 165 | pg/L |
| Meeker Slough | PCB 149 | Total | 540 | pg/L |
| Meeker Slough | PCB 151 | Total | 189 | pg/L |
| Meeker Slough | PCB 153 | Total | 663 | pg/L |
| Meeker Slough | PCB 156 | Total | 113 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Meeker Slough | PCB 158 | Total | 94 | pg/L |
| Meeker Slough | PCB 170 | Total | 203 | pg/L |
| Meeker Slough | PCB 174 | Total | 194 | pg/L |
| Meeker Slough | PCB 177 | Total | 108 | pg/L |
| Meeker Slough | PCB 180 | Total | 487 | pg/L |
| Meeker Slough | PCB 183 | Total | 135 | pg/L |
| Meeker Slough | PCB 187 | Total | 215 | pg/L |
| Meeker Slough | PCB 194 | Total | 146 | pg/L |
| Meeker Slough | PCB 195 | Total | 45.7 | pg/L |
| Meeker Slough | PCB 201 | Total | 19.8 | pg/L |
| Meeker Slough | PCB 203 | Total | 107 | pg/L |
| Oddstad PS | PCB 008 | Total | 15 | pg/L |
| Oddstad PS | PCB 018 | Total | 42.4 | pg/L |
| Oddstad PS | PCB 028 | Total | 89.6 | pg/L |
| Oddstad PS | PCB 031 | Total | 48.2 | pg/L |
| Oddstad PS | PCB 033 | Total | 23.4 | pg/L |
| Oddstad PS | PCB 044 | Total | 156 | pg/L |
| Oddstad PS | PCB 049 | Total | 87.6 | pg/L |
| Oddstad PS | PCB 052 | Total | 198 | pg/L |
| Oddstad PS | PCB 056 | Total | 66.5 | pg/L |
| Oddstad PS | PCB 060 | Total | 33.3 | pg/L |
| Oddstad PS | PCB 066 | Total | 117 | pg/L |
| Oddstad PS | PCB 070 | Total | 201 | pg/L |
| Oddstad PS | PCB 087 | Total | 288 | pg/L |
| Oddstad PS | PCB 095 | Total | 398 | pg/L |
| Oddstad PS | PCB 099 | Total | 213 | pg/L |
| Oddstad PS | PCB 101 | Total | 411 | pg/L |
| Oddstad PS | PCB 105 | Total | 139 | pg/L |
| Oddstad PS | PCB 110 | Total | 533 | pg/L |
| Oddstad PS | PCB 118 | Total | 289 | pg/L |
| Oddstad PS | PCB 128 | Total | 115 | pg/L |
| Oddstad PS | PCB 132 | Total | 241 | pg/L |
| Oddstad PS | PCB 138 | Total | 722 | pg/L |
| Oddstad PS | PCB 141 | Total | 149 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Oddstad PS | PCB 149 | Total | 677 | pg/L |
| Oddstad PS | PCB 151 | Total | 295 | pg/L |
| Oddstad PS | PCB 153 | Total | 624 | pg/L |
| Oddstad PS | PCB 156 | Total | 66.7 | pg/L |
| Oddstad PS | PCB 158 | Total | 66.6 | pg/L |
| Oddstad PS | PCB 170 | Total | 238 | pg/L |
| Oddstad PS | PCB 174 | Total | 334 | pg/L |
| Oddstad PS | PCB 177 | Total | 174 | pg/L |
| Oddstad PS | PCB 180 | Total | 754 | pg/L |
| Oddstad PS | PCB 183 | Total | 239 | pg/L |
| Oddstad PS | PCB 187 | Total | 470 | pg/L |
| Oddstad PS | PCB 194 | Total | 289 | pg/L |
| Oddstad PS | PCB 195 | Total | 88.3 | pg/L |
| Oddstad PS | PCB 201 | Total | 45.9 | pg/L |
| Oddstad PS | PCB 203 | Total | 266 | pg/L |
| Outfall to Lower Silver Ck | PCB 008 | Total | 68.6 | pg/L |
| Outfall to Lower Silver Ck | PCB 008 | Total | 2020 | pg/L |
| Outfall to Lower Silver Ck | PCB 008 | Total | 63.8 | pg/L |
| Outfall to Lower Silver Ck | PCB 018 | Total | 105 | pg/L |
| Outfall to Lower Silver Ck | PCB 018 | Total | 3980 | pg/L |
| Outfall to Lower Silver Ck | PCB 018 | Total | 195 | pg/L |
| Outfall to Lower Silver Ck | PCB 028 | Total | 308 | pg/L |
| Outfall to Lower Silver Ck | PCB 028 | Total | 21500 | pg/L |
| Outfall to Lower Silver Ck | PCB 028 | Total | 782 | pg/L |
| Outfall to Lower Silver Ck | PCB 031 | Total | 217 | pg/L |
| Outfall to Lower Silver Ck | PCB 031 | Total | 13500 | pg/L |
| Outfall to Lower Silver Ck | PCB 031 | Total | 572 | pg/L |
| Outfall to Lower Silver Ck | PCB 033 | Total | 168 | pg/L |
| Outfall to Lower Silver Ck | PCB 033 | Total | 9340 | pg/L |
| Outfall to Lower Silver Ck | PCB 033 | Total | 429 | pg/L |
| Outfall to Lower Silver Ck | PCB 044 | Total | 516 | pg/L |
| Outfall to Lower Silver Ck | PCB 044 | Total | 56700 | pg/L |
| Outfall to Lower Silver Ck | PCB 044 | Total | 1900 | pg/L |
| Outfall to Lower Silver Ck | PCB 049 | Total | 250 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Outfall to Lower Silver Ck | PCB 049 | Total | 28000 | pg/L |
| Outfall to Lower Silver Ck | PCB 049 | Total | 901 | pg/L |
| Outfall to Lower Silver Ck | PCB 052 | Total | 720 | pg/L |
| Outfall to Lower Silver Ck | PCB 052 | Total | 86300 | pg/L |
| Outfall to Lower Silver Ck | PCB 052 | Total | 2970 | pg/L |
| Outfall to Lower Silver Ck | PCB 056 | Total | 498 | pg/L |
| Outfall to Lower Silver Ck | PCB 056 | Total | 44200 | pg/L |
| Outfall to Lower Silver Ck | PCB 056 | Total | 1520 | pg/L |
| Outfall to Lower Silver Ck | PCB 060 | Total | 267 | pg/L |
| Outfall to Lower Silver Ck | PCB 060 | Total | 18300 | pg/L |
| Outfall to Lower Silver Ck | PCB 060 | Total | 741 | pg/L |
| Outfall to Lower Silver Ck | PCB 066 | Total | 840 | pg/L |
| Outfall to Lower Silver Ck | PCB 066 | Total | 77400 | pg/L |
| Outfall to Lower Silver Ck | PCB 066 | Total | 2660 | pg/L |
| Outfall to Lower Silver Ck | PCB 070 | Total | 1560 | pg/L |
| Outfall to Lower Silver Ck | PCB 070 | Total | 155000 | pg/L |
| Outfall to Lower Silver Ck | PCB 070 | Total | 5660 | pg/L |
| Outfall to Lower Silver Ck | PCB 087 | Total | 2130 | pg/L |
| Outfall to Lower Silver Ck | PCB 087 | Total | 240000 | pg/L |
| Outfall to Lower Silver Ck | PCB 087 | Total | 8260 | pg/L |
| Outfall to Lower Silver Ck | PCB 095 | Total | 1570 | pg/L |
| Outfall to Lower Silver Ck | PCB 095 | Total | 187000 | pg/L |
| Outfall to Lower Silver Ck | PCB 095 | Total | 6920 | pg/L |
| Outfall to Lower Silver Ck | PCB 099 | Total | 1170 | pg/L |
| Outfall to Lower Silver Ck | PCB 099 | Total | 144000 | pg/L |
| Outfall to Lower Silver Ck | PCB 099 | Total | 4990 | pg/L |
| Outfall to Lower Silver Ck | PCB 101 | Total | 2630 | pg/L |
| Outfall to Lower Silver Ck | PCB 101 | Total | 315000 | pg/L |
| Outfall to Lower Silver Ck | PCB 101 | Total | 10600 | pg/L |
| Outfall to Lower Silver Ck | PCB 105 | Total | 1760 | pg/L |
| Outfall to Lower Silver Ck | PCB 105 | Total | 147000 | pg/L |
| Outfall to Lower Silver Ck | PCB 105 | Total | 5970 | pg/L |
| Outfall to Lower Silver Ck | PCB 110 | Total | 3800 | pg/L |
| Outfall to Lower Silver Ck | PCB 110 | Total | 417000 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Outfall to Lower Silver Ck | PCB 110 | Total | 14300 | pg/L |
| Outfall to Lower Silver Ck | PCB 118 | Total | 3570 | pg/L |
| Outfall to Lower Silver Ck | PCB 118 | Total | 316000 | pg/L |
| Outfall to Lower Silver Ck | PCB 118 | Total | 12300 | pg/L |
| Outfall to Lower Silver Ck | PCB 128 | Total | 967 | pg/L |
| Outfall to Lower Silver Ck | PCB 128 | Total | 70700 | pg/L |
| Outfall to Lower Silver Ck | PCB 128 | Total | 2800 | pg/L |
| Outfall to Lower Silver Ck | PCB 132 | Total | 1600 | pg/L |
| Outfall to Lower Silver Ck | PCB 132 | Total | 142000 | pg/L |
| Outfall to Lower Silver Ck | PCB 132 | Total | 6000 | pg/L |
| Outfall to Lower Silver Ck | PCB 138 | Total | 5310 | pg/L |
| Outfall to Lower Silver Ck | PCB 138 | Total | 466000 | pg/L |
| Outfall to Lower Silver Ck | PCB 138 | Total | 17500 | pg/L |
| Outfall to Lower Silver Ck | PCB 141 | Total | 865 | pg/L |
| Outfall to Lower Silver Ck | PCB 141 | Total | 70800 | pg/L |
| Outfall to Lower Silver Ck | PCB 141 | Total | 3020 | pg/L |
| Outfall to Lower Silver Ck | PCB 149 | Total | 2690 | pg/L |
| Outfall to Lower Silver Ck | PCB 149 | Total | 230000 | pg/L |
| Outfall to Lower Silver Ck | PCB 149 | Total | 9890 | pg/L |
| Outfall to Lower Silver Ck | PCB 151 | Total | 874 | pg/L |
| Outfall to Lower Silver Ck | PCB 151 | Total | 85700 | pg/L |
| Outfall to Lower Silver Ck | PCB 151 | Total | 3490 | pg/L |
| Outfall to Lower Silver Ck | PCB 153 | Total | 3230 | pg/L |
| Outfall to Lower Silver Ck | PCB 153 | Total | 250000 | pg/L |
| Outfall to Lower Silver Ck | PCB 153 | Total | 11300 | pg/L |
| Outfall to Lower Silver Ck | PCB 156 | Total | 659 | pg/L |
| Outfall to Lower Silver Ck | PCB 156 | Total | 55700 | pg/L |
| Outfall to Lower Silver Ck | PCB 156 | Total | 2290 | pg/L |
| Outfall to Lower Silver Ck | PCB 158 | Total | 596 | pg/L |
| Outfall to Lower Silver Ck | PCB 158 | Total | 48000 | pg/L |
| Outfall to Lower Silver Ck | PCB 158 | Total | 1900 | pg/L |
| Outfall to Lower Silver Ck | PCB 170 | Total | 852 | pg/L |
| Outfall to Lower Silver Ck | PCB 170 | Total | 55500 | pg/L |
| Outfall to Lower Silver Ck | PCB 170 | Total | 2740 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Outfall to Lower Silver Ck | PCB 174 | Total | 735 | pg/L |
| Outfall to Lower Silver Ck | PCB 174 | Total | 50200 | pg/L |
| Outfall to Lower Silver Ck | PCB 174 | Total | 2500 | pg/L |
| Outfall to Lower Silver Ck | PCB 177 | Total | 426 | pg/L |
| Outfall to Lower Silver Ck | PCB 177 | Total | 28800 | pg/L |
| Outfall to Lower Silver Ck | PCB 177 | Total | 1400 | pg/L |
| Outfall to Lower Silver Ck | PCB 180 | Total | 1710 | pg/L |
| Outfall to Lower Silver Ck | PCB 180 | Total | 102000 | pg/L |
| Outfall to Lower Silver Ck | PCB 180 | Total | 5350 | pg/L |
| Outfall to Lower Silver Ck | PCB 183 | Total | 490 | pg/L |
| Outfall to Lower Silver Ck | PCB 183 | Total | 33300 | pg/L |
| Outfall to Lower Silver Ck | PCB 183 | Total | 1650 | pg/L |
| Outfall to Lower Silver Ck | PCB 187 | Total | 782 | pg/L |
| Outfall to Lower Silver Ck | PCB 187 | Total | 45400 | pg/L |
| Outfall to Lower Silver Ck | PCB 187 | Total | 2140 | pg/L |
| Outfall to Lower Silver Ck | PCB 194 | Total | 362 | pg/L |
| Outfall to Lower Silver Ck | PCB 194 | Total | 17900 | pg/L |
| Outfall to Lower Silver Ck | PCB 194 | Total | 963 | pg/L |
| Outfall to Lower Silver Ck | PCB 195 | Total | 127 | pg/L |
| Outfall to Lower Silver Ck | PCB 195 | Total | 6140 | pg/L |
| Outfall to Lower Silver Ck | PCB 195 | Total | 336 | pg/L |
| Outfall to Lower Silver Ck | PCB 201 | Total | 34.5 | pg/L |
| Outfall to Lower Silver Ck | PCB 201 | Total | 2310 | pg/L |
| Outfall to Lower Silver Ck | PCB 201 | Total | 128 | pg/L |
| Outfall to Lower Silver Ck | PCB 203 | Total | 186 | pg/L |
| Outfall to Lower Silver Ck | PCB 203 | Total | 9710 | pg/L |
| Outfall to Lower Silver Ck | PCB 203 | Total | 556 | pg/L |
| Ridder Park Dr SD | PCB 008 | Total | 8.91 | pg/L |
| Ridder Park Dr SD | PCB 018 | Total | 33.9 | pg/L |
| Ridder Park Dr SD | PCB 028 | Total | 82.8 | pg/L |
| Ridder Park Dr SD | PCB 031 | Total | 62.2 | pg/L |
| Ridder Park Dr SD | PCB 033 | Total | 32.6 | pg/L |
| Ridder Park Dr SD | PCB 044 | Total | 205 | pg/L |
| Ridder Park Dr SD | PCB 049 | Total | 98.1 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Ridder Park Dr SD | PCB 052 | Total | 336 | pg/L |
| Ridder Park Dr SD | PCB 056 | Total | 114 | pg/L |
| Ridder Park Dr SD | PCB 060 | Total | 58.5 | pg/L |
| Ridder Park Dr SD | PCB 066 | Total | 201 | pg/L |
| Ridder Park Dr SD | PCB 070 | Total | 432 | pg/L |
| Ridder Park Dr SD | PCB 087 | Total | 684 | pg/L |
| Ridder Park Dr SD | PCB 095 | Total | 1610 | pg/L |
| Ridder Park Dr SD | PCB 099 | Total | 341 | pg/L |
| Ridder Park Dr SD | PCB 101 | Total | 1860 | pg/L |
| Ridder Park Dr SD | PCB 105 | Total | 355 | pg/L |
| Ridder Park Dr SD | PCB 110 | Total | 1530 | pg/L |
| Ridder Park Dr SD | PCB 118 | Total | 865 | pg/L |
| Ridder Park Dr SD | PCB 128 | Total | 552 | pg/L |
| Ridder Park Dr SD | PCB 132 | Total | 1850 | pg/L |
| Ridder Park Dr SD | PCB 138 | Total | 5760 | pg/L |
| Ridder Park Dr SD | PCB 141 | Total | 1670 | pg/L |
| Ridder Park Dr SD | PCB 149 | Total | 5460 | pg/L |
| Ridder Park Dr SD | PCB 151 | Total | 2550 | pg/L |
| Ridder Park Dr SD | PCB 153 | Total | 5890 | pg/L |
| Ridder Park Dr SD | PCB 156 | Total | 388 | pg/L |
| Ridder Park Dr SD | PCB 158 | Total | 502 | pg/L |
| Ridder Park Dr SD | PCB 170 | Total | 2540 | pg/L |
| Ridder Park Dr SD | PCB 174 | Total | 3160 | pg/L |
| Ridder Park Dr SD | PCB 177 | Total | 1730 | pg/L |
| Ridder Park Dr SD | PCB 180 | Total | 6170 | pg/L |
| Ridder Park Dr SD | PCB 183 | Total | 2050 | pg/L |
| Ridder Park Dr SD | PCB 187 | Total | 3450 | pg/L |
| Ridder Park Dr SD | PCB 194 | Total | 1260 | pg/L |
| Ridder Park Dr SD | PCB 195 | Total | 510 | pg/L |
| Ridder Park Dr SD | PCB 201 | Total | 190 | pg/L |
| Ridder Park Dr SD | PCB 203 | Total | 911 | pg/L |
| Rock Springs Dr SD | PCB 008 | Total | 16.9 | pg/L |
| Rock Springs Dr SD | PCB 018 | Total | 22.4 | pg/L |
| Rock Springs Dr SD | PCB 028 | Total | 47.6 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Rock Springs Dr SD | PCB 031 | Total | 38.7 | pg/L |
| Rock Springs Dr SD | PCB 033 | Total | 27.8 | pg/L |
| Rock Springs Dr SD | PCB 044 | Total | 76.3 | pg/L |
| Rock Springs Dr SD | PCB 049 | Total | 34.7 | pg/L |
| Rock Springs Dr SD | PCB 052 | Total | 113 | pg/L |
| Rock Springs Dr SD | PCB 056 | Total | 33.1 | pg/L |
| Rock Springs Dr SD | PCB 060 | Total | 17.2 | pg/L |
| Rock Springs Dr SD | PCB 066 | Total | 60.3 | pg/L |
| Rock Springs Dr SD | PCB 070 | Total | 158 | pg/L |
| Rock Springs Dr SD | PCB 087 | Total | 295 | pg/L |
| Rock Springs Dr SD | PCB 095 | Total | 203 | pg/L |
| Rock Springs Dr SD | PCB 099 | Total | 153 | pg/L |
| Rock Springs Dr SD | PCB 101 | Total | 290 | pg/L |
| Rock Springs Dr SD | PCB 105 | Total | 203 | pg/L |
| Rock Springs Dr SD | PCB 110 | Total | 442 | pg/L |
| Rock Springs Dr SD | PCB 118 | Total | 406 | pg/L |
| Rock Springs Dr SD | PCB 128 | Total | 127 | pg/L |
| Rock Springs Dr SD | PCB 132 | Total | 190 | pg/L |
| Rock Springs Dr SD | PCB 138 | Total | 592 | pg/L |
| Rock Springs Dr SD | PCB 141 | Total | 95.4 | pg/L |
| Rock Springs Dr SD | PCB 149 | Total | 277 | pg/L |
| Rock Springs Dr SD | PCB 151 | Total | 107 | pg/L |
| Rock Springs Dr SD | PCB 153 | Total | 331 | pg/L |
| Rock Springs Dr SD | PCB 156 | Total | 79.1 | pg/L |
| Rock Springs Dr SD | PCB 158 | Total | 69 | pg/L |
| Rock Springs Dr SD | PCB 170 | Total | 97.1 | pg/L |
| Rock Springs Dr SD | PCB 174 | Total | 85.6 | pg/L |
| Rock Springs Dr SD | PCB 177 | Total | 48.6 | pg/L |
| Rock Springs Dr SD | PCB 180 | Total | 205 | pg/L |
| Rock Springs Dr SD | PCB 183 | Total | 59 | pg/L |
| Rock Springs Dr SD | PCB 187 | Total | 102 | pg/L |
| Rock Springs Dr SD | PCB 194 | Total | 68.8 | pg/L |
| Rock Springs Dr SD | PCB 195 | Total | 22.7 | pg/L |
| Rock Springs Dr SD | PCB 201 | Total | 8.34 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Rock Springs Dr SD | PCB 203 | Total | 49 | pg/L |
| Runnymede Ditch | PCB 008 | Total | 74.8 | pg/L |
| Runnymede Ditch | PCB 018 | Total | 177 | pg/L |
| Runnymede Ditch | PCB 028 | Total | 378 | pg/L |
| Runnymede Ditch | PCB 031 | Total | 284 | pg/L |
| Runnymede Ditch | PCB 033 | Total | 177 | pg/L |
| Runnymede Ditch | PCB 044 | Total | 586 | pg/L |
| Runnymede Ditch | PCB 049 | Total | 336 | pg/L |
| Runnymede Ditch | PCB 052 | Total | 865 | pg/L |
| Runnymede Ditch | PCB 056 | Total | 223 | pg/L |
| Runnymede Ditch | PCB 060 | Total | 113 | pg/L |
| Runnymede Ditch | PCB 066 | Total | 499 | pg/L |
| Runnymede Ditch | PCB 070 | Total | 1020 | pg/L |
| Runnymede Ditch | PCB 087 | Total | 1170 | pg/L |
| Runnymede Ditch | PCB 095 | Total | 1400 | pg/L |
| Runnymede Ditch | PCB 099 | Total | 884 | pg/L |
| Runnymede Ditch | PCB 101 | Total | 1630 | pg/L |
| Runnymede Ditch | PCB 105 | Total | 660 | pg/L |
| Runnymede Ditch | PCB 110 | Total | 2140 | pg/L |
| Runnymede Ditch | PCB 118 | Total | 1480 | pg/L |
| Runnymede Ditch | PCB 128 | Total | 425 | pg/L |
| Runnymede Ditch | PCB 132 | Total | 876 | pg/L |
| Runnymede Ditch | PCB 138 | Total | 2460 | pg/L |
| Runnymede Ditch | PCB 141 | Total | 431 | pg/L |
| Runnymede Ditch | PCB 149 | Total | 1760 | pg/L |
| Runnymede Ditch | PCB 151 | Total | 679 | pg/L |
| Runnymede Ditch | PCB 153 | Total | 1780 | pg/L |
| Runnymede Ditch | PCB 156 | Total | 268 | pg/L |
| Runnymede Ditch | PCB 158 | Total | 250 | pg/L |
| Runnymede Ditch | PCB 170 | Total | 490 | pg/L |
| Runnymede Ditch | PCB 174 | Total | 602 | pg/L |
| Runnymede Ditch | PCB 177 | Total | 315 | pg/L |
| Runnymede Ditch | PCB 180 | Total | 1430 | pg/L |
| Runnymede Ditch | PCB 183 | Total | 460 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Runnymede Ditch | PCB 187 | Total | 889 | pg/L |
| Runnymede Ditch | PCB 194 | Total | 537 | pg/L |
| Runnymede Ditch | PCB 195 | Total | 160 | pg/L |
| Runnymede Ditch | PCB 201 | Total | 98.4 | pg/L |
| Runnymede Ditch | PCB 203 | Total | 542 | pg/L |
| SD near Cooley Landing | PCB 008 | Total | 14.2 | pg/L |
| SD near Cooley Landing | PCB 008 | Total | 4590 | pg/L |
| SD near Cooley Landing | PCB 018 | Total | 32.2 | pg/L |
| SD near Cooley Landing | PCB 018 | Total | 5000 | pg/L |
| SD near Cooley Landing | PCB 028 | Total | 72.4 | pg/L |
| SD near Cooley Landing | PCB 028 | Total | 11400 | pg/L |
| SD near Cooley Landing | PCB 031 | Total | 51.6 | pg/L |
| SD near Cooley Landing | PCB 031 | Total | 8850 | pg/L |
| SD near Cooley Landing | PCB 033 | Total | 31.8 | pg/L |
| SD near Cooley Landing | PCB 033 | Total | 6190 | pg/L |
| SD near Cooley Landing | PCB 044 | Total | 78.7 | pg/L |
| SD near Cooley Landing | PCB 044 | Total | 15200 | pg/L |
| SD near Cooley Landing | PCB 049 | Total | 41.7 | pg/L |
| SD near Cooley Landing | PCB 049 | Total | 6970 | pg/L |
| SD near Cooley Landing | PCB 052 | Total | 105 | pg/L |
| SD near Cooley Landing | PCB 052 | Total | 22100 | pg/L |
| SD near Cooley Landing | PCB 056 | Total | 40.4 | pg/L |
| SD near Cooley Landing | PCB 056 | Total | 6840 | pg/L |
| SD near Cooley Landing | PCB 060 | Total | 20.7 | pg/L |
| SD near Cooley Landing | PCB 060 | Total | 3620 | pg/L |
| SD near Cooley Landing | PCB 066 | Total | 85.4 | pg/L |
| SD near Cooley Landing | PCB 066 | Total | 14800 | pg/L |
| SD near Cooley Landing | PCB 070 | Total | 156 | pg/L |
| SD near Cooley Landing | PCB 070 | Total | 29100 | pg/L |
| SD near Cooley Landing | PCB 087 | Total | 192 | pg/L |
| SD near Cooley Landing | PCB 087 | Total | 40300 | pg/L |
| SD near Cooley Landing | PCB 095 | Total | 225 | pg/L |
| SD near Cooley Landing | PCB 095 | Total | 56000 | pg/L |
| SD near Cooley Landing | PCB 099 | Total | 130 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| SD near Cooley Landing | PCB 099 | Total | 27100 | pg/L |
| SD near Cooley Landing | PCB 101 | Total | 258 | pg/L |
| SD near Cooley Landing | PCB 101 | Total | 54900 | pg/L |
| SD near Cooley Landing | PCB 105 | Total | 132 | pg/L |
| SD near Cooley Landing | PCB 105 | Total | 26300 | pg/L |
| SD near Cooley Landing | PCB 110 | Total | 419 | pg/L |
| SD near Cooley Landing | PCB 110 | Total | 89600 | pg/L |
| SD near Cooley Landing | PCB 118 | Total | 281 | pg/L |
| SD near Cooley Landing | PCB 118 | Total | 57500 | pg/L |
| SD near Cooley Landing | PCB 128 | Total | 112 | pg/L |
| SD near Cooley Landing | PCB 128 | Total | 29300 | pg/L |
| SD near Cooley Landing | PCB 132 | Total | 215 | pg/L |
| SD near Cooley Landing | PCB 132 | Total | 56800 | pg/L |
| SD near Cooley Landing | PCB 138 | Total | 703 | pg/L |
| SD near Cooley Landing | PCB 138 | Total | 190000 | pg/L |
| SD near Cooley Landing | PCB 141 | Total | 126 | pg/L |
| SD near Cooley Landing | PCB 141 | Total | 38000 | pg/L |
| SD near Cooley Landing | PCB 149 | Total | 479 | pg/L |
| SD near Cooley Landing | PCB 149 | Total | 131000 | pg/L |
| SD near Cooley Landing | PCB 151 | Total | 178 | pg/L |
| SD near Cooley Landing | PCB 151 | Total | 54200 | pg/L |
| SD near Cooley Landing | PCB 153 | Total | 479 | pg/L |
| SD near Cooley Landing | PCB 153 | Total | 146000 | pg/L |
| SD near Cooley Landing | PCB 156 | Total | 66.5 | pg/L |
| SD near Cooley Landing | PCB 156 | Total | 16300 | pg/L |
| SD near Cooley Landing | PCB 158 | Total | 72.6 | pg/L |
| SD near Cooley Landing | PCB 158 | Total | 18800 | pg/L |
| SD near Cooley Landing | PCB 170 | Total | 184 | pg/L |
| SD near Cooley Landing | PCB 170 | Total | 63900 | pg/L |
| SD near Cooley Landing | PCB 174 | Total | 205 | pg/L |
| SD near Cooley Landing | PCB 174 | Total | 72300 | pg/L |
| SD near Cooley Landing | PCB 177 | Total | 110 | pg/L |
| SD near Cooley Landing | PCB 177 | Total | 41000 | pg/L |
| SD near Cooley Landing | PCB 180 | Total | 473 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| SD near Cooley Landing | PCB 180 | Total | 144000 | pg/L |
| SD near Cooley Landing | PCB 183 | Total | 148 | pg/L |
| SD near Cooley Landing | PCB 183 | Total | 46600 | pg/L |
| SD near Cooley Landing | PCB 187 | Total | 262 | pg/L |
| SD near Cooley Landing | PCB 187 | Total | 88800 | pg/L |
| SD near Cooley Landing | PCB 194 | Total | 138 | pg/L |
| SD near Cooley Landing | PCB 194 | Total | 41900 | pg/L |
| SD near Cooley Landing | PCB 195 | Total | 44.8 | pg/L |
| SD near Cooley Landing | PCB 195 | Total | 15100 | pg/L |
| SD near Cooley Landing | PCB 201 | Total | 18.5 | pg/L |
| SD near Cooley Landing | PCB 201 | Total | 6010 | pg/L |
| SD near Cooley Landing | PCB 203 | Total | 91.7 | pg/L |
| SD near Cooley Landing | PCB 203 | Total | 28800 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 008 | Total | 98.9 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 018 | Total | 206 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 028 | Total | 283 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 031 | Total | 231 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 033 | Total | 169 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 044 | Total | 895 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 049 | Total | 401 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 052 | Total | 392 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 056 | Total | 141 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 060 | Total | 81.6 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 066 | Total | 238 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 070 | Total | 460 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 087 | Total | 498 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 095 | Total | 734 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 099 | Total | 335 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 101 | Total | 845 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 105 | Total | 234 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 110 | Total | 733 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 118 | Total | 438 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 128 | Total | 195 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 132 | Total | 520 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Seabord Ave SD SC-050GAC580 | PCB 138 | Total | 1610 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 141 | Total | 349 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 149 | Total | 1570 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 151 | Total | 811 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 153 | Total | 1380 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 156 | Total | 127 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 158 | Total | 143 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 170 | Total | 658 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 174 | Total | 762 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 177 | Total | 430 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 180 | Total | 1620 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 183 | Total | 488 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 187 | Total | 831 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 194 | Total | 456 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 195 | Total | 180 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 201 | Total | 63.7 | pg/L |
| Seabord Ave SD SC-050GAC580 | PCB 203 | Total | 308 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 008 | Total | 26.9 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 018 | Total | 48.4 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 028 | Total | 96.6 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 031 | Total | 75.5 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 033 | Total | 47.7 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 044 | Total | 252 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 049 | Total | 150 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 052 | Total | 386 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 056 | Total | 73.6 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 060 | Total | 33.5 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 066 | Total | 161 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 070 | Total | 380 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 087 | Total | 555 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 095 | Total | 630 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 099 | Total | 365 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 101 | Total | 728 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 105 | Total | 295 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Seabord Ave SD SC-050GAC600 | PCB 110 | Total | 959 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 118 | Total | 649 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 128 | Total | 193 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 132 | Total | 404 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 138 | Total | 1190 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 141 | Total | 245 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 149 | Total | 872 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 151 | Total | 348 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 153 | Total | 936 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 156 | Total | 127 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 158 | Total | 123 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 170 | Total | 315 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 174 | Total | 417 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 177 | Total | 216 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 180 | Total | 833 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 183 | Total | 291 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 187 | Total | 529 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 194 | Total | 211 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 195 | Total | 77.3 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 201 | Total | 40.4 | pg/L |
| Seabord Ave SD SC-050GAC600 | PCB 203 | Total | 192 | pg/L |
| South Linden PS | PCB 018 | Total | 21.7 | pg/L |
| South Linden PS | PCB 028 | Total | 48.5 | pg/L |
| South Linden PS | PCB 031 | Total | 38.8 | pg/L |
| South Linden PS | PCB 033 | Total | 17.5 | pg/L |
| South Linden PS | PCB 044 | Total | 73.2 | pg/L |
| South Linden PS | PCB 049 | Total | 35.3 | pg/L |
| South Linden PS | PCB 052 | Total | 107 | pg/L |
| South Linden PS | PCB 056 | Total | 39.4 | pg/L |
| South Linden PS | PCB 060 | Total | 22 | pg/L |
| South Linden PS | PCB 066 | Total | 76.1 | pg/L |
| South Linden PS | PCB 070 | Total | 165 | pg/L |
| South Linden PS | PCB 087 | Total | 207 | pg/L |
| South Linden PS | PCB 095 | Total | 200 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| South Linden PS | PCB 099 | Total | 122 | pg/L |
| South Linden PS | PCB 101 | Total | 257 | pg/L |
| South Linden PS | PCB 105 | Total | 131 | pg/L |
| South Linden PS | PCB 110 | Total | 360 | pg/L |
| South Linden PS | PCB 118 | Total | 276 | pg/L |
| South Linden PS | PCB 128 | Total | 110 | pg/L |
| South Linden PS | PCB 132 | Total | 156 | pg/L |
| South Linden PS | PCB 138 | Total | 539 | pg/L |
| South Linden PS | PCB 141 | Total | 105 | pg/L |
| South Linden PS | PCB 149 | Total | 362 | pg/L |
| South Linden PS | PCB 151 | Total | 145 | pg/L |
| South Linden PS | PCB 153 | Total | 431 | pg/L |
| South Linden PS | PCB 156 | Total | 52.8 | pg/L |
| South Linden PS | PCB 158 | Total | 58.5 | pg/L |
| South Linden PS | PCB 170 | Total | 142 | pg/L |
| South Linden PS | PCB 174 | Total | 214 | pg/L |
| South Linden PS | PCB 177 | Total | 105 | pg/L |
| South Linden PS | PCB 180 | Total | 721 | pg/L |
| South Linden PS | PCB 183 | Total | 202 | pg/L |
| South Linden PS | PCB 187 | Total | 583 | pg/L |
| South Linden PS | PCB 194 | Total | 682 | pg/L |
| South Linden PS | PCB 195 | Total | 90.5 | pg/L |
| South Linden PS | PCB 201 | Total | 93.4 | pg/L |
| South Linden PS | PCB 203 | Total | 824 | pg/L |
| Veterans PS | PCB 008 | Total | 3.98 | pg/L |
| Veterans PS | PCB 018 | Total | 17.1 | pg/L |
| Veterans PS | PCB 028 | Total | 27 | pg/L |
| Veterans PS | PCB 031 | Total | 20.4 | pg/L |
| Veterans PS | PCB 033 | Total | 8.94 | pg/L |
| Veterans PS | PCB 044 | Total | 36.2 | pg/L |
| Veterans PS | PCB 049 | Total | 23 | pg/L |
| Veterans PS | PCB 052 | Total | 61.5 | pg/L |
| Veterans PS | PCB 056 | Total | 17.3 | pg/L |
| Veterans PS | PCB 060 | Total | 9.45 | pg/L |

| Sampling Location | Analyte Name | Fraction Name | Result | Unit |
|---|---|---|---|---|
| Veterans PS | PCB 066 | Total | 33.5 | pg/L |
| Veterans PS | PCB 070 | Total | 77 | pg/L |
| Veterans PS | PCB 087 | Total | 112 | pg/L |
| Veterans PS | PCB 095 | Total | 118 | pg/L |
| Veterans PS | PCB 099 | Total | 91.3 | pg/L |
| Veterans PS | PCB 101 | Total | 160 | pg/L |
| Veterans PS | PCB 105 | Total | 78.4 | pg/L |
| Veterans PS | PCB 110 | Total | 227 | pg/L |
| Veterans PS | PCB 118 | Total | 164 | pg/L |
| Veterans PS | PCB 128 | Total | 60.2 | pg/L |
| Veterans PS | PCB 132 | Total | 94.2 | pg/L |
| Veterans PS | PCB 138 | Total | 379 | pg/L |
| Veterans PS | PCB 141 | Total | 66.1 | pg/L |
| Veterans PS | PCB 149 | Total | 210 | pg/L |
| Veterans PS | PCB 151 | Total | 83.8 | pg/L |
| Veterans PS | PCB 153 | Total | 316 | pg/L |
| Veterans PS | PCB 156 | Total | 42.8 | pg/L |
| Veterans PS | PCB 158 | Total | 31.5 | pg/L |
| Veterans PS | PCB 170 | Total | 97.9 | pg/L |
| Veterans PS | PCB 174 | Total | 97.3 | pg/L |
| Veterans PS | PCB 177 | Total | 54.6 | pg/L |
| Veterans PS | PCB 180 | Total | 287 | pg/L |
| Veterans PS | PCB 183 | Total | 73.5 | pg/L |
| Veterans PS | PCB 187 | Total | 140 | pg/L |
| Veterans PS | PCB 194 | Total | 86.6 | pg/L |
| Veterans PS | PCB 195 | Total | 25 | pg/L |
| Veterans PS | PCB 201 | Total | 13.4 | pg/L |
| Veterans PS | PCB 203 | Total | 74.7 | pg/L |

## Table B2. Grain size results data appendix.

| Sampling Location | <0.0039 mm | 0.0039 to <0.0625 mm | <0.0625 mm | 0.0625 to <2.0 mm | 2.0 to <64 mm | V. Fine 0.0625 to <0.125 mm | Fine 0.125 to <0.25 mm | Medium 0.25 to <0.5 mm | Coarse 0.5 to <1.0 mm | V. Coarse 1.0 to <2.0 mm |
|---|---|---|---|---|---|---|---|---|---|---|
| Charcot Ave SD | 11.2 | 29.2 | 40.4 | 7.03 | 0.000 | 4.12 | 1.34 | 1.22 | 0.341 | 0.000 |
| Ridder Park Dr SD | 39.3 | 26.4 | 65.7 | 1.36 | 0.000 | 0.194 | 0.682 | 0.428 | 0.0537 | 0.000 |
| E. Gish Rd SD | 23.5 | 34.7 | 58.1 | 0.345 | 0.000 | 0.345 | 0.000 | 0.000 | 0.000 | 0.000 |
| Seabord Ave SD SC-050GAC580 | 10.3 | 16.0 | 26.3 | 0.0633 | 0.000 | 0.0633 | 0.000 | 0.000 | 0.000 | 0.000 |
| Seabord Ave SD SC-050GAC600 | 1.89 | 3.35 | 5.24 | 0.107 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Line-3A-M at 3A-D | 16.7 | 7.82 | 24.5 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Line4-B-1 | 37.5 | 68.5 | 106.0 | 16.3 | 0.000 | 10.5 | 5.18 | 0.646 | 0.000 | 0.000 |
| Line4-E | 36.0 | 54.2 | 90.2 | 0.117 | 0.000 | 0.117 | 0.000 | 0.000 | 0.000 | 0.000 |
| Line3A-M-1 at Industrial PS | 13.0 | 22.0 | 35.0 | 7.88 | 0.000 | 3.25 | 3.37 | 1.26 | 0.000 | 0.000 |
| SD near Cooley Landing | 17.3 | 23.9 | 41.3 | 0.0260 | 0.000 | 0.0260 | 0.000 | 0.000 | 0.000 | 0.000 |
| Rock Springs Dr SD | 1.17 | 2.19 | 3.36 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Gateway Ave SD | 0.380 | 0.681 | 1.06 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Lower Penitencia Ck | 37.5 | 58.8 | 96.3 | 2.02 | 0.000 | 1.11 | 0.904 | 0.00727 | 0.000 | 0.000 |
| Outfall to Lower Silver Ck | 7.34 | 7.52 | 14.9 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Meeker Slough | 4.85 | 9.77 | 14.6 | 0.437 | 0.000 | 0.437 | 0.000 | 0.000 | 0.000 | 0.000 |
| Oddstad PS | 9.89 | 17.0 | 26.9 | 84.1 | 0.000 | 10.0 | 17.0 | 21.0 | 26.3 | 9.78 |
| Runnymede Ditch | 57.7 | 111 | 169 | 4.89 | 0.000 | 4.87 | 0.0243 | 0.000 | 0.000 | 0.000 |
| Line9-D | 3.39 | 5.25 | 8.64 | 2.10 | 0.000 | 0.621 | 0.914 | 0.325 | 0.244 | 0.000 |
| South Linden PS | 2.64 | 3.97 | 6.61 | 0.00927 | 0.000 | 0.00927 | 0.000 | 0.000 | 0.000 | 0.000 |
| Veterans PS | 0.0348 | 0.0503 | 0.0851 | 6.98 | 0.000 | 0.229 | 2.52 | 4.23 | 0.000 | 0.000 |

# Appendix 6

Proposed Alternative Approach to Pollutants of Concern
and Long Term Trends Monitoring, July 23, 2014

CONTRA COSTA
CLEAN WATER
PROGRAM

**Thomas E. Dalziel**
**Program Manager**

July 23, 2014

Mr. Bruce Wolfe, Executive Officer
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San Francisco Bay Region
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Oakland, CA 94612

Ms. Pamela Creedon, Executive Officer
California Regional Water Quality Control Board
Central Valley Region
Sacramento Office
11020 Sun Center Drive, Suite 200
Rancho Cordova, CA 95670-6114

**Subject: Proposed Alternative Approach to Pollutants of Concern and Long Term Trends Monitoring**

Dear Mr. Wolfe and Ms. Creedon:

The Contra Costa Clean Water Program (CCCWP) respectfully submits this letter to formally request approval of an alternative approach to Pollutants of Concern and Long Term Trends Monitoring. This monitoring program is required under Provision C.8.e of the National Pollutant Discharge Elimination System (NPDES) permits for urban stormwater discharges issued to CCCWP Permittees by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) and the Central Valley Regional Water Quality Control Board (CVRWQCB) in Order No. R2-2009-0074 and Order No. R5-2010-0102, respectively. Our proposal is to:

1) Sample no more than two more storms at the existing Marsh Creek POC loads station for mercury, methylmercury, and SSC only. The sampling would be timed to capture upper watershed flow (i.e., flow from the Marsh Creek Reservoir).
2) Conduct PCB source identification studies, following the approach proposed in the Integrated Monitoring Report, Part C.
3) Increase the number of LID effectiveness evaluation samples collected and analyzed as part of the approved methylmercury control study plan.

Resources saved under item #1 above, would be used to identify source areas of polychlorinated biphenyls (PCBs) in response to SFBRWQCB information needs (#2 above), and to collect and analyze additional Low Impact Development (LID) effectiveness evaluation samples (#3 above) in response to CVRWQCB information needs.

Details on the background and rationale for this proposal appear below.

## Background on the Current C.8.e Monitoring Approach

Contra Costa County is divided between the jurisdictions of the SFBRWQCB and the CVRWQCB. Historically, the NPDES stormwater permits issued by each Regional Board to CCCWP Permittees within their respective jurisdictions have had nearly identical provisions, to promote a coordinated countywide program of water quality management. Subsequent to the issuance of the Municipal Regional Permit (MRP, Order No. R2-2009-0074) by the SFBRWQCB in 2009, additional coordination between CCCWP, SFBRWQCB, and CVRWQCB staff helped develop coordinated permit language for Eastern Contra Costa County Permittees (East County Permit, Order No. R5-2010-0102). The coordination promoted efficient use of countywide resources for water quality monitoring addressing the needs of both Regional Boards.

Provision C.8.e in both the MRP and the East County Permit requires monitoring to quantify annual loads and long term trends for pollutants of concern (POCs) in tributaries that flow to San Francisco Bay (the Bay) and the Sacramento San Joaquin River Delta (the Delta). POCs are constituents that are known or suspected to cause or contribute to impairment of receiving water quality, including constituents with established Total Maximum Daily Loads (TMDLs).

TMDLs have been established for mercury and polychlorinated biphenyls (PCBs) in San Francisco Bay. A TMDL for mercury and methylmercury has been established for the Delta. The SFBRWQCB has adopted a TMDL for pesticides in urban creeks that has been approved by the United States Environmental Protection Agency (USEPA). The CVRWQCB is developing a TMDL for diazinon and chlorpyrifos in the Central Valley, as well as a separate TMDL for pyrethroid pesticides in the Central Valley. Thus, the primary POCs as defined by TMDLs adopted or under development are mercury (including methylmercury), PCBs, and pesticides (including, but not limited to diazinon, chlorpyrifos, and pyrethroids).

In addition to POCs with existing or pending TMDLs, the SFBRWQCB and the CVRWQCB have required through Provision C.8.e monitoring information for Total and Dissolved Copper; Suspended Sediments Concentrations (SSC); Total Organic Carbon; Water Column Toxicity; Nitrate; Phosphorous; Hardness; Total and Dissolved Selenium; Total Polybrominated Diphenyl Ethers (PBDEs); Total Poly-Aromatic Hydrocarbons (PAHs); Bedded Sediment Toxicity; and, Pollutants in fine-grained bedded sediments.

Both the MRP and the East County Permit include the following language allowing an alternative approach to the specific details proposed in Provision C.8.e:

*Permittees shall implement the following POC monitoring components or pursue an alternative approach that addresses each of the aforementioned management information needs. An alternative approach may be pursued by Permittees provided that: either similar data types, data quality, data quantity are collected with an equivalent level of effort described; or an equivalent level of monitoring effort is employed to answer the management information needs. The alternative approach may be an inter-regional effort designed to improve measurement and estimation of pollutant loads to the Bay/Delta from small tributaries.*

During the first term of the MRP, CCCWP joined with other members of the Bay Area Stormwater Management Agencies Association (BASMAA) in a regional collaboration to develop and implement an alternative approach to Provision C.8.e, with buy-in from SFBRWQCB staff[1]. The forum for discussing and managing the alternative approach to C.8.e monitoring is referred to as the Small Tributaries Loading Strategy (STLS) Workgroup, which is a subcommittee of the RMP's Sources, Pathways and Loadings Workgroup. Stakeholders involved in the STLS include BASMAA representatives, staff of the San Francisco Estuary Institute, and staff of the SFBRWQCB.

Marsh Creek was one of two locations selected by the STLS for monitoring in fulfillment of Provision C.8.e. Marsh Creek drains over 60,000 acres. It is comprised of an upper and lower watershed, because of the Marsh Creek Reservoir, which is designed to provide stormwater detention for flood protection of downstream areas. Flows from the upper watershed only reach the lower watershed intermittently, after late season storms saturate ground levels and fill the reservoir sufficiently to initiate flows from the primary spillway. When only the lower watershed is sampled during lighter, more frequent storm events, the flows are dominated by urban runoff from the surrounding communities. Marsh Creek was selected based on the following rationale:

- The Mount Diablo Mercury mine site is located in the upper watershed of Marsh Creek. Mercury and methylmercury have been previously monitored in the upper watershed by other parties, with support from Contra Costa County Department of Public Works (Slotton et al, 1998); however, prior to the implementation of C.8.e monitoring under the MRP and the East County Permit, no data have been available on mercury loads into lower Marsh Creek.
- Mercury loads discharged from Marsh Creek affect both the Delta and the Bay because the Bay is downstream of the Delta; therefore, mercury loads monitoring at Marsh Creek is responsive to TMDLs established for both the Bay and for the Delta.
- The urbanized areas of the lower Marsh Creek watershed are predominantly new residential and commercial areas; PCBs monitoring at this location was expected to verify the working hypothesis that newer urban areas have lower PCB yields per unit area compared to older urban or older industrial areas.

[1] The Alternative Approach agreed to by the BASMAA regional collaboration included monitoring at Marsh Creek, which is located in the Central Valley Region, to count towards one of the required locations in the San Francisco Bay Region. Since this was not a change from the original East County Permit requirements, buy-in from CVRWQCB staff was not needed.

- Marsh Creek is the second largest watershed in Contra Costa County, after Walnut Creek.

The second location monitored in Contra Costa County in fulfillment of Provision C.8.e. is the North Richmond Stormwater Pumping Station (NRSPS). The NRSPS provides flood protection for a 900 acre watershed. That location was monitored as a special study of the San Francisco Bay Regional Monitoring Program (RMP). The rationale for monitoring at the NRSPS was:

- The NRSPS is also the location where an MRP-required pilot study is being conducted to evaluate the feasibility and potential benefits of diverting urban stormwater into sanitary sewers. Establishing current POC loads in the watershed is helpful to putting the results of the pilot study into context.
- The watershed served by the NRSPS is a mixture of older urban and older industrial areas; therefore, the PCB yields per unit area would be expected to be higher as compared to newer urban areas such as lower Marsh Creek Watershed.

## Rationale for a New C.8.e Monitoring Approach

The rationale for a new monitoring approach in response to Provision C.8.e is based on a review of lessons learned from the monitoring performed to date. Those lessons learned are framed in the context of the following four priority management information needs identified in both the MRP and the East County Permit:

1) Identifying which Bay and Delta tributaries (including stormwater conveyances) contribute most to Bay and Delta impairment from pollutants of concern;
2) Quantifying annual loads or concentrations of pollutants of concern from tributaries to the Bay and Delta;
3) Quantifying the decadal-scale loading or concentration trends of pollutants of concern from small tributaries to the Bay and Delta; and
4) Quantifying the projected impacts of management actions (including control measures) on tributaries and identifying where these management actions should be implemented to have the greatest beneficial impact.

The state of knowledge regarding each management question is summarized below. Detailed results are available in CCCWP's Integrated Monitoring Report, Part A, Appendix A-7 (Pollutants of Concern Loads Monitoring Data Progress Report, Water Years 2012 and 2013), and CCCWP's Integrated Monitoring Report, Part C (Pollutants of Concern Implementation Plan). Both of these documents were submitted to the SFBRWQCB and the CVRWQCB in March, 2014, in fulfillment of Provisions C.8.g of the MRP and the East County Permit.

## Question 1: Which tributaries contribute the most to impairment from POCs?

Tributaries draining watersheds with large areas of old industrial and old urban land uses have the greatest contribution of PCBs per unit area, as compared to new urban and open space land uses. This has been well-documented by the monitoring results that were outcomes of the C.8.e monitoring approach agreed to by the STLS. As expected, the older urban and older industrial land use of the NRSPS watershed has a higher PCB annual load per unit area (yield) as compared to the lower Marsh Creek watershed.

In contrast to PCBs, mercury yields are more consistent regionally among different land use types. Older industrial areas still have somewhat higher yields compared to new urban and open spaces; however, the difference among land uses for mercury yields is two-fold or three-fold, rather than orders of magnitude, as with PCBs. Legacy mercury mines are known to have a direct impact on mercury yields; this has been shown in the case of the New Almaden Mercury Mine in the Guadalupe River watershed.

We don't have enough information yet about upper Marsh Creek watershed flows to characterize whether or not the Mount Diablo Mercury Mine site significantly affects mercury and methylmercury yields in that watershed. Due to very dry conditions over the past several years, upper watershed flows were only sampled once for mercury, methylmercury and SSC (out of thirty grab samples for total mercury and sixteen grab samples for methylmercury). CCCWP recommends waiting for upper watershed flow before collecting any more stormwater grab samples from Marsh Creek for mercury or methylmercury.

The MRP and the East County Permit require an average of four storms per year. A numeric requirement for storms per year sampled promotes sampling smaller, more high frequency storms. The rationale for revising the numeric requirement for storms sampled is that we have enough information on lower watershed flows that are dominated by urban runoff. It is a better use of CCCWP monitoring resources, and more responsive to this management question, to wait for upper watershed flows that have much longer recurrence intervals.

**Question 2: What are annual POC loads?**

Annual POC loads are estimated using a Regional Watershed Spreadsheet Model (RWSM). The model uses POC yields based on land use to estimate loads. That modeling effort has been under way for several years, and an initial draft report on model results has been reviewed by the STLS. The POC loads monitoring approach implemented by the STLS was aimed at improving estimates derived from the RWSM. Findings of the initial modeling report suggest that further refinement and improvement of the model may not be warranted – we have enough information about source areas of POCs to cease the base of watershed tributary monitoring approach and move monitoring closer to source areas.

**Question 3: What is the decadal scale loading trend for POCs?**

To characterize the change in POC loads over time, it is not necessary or appropriate to monitor tributaries annually. Decadal scale changes will be best detected after one to two decades of focused implementation on POC load reduction projects. A key lesson learned during the past four years of implementing pilot projects required by the MRP is that attaining aggressive TMDL goals for POCs, such as the mandated ninety percent reduction in PCB loadings required by the San Francisco Bay TMDL would require implementation of widespread stormwater treatment retrofits in developed areas. Such a massive scale of stormwater treatment is beyond the existing engineering and economic capacity of Permittees. Attainment of such far-reaching load reductions would require development of new revenue programs to fund stormwater quality improvement. This represents a significant undertaking that Permittees are currently exploring through negotiation of the reissuance of the MRP.

Rather than monitoring annually in tributaries to detect change, CCCWP proposes that it is better to measure progress by assessing the amount of urban stormwater that was treated prior to adoption of TMDLs, and modeling the benefits of new stormwater treatment based on effectiveness assessments at a limited number of representative treatment systems. Over time, as stormwater treatment is implemented and more areas of urban hardscape are disconnected from direct, untreated discharges to receiving waters, the cumulative POC load reduction benefit can be quantified based on the measured effectiveness at representative stormwater treatment systems and the amount of stormwater treated.

**Question 4: What is the projected impact of control measures and where should control measures be implemented?**

Results reported in the Integrated Monitoring Report, Part A, document some good news related to this question for pesticides, which is that source control works. Diazinon and chlorpyrifos were re-registered to restrict use to registered professional applicators. Diazinon and chlorpyrifos are now consistently below water quality objectives in Marsh Creek, and acute toxicity to the water flea *daphnia magna* (an organism highly sensitive to diazinon and chlorpyrifos) has been essentially eliminated.

We have detected toxicity to the benthic amphipod *hyalella azteca* at a number of locations. CCCWP is currently conducting a Stressor-Source Identification Study (SSID) to determine the causes of toxicity. Preliminary results confirm the working hypothesis that pyrethroid pesticides cause the observed toxicity. Following the model of diazinon and chlorpyrifos, the answer to "where should control measures be implemented?" is "at the source – producers." Consequently, CCCWP will work with BASMAA and members of the California Association of Stormwater Agencies (CASQA) to lobby for re-registration of pyrethroid pesticides, building on lessons learned from diazinon and chlorpyrifos. This approach is responsive to TMDLs for pesticides established by the SFBRWQCB and the CVRWQCB.

For PCBs, CCCWP has proposed in our Integrated Monitoring Report, Part C an approach to identifying PCB source areas where source control is expected to yield PCB load reduction benefits. Some "high opportunity areas" have already been identified in old industrial areas of Richmond; additional areas may be identified through this source identification approach. CCCWP recommends that this source-oriented approach is the most productive path forward to address goals established by the San Francisco Bay PCBs TMDL.

Stormwater treatment retrofits applied to older urban areas to attain PCB load reduction goals will also address mercury load reduction goals. The preferred approach to stormwater treatment in Contra Costa County is Low Impact Development (LID). However, the benefits of LID for reducing methylmercury loads have not been evaluated, either in Contra Costa County or in any scientific literature.

CCCWP has proposed to evaluate the benefits of LID for methylmercury load reduction through the Methylmercury Control Study Plan submitted to the CVRWQCB. Comments received from CVRWQCB staff indicate that an increased level of LID effectiveness evaluation is desirable; therefore, CCCWP proposes to increase the level of monitoring effort for LID effectiveness in the methylmercury control study, to better quantify the projected impact of control measures.

**Summary**

In conclusion, CCCWP's recommended alternative approach to C.8.e monitoring in the MRP and the East County Permit are as follows:

1) Sample no more than two more storms at the existing Marsh Creek POC loads station for mercury, methylmercury, and SSC only. The sampling would be timed to capture upper watershed flow (i.e., flow from the Marsh Creek Reservoir).
2) Conduct PCB source identification studies, following the approach proposed in the Integrated Monitoring Report, Part C.
3) Increase the number of LID effectiveness evaluation samples collected and analyzed for the approved Methylmercury Control Study Plan.

If you have any questions or concerns, please don't hesitate to contact me at (925) 313-2392, tdalz@pw.cccounty.us.

Sincerely,

Thomas E. Dalziel
Program Manager
Contra Costa Clean Water Program

cc: Selina Louie, Richard Looker, Thomas Mumley (SFBRWQCB)
Genevieve Sparks, Janice Cooke (CVRWQCB)

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# Appendix 7

Pollutants of Concern Sediment Screening 2015
Annual Sampling and Analysis Report

# Contra Costa Clean Water Program

## Pollutants of Concern Sediment Screening
## 2015 Annual Sampling and Analysis Report

March 4, 2016

***Submitted to:***


Contra Costa Clean Water Program
255 Glacier Drive
Martinez, California 94553


***Submitted by:***


ADH Environmental
3065 Porter Street, Suite 101
Soquel, California 95073

# 1.0 INTRODUCTION

The Contra Costa Clean Water Program (CCCWP) began implementation of an ongoing sediment screening study in spring 2015 to address the Pollutants of Concern (POC) monitoring requirement of the California Regional Water Quality Control Board San Francisco Bay Region Municipal Regional Stormwater NPDES Permit (MRP)[1]. Sampling locations were selected in public right-of-ways, or on private property adjacent to public right of ways, known or suspected of having high opportunity for PCB/mercury control. CCCWP permittees provided information on historic and present day land use, prior monitoring results, and other information to assist CCCWP in developing target sampling locations.

Prior to sample collection, desktop reconnaissance and windshield surveys were conducted to inform the monitoring approach and assist in sampling logistics. Much of the sampling and analysis procedures of this present work originated from the BASMAA Clean Watersheds for a Clean Bay Task 3 study[2].

Samples were screened for 1) total PCB congeners using EPA Method 8082A; 2) total mercury; 3) total organic carbon; and 4) particle size distribution. For quality control/quality assurance purposes, blind field duplicate samples were collected and analyzed, and a selection of samples with PCB congener results above 100 ppb were reanalyzed with a more rigorous test method (EPA Method 1668C).

Figures 1 through 4 provide a geographical overview of the 57 sampling locations throughout Contra Costa County that were sampled between April and September 2015.

[1] California Regional Water Quality Control Board San Francisco Bay Region Municipal Regional Stormwater NPDES Permit, Order No. R2-2015-0049, November 19, 2015.
[2] Sampling and Analysis Plan, Bay Area Stormwater Management Agencies Association Clean Watersheds for a Clean Bay - Implementing the San Francisco Bay's PCBs and Mercury TMDLs with a Focus on Urban Runoff, Task 3. Prepared by Applied Marine Sciences. September 4, 2012.

**Figure 1. Sampling Locations – West County**

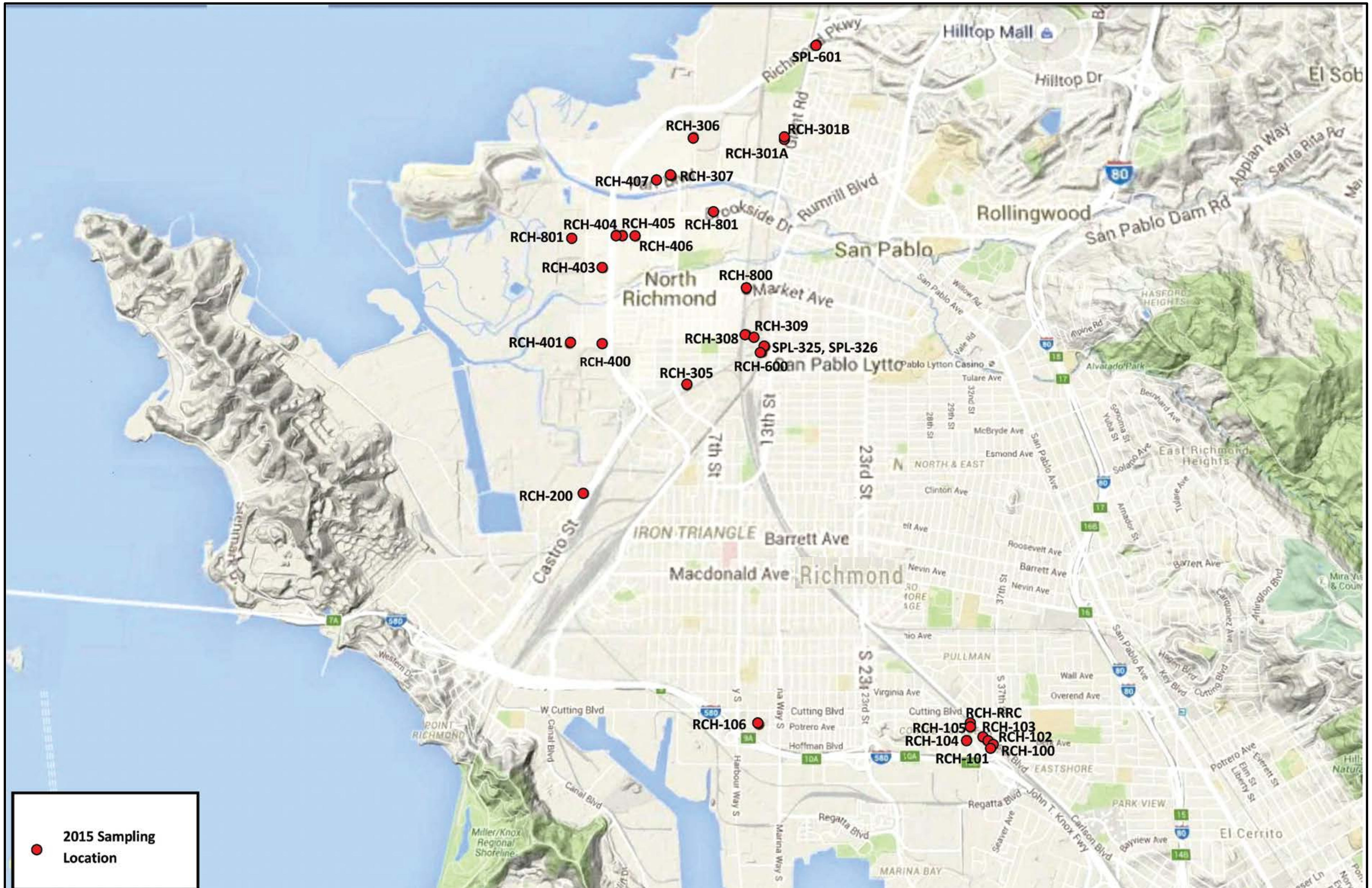


**Figure 2. Sampling Locations – Northwest County**

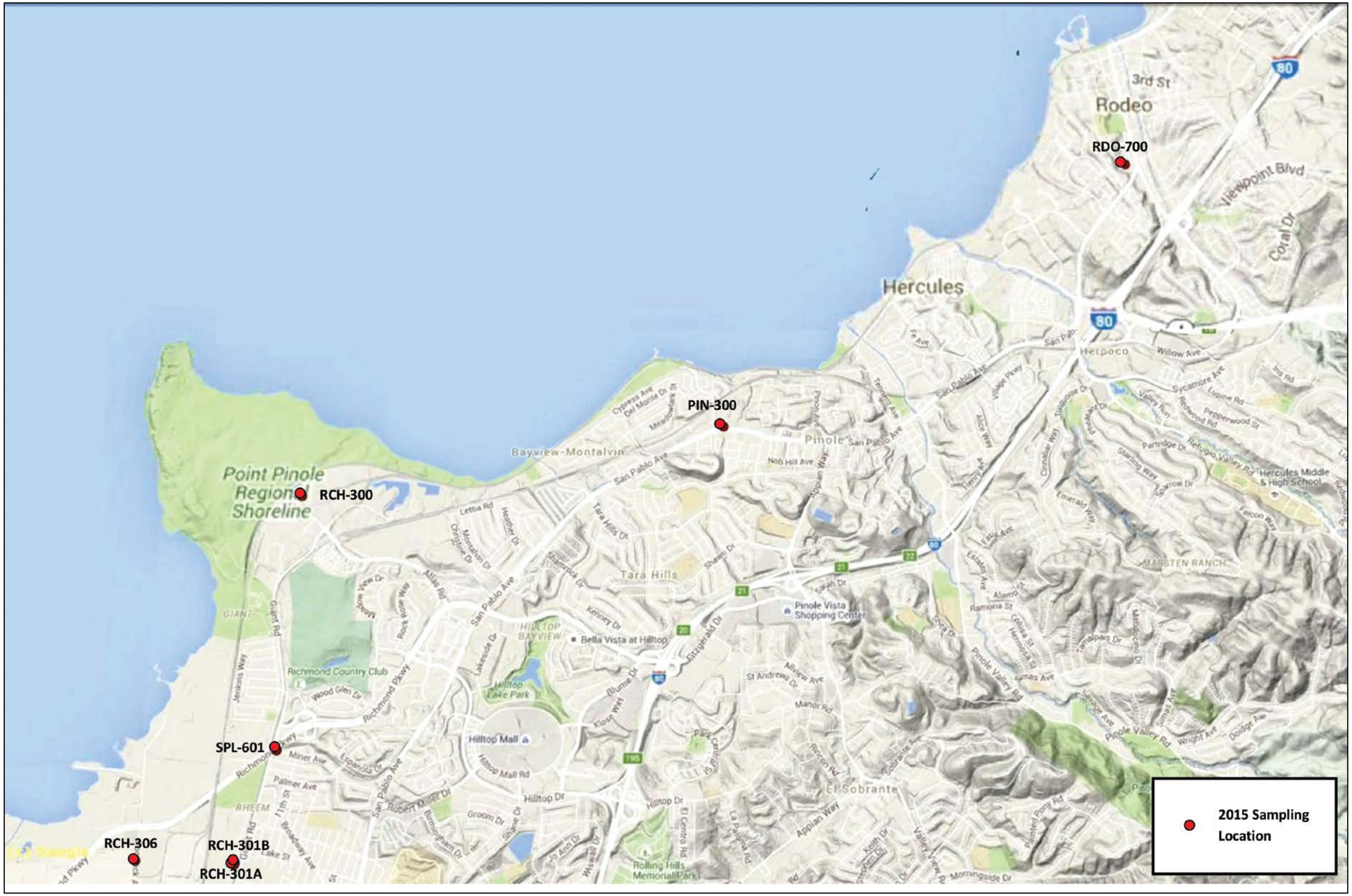


**Figure 3. Sampling Locations – North County**

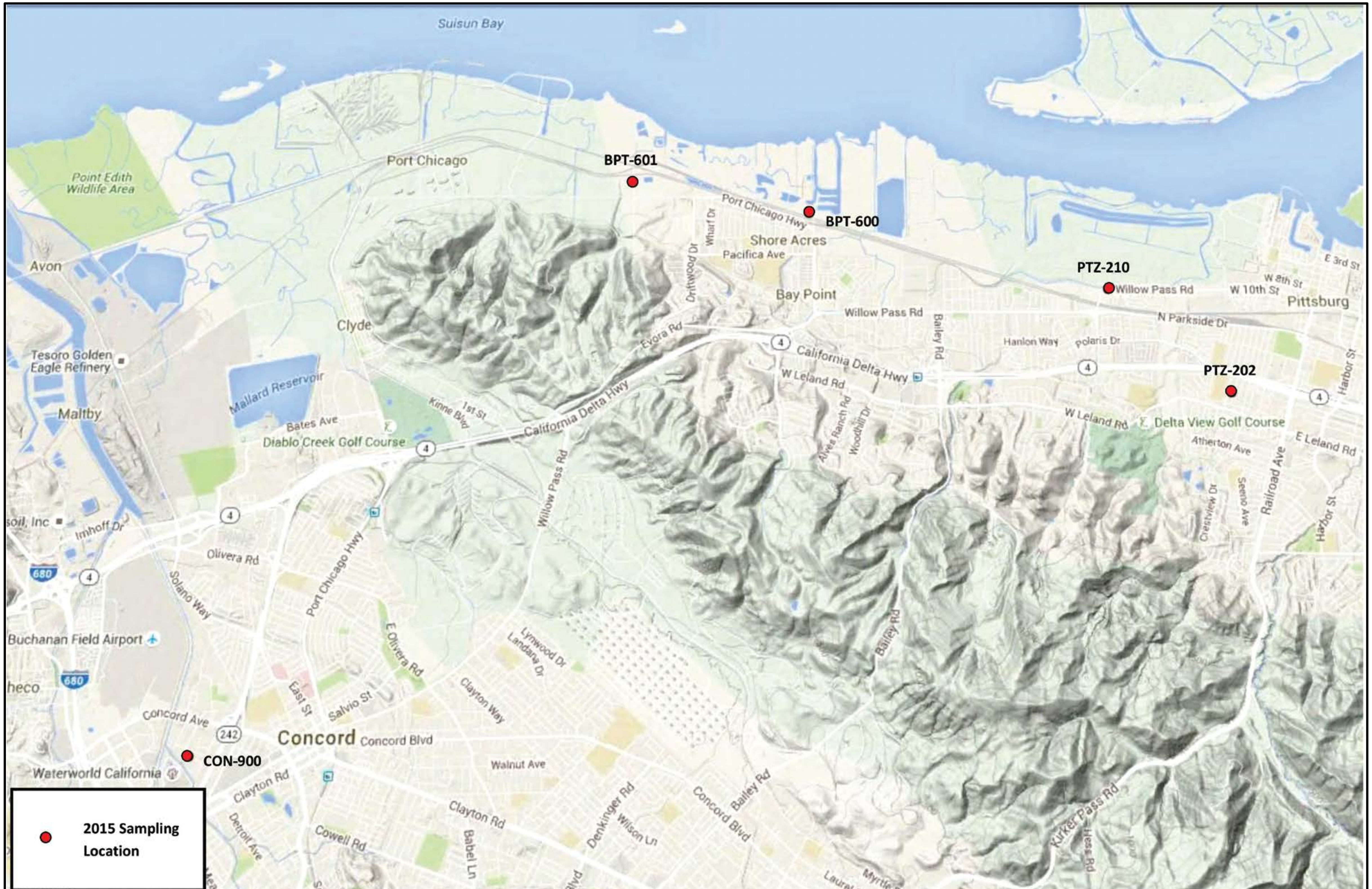
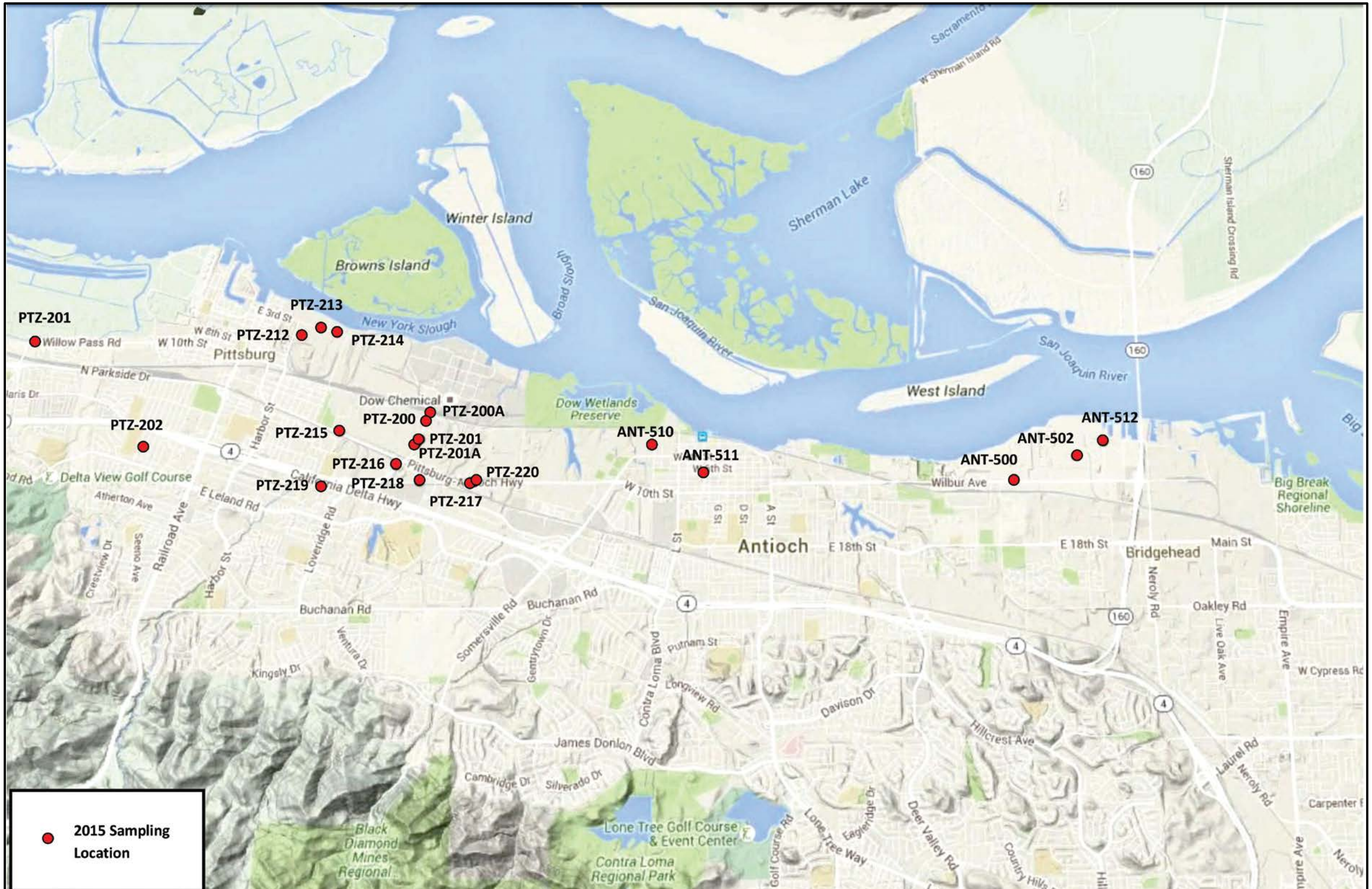


**Figure 4. Sampling Locations – Northeast County**



# 2.0 METHODS

The monitoring contractor for CCCWP, ADH Environmental (ADH), implemented the desktop reconnaissance, windshield survey and sampling work under the direction of CCCWP. The following subsections briefly describe field and laboratory methods that were followed in the implementation of this study. For further detail, please refer to the project SAP[3] and QAPP[4].

## 2.1 Field Methods

General sampling locations adjacent to or within suspected source properties were identified during the desktop reconnaissance and windshield survey phases. Exact sediment sampling locations were determined in the field at the time of sampling based on sediment availability, site accessibility, signs of sediment accumulation/erosion, visible signs of potential contamination (e.g., stained soils), and topographical features which may indicate location of prior disposal (e.g., sediment mounds). Soil sample locations and coordinates were recorded on field datasheets as sampling was conducted.

Sampling implements were cleaned prior to use, and between sampling sites, by washing with non-phosphate detergent, hydrochloric acid, and methanol. Deionized water was used to rinse the implements after each washing agent was applied.

Prior to sediment collection, each sampling point was cleared of vegetation and/or large gravel, if such material was present. Target sediment was scooped with a stainless steel sampling implement (e. g., trowel or spoon) and placed into a stainless steel compositing bucket or tray. In cases where sediment samples were taken from street surfaces or hardscape areas, a small nylon or natural fiber pre-cleaned brush was used in conjunction with a trowel or scoop. After homogenization within the compositing bucket or tray, subsamples were transferred to certified-cleaned, 8-ounce glass jars and cooled to 4 C. Samples were either shipped immediately to ALS Laboratory of Kelso, Washington for analysis or were held at 4 C (particle size distribution samples) and -20 C (all other samples) pending shipping to ALS. Archived samples from each location, and from each composite area if applicable, were collected and stored at ADH Environmental in Soquel, California at 4 or -20 C as appropriate for possible future analysis or re-analysis.

## 2.2 Laboratory Methods

Australian Laboratory Services (ALS, formerly Columbia Analytical Services) of Kelso, Washington performed all analytical testing. Table 2 presents the study's analytical test types, methods, reporting limits and holding times. Results for PCBs, mercury and TOC were reported on a dry-weight basis.

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[3] Contra Costa Clean Water Program, Sampling and Analysis Plan Draft, Pollutants of Concern Monitoring; Pesticides and Toxicity Monitoring: MRP Provisions C.6.f and C.6.g. Prepared by ADH Environmental. January 21, 2016.

[4] Contra Costa Clean Water Program, Quality Assurance Project Plan Draft, Pollutants of Concern Monitoring; Pesticides and Toxicity Monitoring: MRP Provisions C.6.f and C.6.g. Prepared by ADH Environmental. January 26, 2016.

**Table 1. Analytical Tests, Methods, Reporting Limits and Holding Times**

| Analytical Test | Method | Reporting Limit | Holding Time |
|---|---|---|---|
| Total PCBs (RMP 40 congeners)[1] | EPA 8082A | 0.5 µg/Kg | 1 year |
| Total PCBs (RMP 40 congeners)[1] | EPA 1668C | 0.5 µg/Kg | 1 year |
| Total Mercury | EPA 7471B | 5 µg/Kg | 1 year |
| Total Organic Carbon (TOC) | ASTM D4129-05M | 0.05 % | 28 days |
| Particle Size Distribution (PSD)[2] | ASTM D422M | 0.01 % | 28 days |

[1] San Francisco Bay Regional Monitoring Program 40 PCB congeners include PCB-8, 18, 28, 31, 33, 44, 49, 52, 56, 60, 66, 70, 74, 87, 95, 97, 99, 101, 105, 110, 118, 128, 132, 138, 141, 149, 151, 153, 156, 158, 170, 174, 177, 180, 183, 187, 194, 195, 201, and 203.
[2] Particle size distribution by the Wentworth scale; percent fines (slit and clay) are less than 62.5 microns.

# 3.0 QUALITY ASSURANCE / QUALITY CONTROL ANALYSIS

ADH performed verification and validation of all laboratory data per the project draft QAPP and consistent with SWAMP 2008 measurement quality objectives (MQOs)[5].

Of 61 samples collected overall, four were blind field duplicate samples (sample IDs with a "D" as the last character). Duplicate sample relative percent differences (RPDs) for the sum of PCB congeners ranged from 6 to 61 percent; RPDs for mercury ranged from 10 to 16 percent. Given that the distribution of PCBs in Bay Area sediments can display micro-heterogeneity, the RPD range between original and field duplicate samples is considered acceptable.

All samples for all analyses met quality control objectives, with the exception of those samples for PCB congeners shown in Table 2 below. Given that all the quality control issues described in Table 2 show the issues were of minor consequence, the data from these samples are of acceptable quality and have been included in the data set for this annual report.

**Table 2. Quality Control Issues and Analysis for PCB Congeners in the 2015 Project Data Set**

| Lab Sample ID | Issue | Analysis |
|---|---|---|
| RCH-450-042215, PTZ-201A-043015 | Matrix interference in matrix spike samples for many congeners caused high bias in the matrix spike concentrations. | Recovery in the Laboratory Control Sample was acceptable, indicating the analytical batch was in control. The interference appeared to be minimal. |
| RCH-400-042215 | Matrix spike recovery for a few congeners was outside control criteria. | Recovery in the Laboratory Control Sample was acceptable, indicating the analytical batch was in control. |
| Samples in service request K1505559, K1505560, K1506492 | Method detection limits (MDLs) elevated for most samples due to matrix interference. | Results were flagged in the EDDs indicating matrix interference. This issue is somewhat compensated for by substituting half the MDL in the calculation of the sum of congeners. |
| Samples in service request K1511190 | Recoveries of Laboratory Control Samples for several congeners were outside control criteria. | Based on the method and historic data, the observed recoveries were in the range expected for this procedure. |
| Samples in service request K1511190 | Matrix interference in matrix spike samples for many congeners caused high bias in the matrix spike concentrations. in the case of PCB 18 in sample ANT-552-100115, the Interference completely prevented recovery at the spiked concentration. For a few analytes, matrix spike recoveries were outside control criteria. | Recovery in the Laboratory Control Sample was acceptable, indicating the analytical batch was in control. The interference appeared to be minimal. For PCB 18 in the named sample, there is the potential for low bias in the matrix recoveries. This result was flagged as negatively biased in the EDD. |
| Laboratory Control Sample (LCS) KWG1505813-3 | The upper control criterion was exceeded for PCB 138, indicating a high bias. | The sample data was not significantly affected. No further corrective action was appropriate. |
| SPL-600-061115 | Matrix interference in matrix spike samples for many congeners caused high bias in the matrix spike concentrations. | Based on the magnitude of background contribution, the interference appeared to be minimal. |

[5] Surface Water Ambient Monitoring Program Quality Assurance Project Plan. Version 1.0. Prepared for the California State Water Quality Control Board by the SWAMP Quality Assurance Team. September 1, 2008.

# 4.0 RESULTS

Sediment samples were collected between April and September 2015 at 57 locations throughout Contra Costa County. Table 3 provides a summary of sampling information, including date of collection and sample location coordinates. The sample identifier is formatted according to the following code:

CC-LLL-SSSS-O-D

Where,

| | | |
|---|---|---|
| CC | = | County code (Contra Costa) |
| LLL | = | General location (ANT = Antioch, BPT = Bay Point, CON = Concord, PIN = Pinole, PTZ = Pittsburg, RCH = Richmond, RDO = Rodeo, SPL = San Pablo) |
| SSSS | = | Site designation (alpha-numeric code up to four characters) |
| O | = | Ownership code (R = public right of way, P = private property, U = unknown) |
| D | = | Blind field duplicate sample |

Table 4 presents analytical results of 61 sediment samples from 2015, including four field duplicate results. Total PCB results were calculated by summing all 40 congeners, including the substitution of half the method detection limit for congeners that were not detected. The substitution of half the method detection limit is consistent with the BASMAA Regional Monitoring Coalition Creek Status Monitoring Program reporting procedures. Values in bold italics indicate the total PCBs results exceed 500 parts per billion (ppb), or that the total mercury results exceed 750 ppb. Exceedances of these action levels indicates that a sampling location meets the concentration criterion of a high opportunity area for PCBs or mercury controls. Four PCBs samples and four mercury samples exceeded the action levels, while only one sample, CC-RCH-401-R, exceeded the action level for both PCBs and mercury.

Although gravel was present in abundant amounts in many samples, it was excluded from test aliquots for PCBs, mercury and TOC determination. This is a standard laboratory practice; by excluding the gravel and pebbles from these tests, we are left with a better estimate of pollutant concentrations that are available for entrainment in stormwater runoff.

Table 5 presents the results of a quality control check on the viability of EPA method 8082A to screen for the presence of PCBs in test sediments. Seven sediment samples exceeding 100 ppb were reanalyzed by the more rigorous EPA method 1668C. Method 1668C uses high-resolution gas chromatography/high-resolution mass spectrometry and suffers less from matrix interference than method 8082A (standard gas chromatography). The analytical cost of method 1668C is nearly three times the cost of method 8082A and, therefore, there is a substantial cost benefit in utilizing the less expensive method for screening purposes. The MRP allows the use of the less expensive method 8082A, provided it is used "as appropriate to address the management information needs."

To confirm the concentration of PCBs in 2015 samples were accurately determined, CCCWP elected to reanalyze seven archived sediment samples by method 1668C as a quality control check on the viability of method 8082A. Results of the reanalysis are presented in Table 5 and indicate the screening method (8082A) served the intended purpose of accurately identifying sediment that exceeded the 500 parts per billion action level. In five of seven samples, the result by method 1668C was higher by an average of 42 percent than the result by method 8082A; in two of seven samples, the result by method 1668C was lower by an average of 32 percent than the result by method 8082A. Overall, these results are considered to be in good agreement with each other, given the general micro-heterogeneity of PCB distribution in Bay Area sediments. For context in terms of variability of results among the same sample, the average percent difference between original samples and field duplicates was 35 percent.

**Table 3. Sample Identifier, Date Sampled, Position Coordinates and Sampling Notes**

| Sample ID | Date Sampled | Latitude (Deg. N) | Longitude (Deg. W) | Sampling Notes |
|---|---|---|---|---|
| CC-ANT-500-R | 04/30/15 | 38.01238 | 121.77036 | Local area composite |
| CC-ANT-501-R | 04/30/15 | 38.01239 | 122.77729 | Local area composite |
| CC-ANT-502-R | 04/30/15 | 38.01511 | 121.76111 | Local area composite |
| CC-ANT-510-R | 09/30/15 | 38.01664 | 121.82357 | Local area composite |
| CC-ANT-511-R | 10/01/15 | 38.01349 | 121.81588 | Local area composite |
| CC-ANT-512-R | 10/01/15 | 38.01678 | 121.75701 | Local area composite |
| CC-ANT-512-R-D | 10/01/15 | 38.01678 | 121.75701 | Field duplicate |
| CC-BPT-600-R | 09/29/15 | 38.03902 | 121.96115 | Local area composite |
| CC-BPT-601-R | 09/29/15 | 38.04293 | 121.98805 | Local area composite |
| CC-CON-900-R | 06/11/15 | 37.97577 | 122.04899 | Local area composite |
| CC-PIN-800-R | 06/11/15 | 38.00531 | 122.30902 | Local area composite |
| CC-PTZ-200-R | 04/30/15 | 38.01971 | 121.85702 | Local area composite |
| CC-PTZ-200A-R | 04/30/15 | 38.02069 | 121.85654 | Local area composite |
| CC-PTZ-201-R | 04/30/15 | 38.01748 | 121.85775 | Local area composite |
| CC-PTZ-201-R-D | 04/30/15 | 38.01748 | 121.85775 | Field duplicate |
| CC-PTZ-201A-R | 04/30/15 | 38.01707 | 121.85822 | Local area composite |
| CC-PTZ-202-R | 04/30/15 | 38.01675 | 121.89852 | Local area composite |
| CC-PTZ-210-R | 09/29/15 | 38.02942 | 121.91618 | Sampled several points along fence line |
| CC-PTZ-212-R | 09/29/15 | 38.03007 | 121.87628 | Local area composite |
| CC-PTZ-213-R | 09/29/15 | 38.03104 | 121.87352 | Local area composite |
| CC-PTZ-214-R | 09/29/15 | 38.03035 | 121.87101 | Local area composite |
| CC-PTZ-215-R | 09/29/15 | 38.01847 | 121.86964 | Local area composite |
| CC-PTZ-216-R | 09/29/15 | 38.01444 | 121.8611 | Local area composite |
| CC-PTZ-217-R | 09/29/15 | 38.01242 | 121.84998 | Local area composite |
| CC-PTZ-218-R | 09/29/15 | 38.01253 | 121.85755 | Local area composite |
| CC-PTZ-219-R | 09/29/15 | 38.01209 | 121.87191 | Local area composite |
| CC-PTZ-220-R | 09/29/15 | 38.01241 | 121.84954 | Local area composite |
| CC-RCH-100-R | 04/21/15 | 37.9225 | 122.33523 | Local area composite |
| CC-RCH-101-R | 04/21/15 | 37.92231 | 122.33538 | Local area composite |
| CC-RCH-102-R | 04/21/15 | 37.92287 | 122.33576 | Local area composite |
| CC-RCH-103-R | 04/21/15 | 37.92314 | 122.33617 | Local area composite |
| CC-RCH-104-R | 04/21/15 | 37.92291 | 122.33773 | Local area composite |
| CC-RCH-105-R | 04/21/15 | 37.92385 | 122.33732 | Local area composite |
| CC-RCH-106-R | 04/21/15 | 37.92406 | 122.35789 | Local area composite |
| CC-RCH-200-R | 04/21/15 | 37.94194 | 122.37561 | Local area composite |
| CC-RCH-300-P | 04/22/15 | 37.99972 | 122.35152 | Site under construction took samples throughout property; escorted by Joanne Le |
| CC-RCH-301A-R | 04/22/15 | 37.97147 | 122.35573 | Local area composite; truck path |
| CC-RCH-301B-R | 04/22/15 | 37.97161 | 122.35569 | Local area composite; horse stables |
| CC-RCH-305-P | 04/22/15 | 37.95066 | 122.36551 | 4-point composite of 1 large property comprised |

**Table 3. Sample Identifier, Date Sampled, Position Coordinates and Sampling Notes**

| Sample ID | Date Sampled | Latitude (Deg. N) | Longitude (Deg. W) | Sampling Notes |
|---|---|---|---|---|
| | | | | of 10 APNs; escorted by Joanne Le:<br>37.95065, 122.36660<br>37.95066, 122.36551<br>37.95055, 122.36627<br>37.95053, 122.36583 |
| CC-RCH-305-P-D | 04/22/15 | 37.95066 | 122.36551 | Field duplicate |
| CC-RCH-306-R | 04/22/15 | 37.97175 | 122.36529 | Local area composite |
| CC-RCH-307-R | 04/22/15 | 37.96828 | 122.36748 | Local area composite |
| CC-RCH-308-R | 04/22/15 | 37.95487 | 122.35949 | Local area composite; vacant lot with heavy trackout |
| CC-RCH-309-R | 04/22/15 | 37.95465 | 122.35885 | Local area composite |
| CC-RCH-400-R-02 | 04/29/15 | 37.95413 | 122.37417 | Local area composite |
| CC-RCH-401-R | 04/29/15 | 37.95411 | 122.37758 | Local area composite |
| CC-RCH-402-R | 04/29/15 | 37.96031 | 122.73435 | Local area composite |
| CC-RCH-403-R | 04/29/15 | 37.96043 | 122.37438 | Local area composite |
| CC-RCH-404-R | 04/29/15 | 37.96331 | 122.37315 | Local area composite |
| CC-RCH-405-R | 04/29/15 | 37.96327 | 122.37247 | Local area composite |
| CC-RCH-406-R | 04/29/15 | 37.96311 | 122.37111 | Local area composite |
| CC-RCH-407-R | 04/29/15 | 37.96801 | 122.36909 | Local area composite |
| CC-RCH-700-R | 06/11/15 | 37.96492 | 121.35792 | Local area composite |
| CC-RCH-800-R | 09/30/15 | 37.95861 | 122.35958 | Local area composite |
| CC-RCH-801-R | 09/30/15 | 37.96521 | 122.36306 | Local area composite |
| CC-RCH-RRC-P | 04/22/15 | 37.92411 | 122.33736 | 4-point composite along railroad lines:<br>37.95857, 122.35794<br>37.92410, 122.33736<br>37.95010, 122.36629<br>37.97174, 122.35551 |
| CC-RDO-700-R | 09/30/15 | 38.02756 | 122.26695 | Local area composite |
| CC-SPL-325-P | 09/30/15 | 37.95386 | 122.35759 | Group composite; separate piles of soil on same property as SPL-326-093015; escorted by Amanda Booth |
| CC-SPL-325-P-D | 09/30/15 | 37.95386 | 122.35759 | Field duplicate |
| CC-SPL-326-P | 09/30/15 | 37.95352 | 122.35795 | Local area composite; several piles of soil on property, sampled each |
| CC-SPL-600-P | 06/11/15 | 37.95335 | 122.35787 | Group composite; several piles of soil on property, sampled each |
| CC-SPL-601-R | 06/11/15 | 37.97995 | 122.35235 | Group composite; sampled at various points around perimeter of property |

**Table 4. Total PCBs, Total Mercury, Total Organic Carbon and Particle Size Distribution Results**

| Sample ID | Total PCBs (µg/Kg) [1] | Total Hg (µg/Kg) [2] | TOC (%) | Particle Size Distribution | | | |
|---|---|---|---|---|---|---|---|
| | | | | Gravel (%) | Sand (%) | Silt (%) | Clay (%) |
| CC-ANT-500-R | 251.9 | 328 | 2.12 | 3.20 | 79.53 | 15.04 | 2.23 |
| CC-ANT-501-R | 3.46 | 17 | 0.513 | 0.94 | 76.68 | 21.25 | 1.13 |
| CC-ANT-502-R | 23.66 | 23 | 0.53 | 0.59 | 95.78 | 3.40 | 0.23 |
| CC-ANT-510-R | ***2,531*** | 151 | 1.86 | 46.85 | 36.22 | 15.43 | 1.49 |
| CC-ANT-511-R | 7.31 | 178 | 0.822 | 63.47 | 28.02 | 7.50 | 1.00 |
| CC-ANT-512-R | 6.55 | 27 | 0.824 | 23.46 | 71.43 | 4.60 | 0.51 |
| CC-ANT-512-R-D | 5.12 | 23 | 0.685 | 2.58 | 89.43 | 6.91 | 1.08 |
| CC-BPT-600-R | 50.21 | 376 | 8.42 | 57.96 | 24.39 | 15.28 | 2.37 |
| CC-BPT-601-R | 1.79 | 78 | 3.4 | 63.45 | 31.34 | 4.15 | 1.05 |
| CC-CON-900-R | 4.47 | 111 | 0.688 | 26.07 | 52.69 | 16.77 | 4.47 |
| CC-PIN-800-R | 3.46 | 49 | 1.03 | 14.38 | 76.76 | 7.75 | 1.11 |
| CC-PTZ-200A-R | 19.33 | 194 | 1.56 | 24.91 | 45.42 | 27.68 | 1.99 |
| CC-PTZ-200-R | 15.34 | 227 | 1.32 | 58.19 | 30.84 | 9.84 | 1.13 |
| CC-PTZ-201A-R | 338.7 | 287 | 5.72 | 1.26 | 69.23 | 27.88 | 1.63 |
| CC-PTZ-201-R | 59.91 | 276 | 5.27 | 47.45 | 33.53 | 17.61 | 1.42 |
| CC-PTZ-201-R-D | 49.78 | 240 | 5.76 | 13.38 | 44.86 | 39.58 | 2.18 |
| CC-PTZ-202-R | 3.07 | 373 | 0.537 | 23.72 | 54.36 | 18.91 | 3.01 |
| CC-PTZ-210-R | ***1,061*** | 109 | 1.8 | 2.92 | 51.17 | 37.43 | 8.47 |
| CC-PTZ-212-R | 32.46 | 248 | 7.56 | 31.04 | 54.50 | 12.55 | 1.91 |
| CC-PTZ-213-R | 54.92 | 640 | 1.13 | 37.76 | 27.09 | 31.32 | 3.82 |
| CC-PTZ-214-R | 21.40 | ***1,670*** | 10.5 | 12.98 | 46.92 | 30.58 | 9.52 |
| CC-PTZ-215-R | 14.09 | 151 | 14.1 | 56.28 | 34.35 | 7.89 | 1.48 |
| CC-PTZ-216-R | 10.48 | 606 | 3.34 | 36.38 | 48.20 | 13.18 | 2.24 |
| CC-PTZ-217-R | 6.26 | 637 | 1.15 | 51.17 | 39.96 | 7.18 | 1.70 |
| CC-PTZ-218-R | 4.30 | 229 | 2.12 | 5.37 | 70.48 | 20.89 | 3.26 |
| CC-PTZ-219-R | 14.03 | 167 | 21.9 | 29.51 | 53.71 | 13.83 | 2.95 |
| CC-PTZ-220-R | 18.87 | ***1,042*** | 23.14 | 60.77 | 32.86 | 5.39 | 0.98 |
| CC-RCH-100-R | 25.62 | 129 | 1.39 | 17.85 | 60.63 | 17.64 | 3.88 |
| CC-RCH-101-R | 34.74 | 128 | 6.23 | 21.56 | 59.08 | 17.86 | 1.49 |
| CC-RCH-102-R | 3.52 | 45 | 1.13 | 3.57 | 32.06 | 49.06 | 15.31 |
| CC-RCH-103-R | 19.03 | 84 | 0.659 | 24.69 | 60.99 | 12.00 | 2.32 |
| CC-RCH-104-R | 123.7 | 607 | 1.34 | 43.23 | 39.29 | 14.15 | 3.33 |
| CC-RCH-105-R | 28.05 | 157 | 1.01 | 31.41 | 61.51 | 6.16 | 0.92 |
| CC-RCH-106-R | 57.44 | 470 | 1.07 | 33.65 | 47.16 | 14.95 | 4.25 |
| CC-RCH-200-R | 34.20 | 437 | 1.7 | 29.67 | 42.97 | 24.75 | 2.62 |
| CC-RCH-300-P | 110.7 | 83 | 0.864 | 5.75 | 53.53 | 36.95 | 3.77 |
| CC-RCH-301A-R | 13.55 | 393 | 3.25 | 44.67 | 45.64 | 8.50 | 1.19 |
| CC-RCH-301B-R | 6.61 | 402 | 1.22 | 48.08 | 42.20 | 8.52 | 1.20 |
| CC-RCH-305-P | 26.12 | 104 | 2.08 | 41.37 | 41.73 | 15.06 | 1.84 |

**Table 4. Total PCBs, Total Mercury, Total Organic Carbon and Particle Size Distribution Results**

| Sample ID | Total PCBs (µg/Kg) [1] | Total Hg (µg/Kg) [2] | TOC (%) | Particle Size Distribution Gravel (%) | Sand (%) | Silt (%) | Clay (%) |
|---|---|---|---|---|---|---|---|
| CC-RCH-305-P-D | 24.62 | 119 | 2.27 | 35.44 | 46.56 | 16.09 | 1.90 |
| CC-RCH-306-R | 5.78 | 94 | 1.19 | 22.67 | 60.61 | 15.22 | 1.49 |
| CC-RCH-307-R | 84.63 | 172 | 1.81 | 14.01 | 63.36 | 21.71 | 0.92 |
| CC-RCH-308-R | 47.16 | 144 | 2.91 | 25.93 | 54.60 | 18.21 | 1.27 |
| CC-RCH-309-R | 71.01 | 540 | 3.41 | 41.01 | 42.52 | 15.67 | 0.80 |
| CC-RCH-400-R | 12.66 | 202 | 2.01 | 49.52 | 40.34 | 8.38 | 1.75 |
| CC-RCH-401-R | ***6,383*** | ***20,600*** | 4.42 | 27.12 | 35.48 | 32.51 | 4.90 |
| CC-RCH-402-R | 32.94 | 511 | 3.16 | 40.82 | 43.49 | 14.15 | 1.54 |
| CC-RCH-403-R | 30.49 | 331 | 1.21 | 43.34 | 44.37 | 11.29 | 1.00 |
| CC-RCH-404-R | 132.8 | 136 | 2.4 | 34.46 | 57.99 | 7.55 | 0.00 |
| CC-RCH-405-R | 55.68 | 161 | 2.26 | 54.11 | 35.87 | 9.14 | 0.88 |
| CC-RCH-406-R | 7.59 | 564 | 0.717 | 22.95 | 50.47 | 20.62 | 5.96 |
| CC-RCH-407-R | 22.76 | 183 | 1.13 | 23.14 | 66.09 | 10.23 | 0.54 |
| CC-RCH-700-R | 16.19 | 207 | 1.26 | 32.94 | 55.53 | 9.97 | 1.56 |
| CC-RCH-800-R | 29.00 | 260 | 1.76 | 50.52 | 44.80 | 4.22 | 0.46 |
| CC-RCH-801-R | 99.49 | 507 | 0.936 | 60.71 | 29.44 | 8.05 | 1.79 |
| CC-RCH-RRC-P | 54.22 | ***930*** | 1.61 | 36.31 | 28.14 | 28.58 | 6.97 |
| CC-RDO-700-R | 16.00 | 95 | 4.51 | 30.20 | 59.41 | 9.10 | 1.28 |
| CC-SPL-325-P | 40.83 | 196 | 3.85 | 29.08 | 43.33 | 22.54 | 5.06 |
| CC-SPL-325-P-D | 21.82 | 216 | 3.9 | 46.51 | 32.96 | 16.95 | 3.58 |
| CC-SPL-326-P | 84.83 | 104 | 4.09 | 42.27 | 46.30 | 10.33 | 1.09 |
| CC-SPL-600-P | ***1,291*** | 149 | 5.2 | 22.29 | 65.10 | 11.71 | 0.89 |
| CC-SPL-601-P | 116.2 | 431 | 3.33 | 16.17 | 56.79 | 24.16 | 2.87 |

[1] Total PCBs values in ***Bold Italics*** exceed 500 ppb.
[2] Total Hg values in ***Bold Italics*** exceed 750 ppb.

**Table 5. Comparison of PCB Test Results By Two Analytical Methods: EPA 8082A vs. EPA 1668**

| Sample ID | Total PCBs (µg/Kg) EPA 8082A | EPA 1668C | Percent Increase or Decrease (%) |
|---|---|---|---|
| CC-ANT-500-U | 251.9 | 467.9 | 86 |
| CC-PTZ-201A-U | 338.7 | 195.1 | -42 |
| CC-RCH-104-U | 123.7 | 159.2 | 29 |
| CC-RCH-300-U | 110.7 | 162.5 | 47 |
| CC-RCH-401-U | 6,383 | 5,072 | -21 |
| CC-RCH-404-U | 132.8 | 175.0 | 32 |
| CC-SPL-600-U | 1,291 | 1,631 | 26 |

# Appendix 8

Final Report: Pilot Stormwater Diversion Project,
North Richmond Stormwater Pump Station

# FINAL REPORT: PILOT STORMWATER DIVERSION PROJECT

North Richmond Stormwater Pump Station
Contra Costa, California

*Prepared for:*

**Contra Costa County**
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March 2016

Project No. 5025153001.01

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## 1.0 EXECUTIVE SUMMARY

Normally, municipal staff would never consider deliberately diverting stormwater into their community's sanitary sewage treatment systems, but that is exactly what this award-winning pilot project accomplished. The motivation was a requirement established in the 2009 National Pollutant Discharge Elimination System (NPDES) Permit for Urban Stormwater Discharges issued to the Contra Costa Clean Water Program's (CCCWP) 21 permittees, along with all of the other municipal stormwater permittees in the San Francisco Bay Area. Order number R2-2009-0074, issued on October 14, 2009 and commonly known as "The Municipal Regional Permit" (MRP), was the first Bay Area municipal stormwater permit adopted after water quality plans for mercury and polychlorinated biphenyls (PCBs), known as "Total Maximum Daily Loads," or TMDLs, had been formally established for the Bay. Those TMDL plans call for substantial reduction of pollutant loads from urban stormwater discharges to the Bay – e.g., a 90 percent reduction in the total load of PCBs from all Bay Area stormwater discharges. The MRP issued in 2009 (known as MRP 1.0) required pilot projects to evaluate the feasibility of reducing PCB loads by various methods of treatment and source control. Provision C.12.f of the MRP required permittees to evaluate diversion of dry weather and wet weather urban runoff into sanitary sewage conveyance and treatment systems to determine if diversion to sanitary treatment is a useful tool for reducing PCB loads from urban runoff.

Contra Costa County Watersheds Program (County) led the pilot project for CCCWP. The County owns the North Richmond Stormwater Pump Station (NRSPS) and maintenance is shared through a Joint Exercise of Powers Agreement (JEPA) with the City of Richmond (both CCCWP permittees). The County partnered with the West County Wastewater District (WCWD), to provide conveyance capacity and treatment service. Converting the aging Pump Station facility to divert stormwater gave the County the opportunity to include facility improvements. Project funding came from the County and City and was supplemented with funds from the CCCWP (supported by all CCCWP permittees), as well as grant funds from the United States Environmental Protection Agency. In general, the County and City funds went to the Pump Station improvements and the EPA and CCCWP funds covered the added costs of planning, designing, implementing, monitoring, and reporting on the diversion pilot project.

The County completed construction of the diversion infrastructure in the fall of 2015. Pilot tests of dry and wet weather diversions of water from the pump station to WCWD were successfully completed by November 2015, and results formally reported to the County by January 2016. This final project report documents the project implementation and lessons learned for inclusion in the annual “Urban Creeks Monitoring Report”, a deliverable required in the MRP. Findings and recommendations are expected to guide actions during the next five year MRP.

The lessons learned from this pilot project include both good news and bad news.

The Good News:

- CCCWP permittees complied with provision C.12.f of MRP 1.0 by collaborating with several partners to complete a pump station stormwater diversion pilot with a permanent, “hard-piped” diversion system installed at the NRSPS.
- WCWD experienced no overflows, sewage treatment system upsets, or other disruptions to operations as a result of the pilot diversion project.
- In addition to rehabilitating existing infrastructure, the NRSPS diversion project offers new operational flexibility to the Pump Station owners.
- Project partners gained a new understanding of the incentives and opportunities that can potentially support co-management of urban runoff with water reclamation systems originally designed for sanitary sewage.
- There is now an established partnership and relationship between the County and WCWD, and with new infrastructure now in place and the pilot successfully completed, there is an opportunity to pursue grant funding to support stormwater harvest and use projects in the future.

The Bad News:

- The wet and dry diversion pilot tests accomplished miniscule load reductions: e.g., about one milligram (0.001 grams) of PCBs, against a required Baywide PCB load reduction of 18,000 grams by the year 2028.
- Conveyance limitations of the sanitary sewage system prohibit substantial scale-up of the pilot to larger diversion flows. The diversion pump installed pumps 200 to 250 gallons per minute into the WCWD collection system. Larger flow rates risk sanitary sewer overflows. The design of the pump station provides 135,000 gallons per minute of stormwater pumping capacity, about 600 times more volume than the diversion. That might be comparable to a person sipping water from a gushing fire hydrant.
- Even if all of the stormwater from the 339 acre catchment served by the NRSPS could be captured and treated – which would require a substantial capital project - the total PCB load reduction possible is on the order of one to ten grams at best, still a tiny fraction of the overall load reduction mandate for the Bay.
- The total project cost was over $1.4 million which included some necessary upgrades to the existing Pump Station infrastructure. The cost for a "stand-alone" stormwater diversion project would be approximately $1 million.

This is an example of opportunistically combining stormwater quality enhancement and municipal infrastructure restoration into one project. The project evolved and changed from its inception five years ago. Initially the project included substantial improvements to the Pump Station until the estimated costs approached $2 million. Then the project was changed to only include improvements to the extent needed to complete the stormwater diversion. The total final project cost was $1,440,000. The actual construction contract for the pump station project was $469,469. Design of the pump station project cost an additional $280,000. Both these design and construction costs reflected a project to divert stormwater plus some improvements to the Pump Station facilities. The remaining $690,531 of the project cost, over and above design and construction, comes from planning studies, monitoring, reporting, project management, and multi-agency coordination. A diversion project of this scale, implemented as a “stand-alone,” without including any infrastructure rehabilitation, would cost close to $1,000,000 for planning, construction, monitoring, project management, and reporting.

In summary, this project achieved the objective of installing and pilot testing urban runoff diversion infrastructure. Diversion of dry and wet weather urban runoff into the nearest water reclamation facility offers only incremental PCB load reduction benefits. Diversion is not a “silver bullet” that will make a significant difference to PCB loads; however, consideration of multiple water quality benefits, such as trash controls, water resource development, and reduction of bacteria, oil and grease, and other urban pollutants discharged to Wildcat Marsh and the Bay may motivate additional, expanded stormwater harvest and use projects in this watershed. Water resource needs may be the overall driver. The newly installed diversion infrastructure installed can harvest and re-use up to 50 million gallons per year of urban runoff, primarily as dry weather urban runoff, should WCWD choose to implement longer term diversions. Overall, the immediate benefit of extending the useful life of the NRSPS and having diversion capabilities, opens longer term planning opportunities that makes this project a success.

On February 25, 2016, the NRSPS Stormwater Diversion Project was awarded the honor of Environmental Project of the Year by the Northern California Chapter of the American Public Works Association (Appendix A). The award named CCCWP as “an essential partner in the development and construction of this innovative project.”

## 2.0 BACKGROUND

This section begins with a summary of the thought process that led to investigation of urban runoff diversions as a tool for implementing TMDLs for pollutants of concern in urban stormwater. The project partners are then described, followed by a description of the project setting.

### 2.1 ORIGINS OF THE STORMWATER DIVERSION CONCEPT

Completion of this pilot project culminates a thought process that has evolved in the Bay Area over the past fifteen years. Table 1 below documents some of the major milestones in this thought process. Details presented below help understand the regulatory and decision making context that led to this pilot project.

**Table 1 Timeline of NRSPS Diversion Pilot Project Development**

| Time Frame | Milestone |
|---|---|
| 2000 – 2002 | Baywide investigation of PCBs in storm drain system sediment leads to discovery of 20 mg/kg PCBs at Ettie Street Pump Station |
| 2006 | Water Board accepts East Bay Municipal Utility District (EBMUD) monitoring at Ettie Street Pump Station diversion as a tSupplemental Environmental Project |
| 2008 | EPA Water Quality Improvement Fund grant awarded to support NRSPS diversion pilot |
| 2009 | MRP 1.0 Adopted |
| 2010 | EBMUD Report on Ettie Street Pump Station Diversion completed<br>BASMAA Feasibility Evaluation Report submitted to Water Board |
| 2010 – 2013 | San Francisco Estuary Institute monitors water quality at NRSPS |
| 2011 – 2013 | CCCWP and the County negotiate agreement with WCWD to accept diversion flows |
| 2013 – 2014 | NRSPS rehabilitation and diversion design completed |
| 2015 | MRP 2.0 issued<br>NRSPS stormwater diversion project constructed, diversion monitored for dry and wet weather event |

Since the advent of the Clean Water Act in 1973, communities have generally tried to keep urban runoff separate from sewage treatment conveyance and infrastructure (sanitary sewage systems). Treating the volumes of runoff generated by storm flows would require development of sufficient treatment capacity that would be unused most of the time. Additionally, the very different compositions of sanitary sewage compared to urban runoff recommend different methods of treatment. Some older cities, such as San Francisco, Portland, and Seattle, have conveyance systems that were originally designed to combine sanitary sewage and storm flows. Those communities have to use much larger treatment systems compared to separate systems, and are continuously working to reduce incidents of combined system overflows of partially–treated water during large storm events. In more modern cities with separate systems, municipal workers implement programs to reduce inflow and infiltration (I & I) of stormwater into their sanitary sewage systems.

More recently, some beach communities in California have begun to implement dry weather diversions of urban runoff into their sanitary sewage systems. A review by the Bay Area Stormwater Management Agencies Association (BASMAA) documented case studies of voluntary diversions to sanitary sewers (BASMAA, 2010). In all cases examined, the motivation was to reduce impacts of bacteria from dry weather urban runoff on nearby beaches. The economic and human health benefits resulting from such dry weather diversions are clear – avoiding beach closures is important to any seaside community. Also, the diversion flows are generally small compared to the sanitary sewage conveyance and treatment capacity, so the risk of conveyance system overflows and/or treatment system disruption is less with dry weather diversions compared to wet weather diversions.

In all of the voluntary diversions reviewed by BASMAA (2010), diversions were designed and operated to shut down during wet weather events to protect the sanitary sewage systems. That is an important point that will inform the lessons learned and recommendations from this pilot project. Substantial equalization and storage capacity is needed for diversion to sanitary sewage systems to make a significant impact on stormwater pollutant loads.

In the Bay Area, the interest in management of stormwater by diversion to sanitary sewers began at the Ettie Street Pump Station (ESPS), located in West Oakland. In the 2000 – 2002 time frame, the discovery of sediments in the sump of the ESPS having PCB concentrations up to 20 mg/kg, well above thresholds of concern for stormwater discharges to the Bay, led staff of the San Francisco Bay Regional Water Quality Control Board (Water Board) to ask whether diversion from the pump station to the nearby East Bay Municipal Utility District (EBMUD) wastewater treatment plant was a reasonable approach to preventing PCB-contaminated sediments from reaching the Bay. EBMUD agreed to monitor a pilot diversion project at the Ettie Street pumping station (EBMUD, 2010). The pilot study was a Supplemental Environmental Project delivered by EBMUD in lieu of a penalty related to a prior incident (Water Board Order No. R2-2006-0028). The study demonstrated that small flows (up to 50 gallons per minute) could safely be diverted into the EBMUD wastewater collection system during a storm event, and that the loads reduced or avoided by the diversion were small in comparison to pollutant loads conveyed by the storm pumps at Ettie Street to the Bay. Interestingly, since the time that sediments with high PCB concentrations were removed from the Ettie Street pump station wet well, PCB concentrations in sediments exceeding 1 mg/kg have not been observed at that location.

During the time that the Ettie Street diversion pilot was being developed by EBMUD, the MRP was being developed by Water Board staff. MRP 1.0 (Order No. R2-2009-0074) included requirements for pilot projects to test diverting stormwater from pump stations into sanitary sewers. Provisions C.11.f (for mercury) and C.12.f (for PCBs) for MRP 1.0 state that:

- Task Description – The Permittees shall evaluate the reduced loads of mercury and PCBs from diversion of dry weather and first flush stormwater flows to sanitary sewers. The knowledge and experience gained through pilot implementation will be used to determine the implementation scope of urban runoff diversion in subsequent permit terms. The Permittees shall document the knowledge and experience gained through pilot implementation, and this documentation will provide a basis for determining the implementation scope of urban runoff diversion projects in subsequent permit terms.
- Implementation Level – The Permittees shall implement pilot projects to address the role of pump stations as a source of pollutants of concern (primarily PCBs and secondarily mercury). This work is in addition to Provisions C.2 and C.10 that address dissolved oxygen depletion and trash impacts in receiving waters. The objectives of this provision are: to implement five pilot projects for urban runoff diversion from stormwater pump stations to POTWs; evaluate the reduced loads of mercury and PCBs resulting from the diversion; and gather information to guide the

selection of additional diversion projects required in future permits. Collectively, the Permittees shall select five stormwater pump stations and five alternates by evaluating drainage characteristics and the feasibility of diverting flows to the sanitary sewer.

(1) The Permittees should work with the local POTW on a watershed, program, or regional level to evaluate feasibility and to establish cost sharing agreements. The feasibility evaluation shall include, but not be limited to, costs, benefits, and impacts on the stormwater and wastewater agencies and the receiving waters relevant to the diversion and treatment of the dry weather and first flush flows.

(2) From this feasibility evaluation, the Permittees shall select five pump stations and five alternates for pilot diversion studies. At least one urban runoff diversion pilot project shall be implemented in each of the five counties (San Mateo, Contra Costa, Alameda, Santa Clara, and Solano). The pilot and alternate locations should be located in industrially dominated catchments where elevated PCB and mercury concentrations are documented.

(3) The Permittees shall implement flow diversion to the sanitary sewer at the five pilot pump stations. As part of the pilot studies, they shall monitor and measure PCB and mercury load reduction.

The reporting requirements of this provision included a feasibility evaluation report for diversion opportunities throughout the Bay Area. That report was completed as a regional project by BASMAA (2010). The final report requirement for each diversion project stated that:

The March 15, 2014 Integrated Monitoring Report shall include:

- Evaluation of pilot program effectiveness.
- PCBs (and mercury) loads reduced.
- Updated feasibility evaluation procedures to guide future diversion project selection.

Following adoption of MRP 1.0 in 2009, the CCCWP selected the NRSPS for the pilot project and the County Public Works Department agreed to be the project lead. The San Francisco Estuary Institute (SFEI) monitored the NRSPS to characterize loads of PCBs and mercury from 2010 to 2013; SFEI's work was initially funded by the EPA Water Quality Improvement fund grant, and later by BASMAA as one of four monitoring projects implemented as a regional collaboration. Negotiation with WCWD to gain their acceptance of the pilot project took place between 2011 and 2013, including two meetings with the WCWD Board of Directors. The design of the project was completed in 2014, and construction was completed in 2015. Dry and wet weather diversion were monitored in the fall of 2015, concurrent with completion of the diversion infrastructure.

This report fulfills the final report requirement established by provisions C.11.f and C.12.f of MRP 1.0. It is included in the 2016 Urban Creeks Monitoring Report, two years later than the required submittal, because of unavoidable delays in the planning, design, and construction of the diversion infrastructure. Water Board staff were closely involved in the development of this project and have been kept informed in writing as to progress on completion of this requirement.

### 2.2 Project Partners

The success of this project results from collaboration among project partners listed in Table 2 below. Details of their roles in developing and implementing this project provided below help understand the institution complexity of this kind of project that spans several jurisdictions and affects many interested parties.

**Table 2 Partners in the NRSPS Diversion Pilot Project**

| Partner | Role |
|---|---|
| Contra Costa County Department of Public Works | Owner of the NRSPS facility |
| City of Richmond | Responsible for a portion of the NRSPS maintenance |
| Contra Costa County Flood Control and Water Conservation District | Designs and builds flood protection facilities<br>Restores and enhances natural resources in creeks |
| West County Wastewater District | Provides sanitary sewage treatment to its service area<br>Operates NRSPS under and O&M agreement with the County (Appendix B)<br>Permitted dry and wet weather diversions for treatment in this pilot study(Appendix C) |
| Contra Costa Clean Water Program (on behalf of 21 permittees) | Supports facilitation, planning, and monitoring through staff and consultant labor, and direct fiscal contributions |
| United States Environmental Protection Agency, Region 9 | Awarded and Managed Water Quality Improvement Fund Grant |
| San Francisco Estuary Partnership | Contract Manager for Water Quality Improvement Fund Grant |
| San Francisco Estuary Institute | Monitoring contractor for grant and subsequent BASMAA-funded project at NRSPS |
| Bay Area Stormwater Management Agencies Association | Regional planning and coordination |
| San Francisco Bay Regional Water Quality Control Board | Regulatory incentives to implement project; supported application for EPA Water Quality Improvement Fund grant; participated in discussions with WCWD |

During the development of MRP 1.0, County staff determined that needed rehabilitation of the NRSPS presented an opportunity to implement a pilot diversion project. The two original low-flow pumps at the NRSPS had failed. Replacement of the low flow pumps presented an opportunity to build a diversion connection to the West County Wastewater District, which has sanitary sewage conveyance located next to the NRSPS. The County sought and obtained grant funding administered by the San Francisco Estuary Project through U.S. EPA's San Francisco Bay Area Water Quality Improvement Fund. The project is one of several in the "Estuary 2100 Phase 2: Building Partnerships for Resilient Watersheds" program. The grant provided $496,649 in EPA funds, matched by $186,383 from the County to plan, design, construct, and monitor an engineered diversion into WCWD. This report also fulfills the final report deliverable requirement of that grant.

Grant funding was used for design, project management, and monitoring of the pilot diversion. Overall costs to complete the diversion exceeded the original grant fund and County match. Additional funds needed for design and construction of the rehabilitation were provided by the County and the City of Richmond. Additional funds needed for monitoring and reporting on the pilot project were provided by the CCCWP (which includes program contributions from the County and the City of Richmond as permittees). The CCCWP contribution was premised on the fact that project completion gained compliance with the MRP provision for all permittees.

The City of Richmond participated as a "silent partner" in this project. City of Richmond staff expressed concerns in the development of this project because of legal matters that the City is addressing. The City of Richmond shares a common outfall with WCWD to discharge treated sanitary sewage to the Bay. The NPDES permit for the common outfall provides joint liability for WCWD and Richmond, and so the City of Richmond's legal concerns over issues such as I&I also relate to WCWD, to some extent.

The WCWD engaged in discussions with County staff in order to prepare the Feasibility Study for the stormwater diversion. Concerns expressed by WCWD staff and Board members included the potential for spills, disruptions to the sewage treatment system, and incurring costs to rate payers that were unrelated to the service of sanitary sewage treatment. WCWD staff and Board members also acknowledged their role as environmental stewards and were willing to move forward with a diversion project, conditioned on their concerns being addressed. The participation of Water Board staff in these discussions was essential to achieving consensus. After a diversion concept plan had been proposed and refined to be responsive to WCWD concerns, an "agreement" in the form of a WCWD Waste Discharge Permit was developed to support the pilot project (Appendix C). Because of the limited scope of the pilot project, WCWD agreed to waive fees for the connection to their sanitary sewage conveyance system and for accepting/treating the discharge. Through its existing contract with the County to operate and maintain the NRSPS, WCWD did charge for the labor and expense of monitoring the discharge to verify it would not cause an upset of WCWD's activated sludge treatment system.

## 2.3 PROJECT SETTING

The community-wide North Richmond Storm Drain Project was built in the early 1970s and included construction of the NRSPS. The NRSPS is designed to manage the stormwater for a portion of the City of Richmond, San Pablo and the unincorporated County area of North Richmond (Figure 1). The project consists of a network of stormwater collection pipes which drain into the wet well of the pump station. The stormwater is then pumped into the discharge channel of the pump station which drains by gravity into a 78-inch discharge pipeline.

The project site is located in a watershed comprised mainly of industrial and residential land (Figure 1). The storm drain collection system delivers stormwater to the NRSPS located on the southwest corner of Gertrude Avenue and Richmond Parkway. The station's 78-inch discharge pipeline runs westward from the pump station along an easement on the Chevron Chemical Company property just south of Gertrude Avenue. At about 950 feet downstream of the pump station, the pipeline expands into an 8-foot by 4-foot box culvert which crosses Gertrude Avenue and runs into a trapezoidal earth channel that drains to Wildcat Creek.

The storm drain collection system consists of over 14,000 linear feet of reinforced concrete pipe in sizes ranging from 15 inches to 84 inches in diameter. The collection system drains an approximate 339 acres area west of 13th Street between Wildcat Creek to the north and Castro Street to the south.

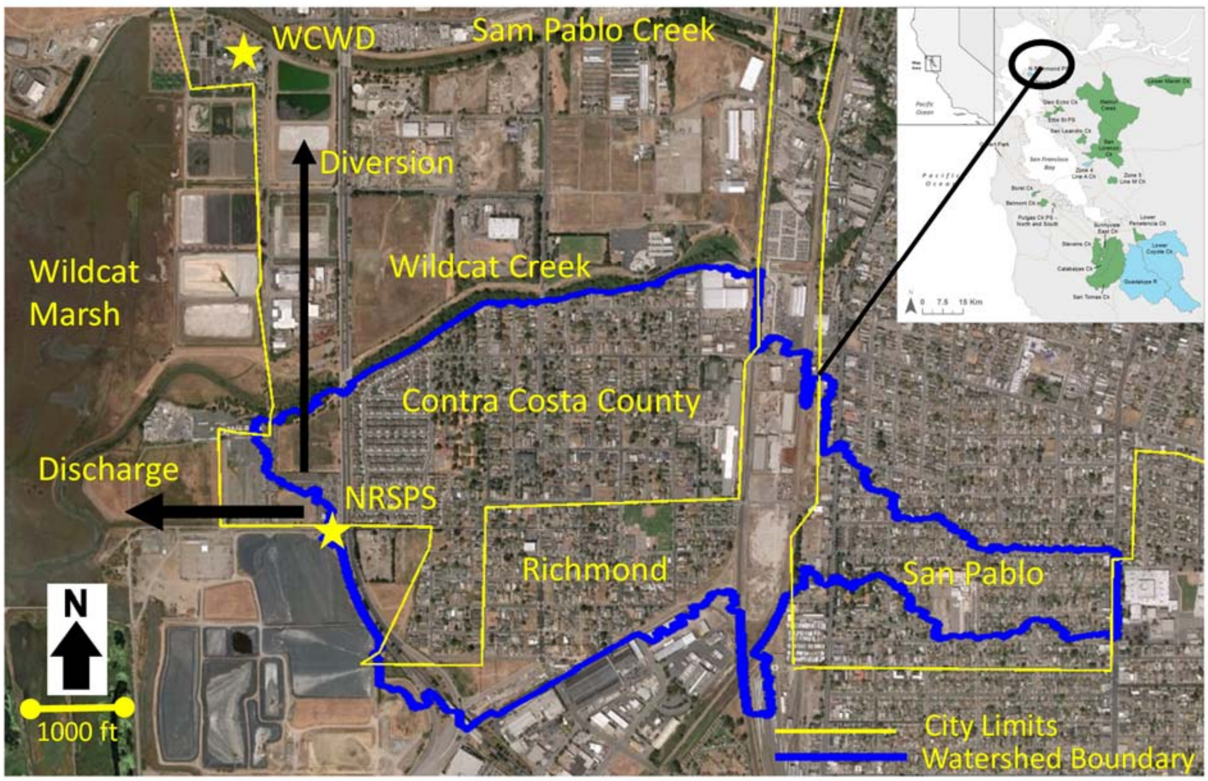



**Figure 1 Watershed Setting of the NRSPS**

The NRSPS's structure consists of a 3-level main structure and a discharge channel. The lowest level of the main structure, approximately 25 feet below ground, is the pump station wet well where stormwater from the collection system is received. Stormwater entering the station is routed to two compartments where it is lifted to the station's discharge channel by the stormwater pumps. The NRSPS is designed for a firm capacity of 135,000 gallons per minute (gpm). Four pumps, each capable of pumping 45,000 gpm of stormwater, are provided in the station. Three of these pumps provide for the firm capacity of the station while the fourth one serves as the standby unit.

The pumping station is designed to handle smaller dry-weather flows as well as storm flows. The original design had two pumps rated at 3,500 gpm each that were set to operate in lead-lag mode. Those low flow pumps were replaced during the rehabilitation with a smaller, 250 gpm pump used for diversion and a larger, 2,500 gpm pump which was connected directly to the discharge channel. The 250 gpm pump was selected because the nearest sewage system conveyance had a capacity restriction of 0.6 million gallons per day (mgd) to 1.4 mgd, or 400 to 1000 gpm (Figure 2). The design intention was to minimize the chance of surging the manhole as a result of the diversion.

A model of the NRSPS watershed was developed using EPA's Stormwater Management Model 5.0 (SWMM). The model was used to explore how increasing diversion volumes related to increased percentages of storm flow treated (Appendix D). Even though the pump station's rated capacity is 135,000 gpm, smaller diversion pumps (i.e., up to 1,900 gpm) can capture significant percentages of overall storm flow for the three events modeled (Table 3), because of the storage and equalization capacity in the stormwater conveyance system leading up to the NRSPS.

**Table 3 SWMM Model Predictions for the Percent Stormwater Treated Under a Range of Theoretical Diversion Flows**

| Theoretical Diversion Flow (gpm) | Percent of stormwater treated for different storm events | | |
|---|---|---|---|
| | April 4, 2013 | September 21, 2013 | February 2005-October 2013 |
| 500 | 3 | 2 | 2 |
| 1400 | 68 | 25 | 36 |
| 1900 | 84 | 44 | 44 |

Table 3 denotes <u>theoretical</u> outcomes of diversion scenarios. As noted above, actual diversion flows in this project were limited to 250 gpm for safety reasons. To achieve greater diversion flows, and therefore larger amounts of stormwater treated, either an alternative to WCWD treatment would be needed, or some means of storing and conveying water to WCWD other than the existing WCWD conveyance system would be needed. This is described in more detail in Section 7.0 below (conclusions and lessons learned).

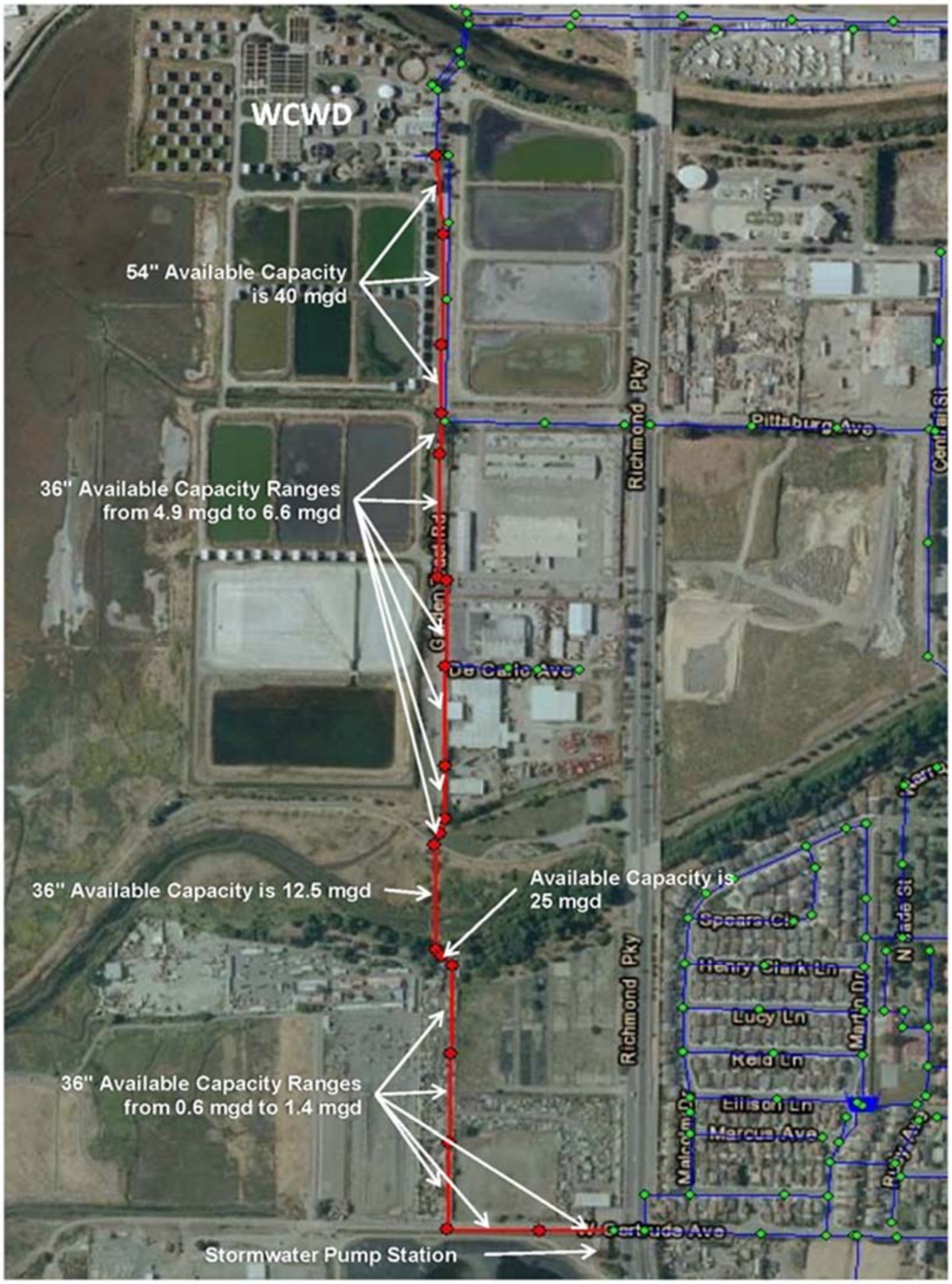


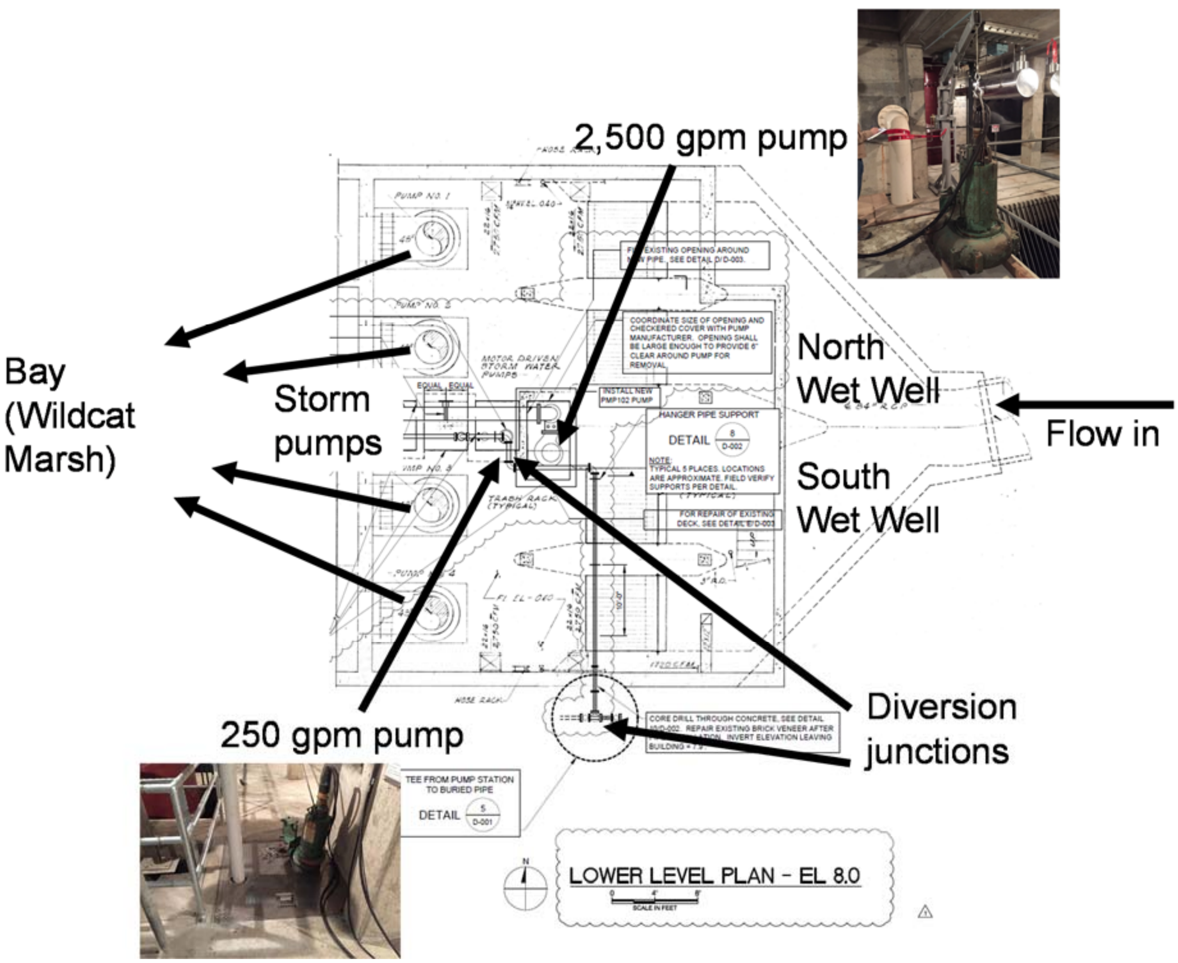

*Figure and Data Provided by Ken Cook, District Engineer, WCWD on 10/9/2012*

**Figure 2 Sewage System Conveyance Capacity in Vicinity of NRSPS**

## 4.0 DIVERSION INFRASTRUCTURE INSTALLED

On April 14, 2015, the Contra Costa County Board of Supervisors awarded a construction contract for the North Richmond Pump Station Stormwater Diversion Project to improve the pump station and provide the capability of diverting stormwater to the WCWD treatment plant for a short, specified period of time. As noted above, the diversion was a NPDES Permit requirement for the County, the Flood Control District, and all 19 cities and towns in the County. The approved construction contract amount was $469,369. The project was funded with grant funds from the Environmental Protection Agency, through the San Francisco Estuary Partnership, and with partnering funds from the CCCWP, City of Richmond, and County. Construction began on July 13, 2015 and was completed on November 24, 2015.

The project removed two 3500 gpm pumps that did not work and replaced them with two new pumps, one rated at 250 gpm and one rated at 2500 gpm (Figure 3). The new 2500 gpm pump is connected to a 14-inch discharge pipe that drains out to the Bay. The new 250 gpm pump is hooked up to a discharge pipe to the Bay as well, but also to a 4-inch discharge pipe from the pump to the outside of the pump station building. Diversion junctions inside the building and outside the building allow flexibility in routing flows from the 4 inch diversion pipe to the Bay, to WCWD, or to alternative treatment and storage should such facilities become available in the future.




*Base figure as provided by the County from design drawings completed by Brown and Caldwell as a subcontractor to LCA Architects*

**Figure 3 Summary of Key NRSPS Improvements Related to the Diversion Project**

Details showing the construction and operation of the valved diversion junctions are shown in Figure 4 below. The design goal for allowing two pathways for diverted water is to provide flexibility for NRSPS owners to explore alternative or supplemental options to treatment with sanitary sewage systems located nearby.

A temporary discharge pipe was installed from the pump station building to an existing Wastewater District manhole in Gertrude Avenue. The temporary discharge pipe was linked to a permanent manhole connection installed as part of this project (Figure 5). The manhole connection included a temporary float switch sensor that would automatically shut down the diversion pump if the manhole surged.

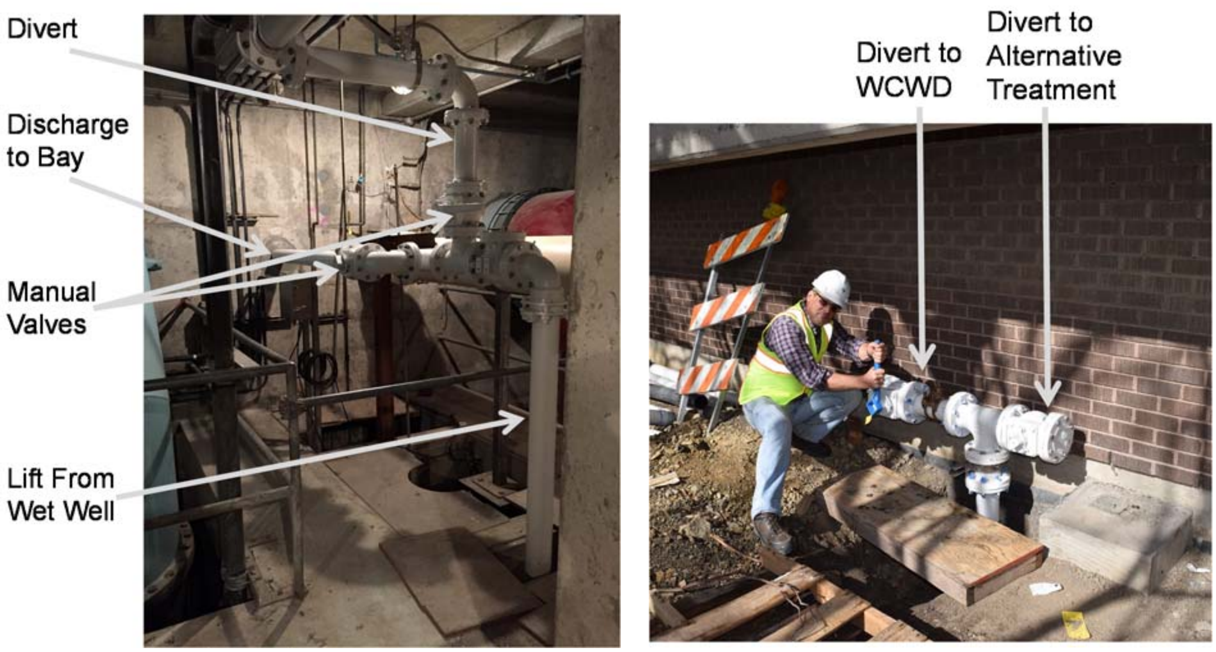



**Figure 4 Valved Diversion Junctions Inside and Outside Building Provide Operational Flexibility**

**Figure 5** **Permanent Manhole Connection to WCWD Linked to the NRSPS via a Temporary Pipe Aligned Along West Gertrude Avenue**

Comparison of the size of pipes conveying diversion flows, low flows, and storm flows helps appreciate the size of the diversion in relation to the conveyance capacity of the NRSPS (Figure 6). The 250 gpm diversion flow pipe is 4 inches in diameter, about the size of an adult’s hand. The newly installed 2,500 gpm low flow pump feeds a pipe, connected only to the Bay, which is 14 inches in diameter, about the length of an adult’s forearm. Storm flows are forced to the Bay by three existing 45,000 gpm pumps, each one discharging through a 48 inch pipe, about an adult’s chest height. The small volume of diversion flows in relation to storm flows helps manage expectations in regards to the pollutant loads reduced by the diversion pilot project described in Section 5.0 below.


**Figure 6** **Comparison of the Pipe Sizes Conveying 250 gpm Diversion Flow, 2,500 gpm Low Flows, and 35,000 gpm storm flows**

Other needed repair and rehabilitation work at the NRSPS was completed in addition to restoring a low flow pump and installing a diversion pump, valves and pipes. The two non-functioning pumps and the old sensor equipment was demolished and removed. The old motor control panel could not be modified to accommodate the new set of pumps, so a separate control panel was installed along with new level sensors. Overall, the project helps extend the useful life of the NRSPS in addition to adding stormwater diversion capability. The description of project costs in Section 6.0 parses out costs of the diversion pilot from those for the necessary repair and rehabilitation at the NRSPS to help understand the cost of infrastructure enhancements addressing only water quality improvement.

## 5.0 WET AND DRY WEATHER PILOT TESTS

During the completion of construction of the diversion, dry weather and wet weather pilot diversions to WCWD were tested. A temporary pump and discharge pipe was linked to the permanent manhole connection located on Gertrude Avenue. The temporary pump provided around 200 gpm of flow to the WCWD collection system; however, dry weather flows are around 100 gpm, therefore the dry weather diversion did not operate continuously. For the dry weather diversion, an average diversion flow rate of 100 gpm was assumed, accounting for pump down time between diversion runs. A temporary pump was necessary because the diversion pilot needed to be conducted before the project was completed. The County was concerned that opportunities for rain events would be lost if the pilot was postponed until installation and testing of the permanent diversion pump had been completed.

The dry weather pilot diversion was completed on September 23, 2015 (Appendix E). The wet weather diversion was completed on November 2, 2015 (Appendix F). Table 4 below summarizes key data from the reports on the diversion pilots. The diversion flow volumes listed in Column A of Table 4 are multiplied by average pollutant concentrations listed in Column B to calculate pollutant loads diverted as shown in Column C. Column D shows ratios of pollutant concentrations to suspended sediment concentrations (SSC), effectively the pollutant concentration in suspended sediments. It is assumed that all sediment is removed from the diverted stormwater at the WCWD treatment plant, along with all pollutants attached to the sediment particles such as PCBs and Mercury.

**Table 4 Monitoring Results from Wet and Dry Weather Diversion Pilots at NRSPS**

| (A) Diversion Information | | (B) Average Pollutant Concentration | | | | (C) Pollutant Load Diverted | | | | (D) Pollutant Concentration in Suspended Sediments | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | mg/L | ng/L | | | kg | mg | | | ng/g | | |
| Type and Date | Flow Diverted (gal)[1] | SSC | Hg | MeHg | PCB | SSC | Hg | MeHg | PCB | Hg SSC | MeHg SSC | PCB SSC |
| Dry 9/10/2015 to 9/23/2015 | 456,000 | 34 | 9.1 | 0.06 | 0.37 | 59 | 16 | 0.10 | 0.64 | 270 | 2 | 11 |
| Wet 11/2/2015 | 32,000 | 52 | 36 | 0.49 | 7.0 | 6 | 4 | 0.06 | 0.84 | 690 | 9 | 134 |

1. Flow for the dry weather event was estimated based on 100 gpm x 60 minutes / hr x 8 hrs per day x 9.5 working days

The flow volume was more than ten-fold larger for the dry weather diversion because it went on for nine and a half working days, as compared to a half a working day for the brief wet weather event sampled on November 2. Despite the much larger flow volume diverted, the PCB loads diverted to WCWD are comparable for the wet and dry pilot tests. This is because the SSC concentration was higher during wet weather (52 mg/L compared to 34 mg/L), and the monitored PCB concentrations in the suspended sediments conveyed by the wet weather event were more than ten-fold higher compared to the dry weather event (134 ng/g compared to 11 ng/g). The same was true for methylmercury (MeHg). Mercury (Hg) concentrations in wet weather suspended sediments were only around three-fold higher compared to dry weather (690 vs 270 ng/g), and so the mercury loads diverted by the dry weather diversion ended up being four-fold greater than the wet weather diversion. The total PCBs removed by treatment during the pilot period was almost one and a half milligrams (1.48 mg) and total Mercury removed was 20 milligrams.

These pollutant concentrations in suspended sediments are consistent with regional trends. Stormwater from a pilot test at 1st Street and Cutting Blvd. in Richmond were recently shown to have mercury / SSC ratios of approximately 1 (Contra Costa Clean Water Program, 2015). PCB The average PCB to suspended sediment ratio of 134 at the NRSPS is typical of older urban areas along the Bay (Contra Costa Clean Water Program, 2013), and consistent with previous monitoring conducted by the San Francisco Estuary Institute (BASMAA, 2014).

## 6.0 PROJECT COSTS

The overall cost of executing this pilot project was $1,440,000. The actual construction contract for the pump station rehabilitation was $469,469; that cost included the construction and contractor labor related to the diversion pilot. Design of the pump station project cost an additional $280,000. Both design and construction reflected a project to divert storm water plus some improvements to the pump station facilities. The remaining project costs, over and above design and construction, comes from planning study, monitoring, reporting, project management, and multi-agency coordination that results from implementing a grant funded pilot project involving multiple jurisdictions with the goal of fulfilling a regulatory mandate.

The following subsections provide a more detailed analysis of costs provided by Contra Costa County to help parse out the base cost of the rehabilitation of the NRSPS from the cost of enhancements needed to accomplish the goal of diverting urban runoff to WCWD. Though the multiple project partners and funders necessitated extensive parsing out of the project costs, the important cost information for most readers is the estimate to replicate this project as a standalone stormwater diversion project, rather than an add-on to a rehabilitation.

### 6.1 FACILITY IMPROVEMENT

Stormwater flowing to the NRSPS comes from the City of Richmond, the unincorporated community of North Richmond, and, to a small extent, the City of San Pablo. The City of Richmond and County share the cost of maintaining, improving, and operating the pump station. Even though the purpose of the project was to divert stormwater to the Wastewater District, some work resulted in improvements to the existing pump station facilities. To divide the project costs amongst the funding partners, costs associated with improvements to the facilities needed to be separated from the costs associated solely with stormwater diversion. Those project costs that improved the pump station facilities had a long-term benefit to the pump station operations. Those project costs associated solely with the temporary stormwater diversion did not help improve pump station operations. The new 2,500 gpm pump is used for lifting low storm flows in the pump station and will save the large 45,000 gpm pumps from being used to evacuate the wet wells during low flow events. The new 250 gpm pump was used for the temporary diversion of stormwater to the WCWD treatment plant, but can also be used to lift dry weather flows in the pump station and extend the service life of both the 2,500 gpm pump and the large 45,000 gpm pumps. The four 45,000 gpm storm pumps (Figure 3) are the primary workhorses of the NRSPS and the most valuable asset and most expensive component. Anything that extends their service life is a benefit to the County and City.

### 6.2 STORMWATER DIVERSION COMPONENTS

That portion of the project that related solely to the temporary diversion of stormwater consists of a permanent discharge pipe installed from the 250 gpm pump to a connection point on the outside of the building. In addition, a temporary discharge hose was installed from the connection point outside the pump station building to the WCWD manhole in Gertrude Avenue. A sensor conduit was also installed from the building to the manhole. Lastly, a permanent discharge pipe was installed into the manhole from the edge of the pavement on Gertrude Avenue to connect with the temporary discharge pipe from the pump station, and a sensor conduit was installed into the manhole. A temporary sensor was placed in the manhole to measure the flow and elevation of the flows within the WCWD manhole to make sure diversion flows did not exceed the capacity of the sewer line.

### 6.3 CONSTRUCTION COST SPLIT

The contractor bid the project on a lump sum basis, but provided a breakdown of costs for all elements of the project. Those elements of the project that constitute the temporary stormwater diversion and facility improvements are shown in Table 5 below.

**Table 5 North Richmond Pump Station Rehabilitation and Diversion Construction Costs**

| Task No. | Description | Stormwater Diversion | Facility Improvements | Totals |
|---|---|---|---|---|
| 1 | Temporary Diversion Pipes (4-inch) | $31,000 | | $31,000 |
| 2 | Temporary Diversion electrical work (50%) | $32,500 | | $32,500 |
| 3 | Facility electrical improvement work (50%) | | $32,500 | $32,500 |
| 4 | Facility pump improvement work | | $183,100 | $183,100 |
| 5 | Facility demolition/preparation work | | $34,000 | $34,000 |
| 6 | Water control during construction | | $22,400 | $22,400 |
| 7 | Miscellaneous Costs | $5,267 | $22,602 | $27,869 |
| 8 | Mobilization and Overhead | $20,034 | $85,966 | $106,000 |
| | **Total Construction Cost** | **$88,801** | **$380,568** | **$469,369** |

1. Miscellaneous Costs, and Mobilization and Overhead are soft costs that are split between Stormwater Diversion and Facility Improvements in proportion to the hard costs for each one (18.9%/81.1%).
2. The cost split for electrical work between the temporary diversion component and the facility improvements component (50%/50%) was provided by the contractor, Valentine Corporation.
3. Total construction cost based on the construction contract awarded to Valentine Corporation on April 1, 2015.
4. Cost breakdown for each task provided by the contractor, Valentine Corporation.

## 6.4 MOST LIKELY PUMP STATION STORMWATER DIVERSION PROJECT COSTS

How does this project compare to other likely stormwater diversion projects in the Bay Area? In some ways the North Richmond Pump Station is different from other pump stations in the Bay Area. These differences need to be examined in order to determine the cost estimate for the most likely pump station diversion project, a project applicable to the average pump station in the Bay Area.

### 6.4.1 Pump Replacement

The NRSPS has suffered from decades of deferred maintenance. As result, the two original smaller 3500 gpm pumps had not been working for years. In addition, the original dry weather flows were based on agricultural land-uses. Today's land-uses, and the land-uses reflected in the General Plan, are more residential and produce less dry weather flows. The combination of a lower demand and two nonfunctioning pumps resulted in a design to install the new diversion project pumps in place of the nonfunctioning pumps. The average pump station will likely have all of its pumps maintained and operating, and may not be able to remove an operational pump for a small stormwater diversion pump. The size of the stormwater diversion pump is based on the limiting capacity of the wastewater district facility accepting the stormwater flows, however, it is likely a much smaller pump size than that needed for pump station operations. Finding a new spot to place a stormwater diversion pump in an existing pump station may or may not present a problem.

### 6.4.2 Agency Coordination

In some cases, the pump station and wastewater district accepting the stormwater is owned by the same agency. In this case, the NRSPS is owned by Contra Costa County and the wastewater treatment plant is owned by the West County Wastewater District. The WCWD, though supportive of the project, was naturally concerned about the potential impact the diversion of stormwater might have on their treatment plant. As result, two years of stormwater sampling and analysis was conducted to determine the constituents in the stormwater. A Feasibility Study was prepared to determine the feasibility of diverting stormwater from the pump station to the treatment plant from an engineering perspective and, given the pollutants and pollutant loading in the stormwater, determine if there were any impacts on the wastewater treatment train. The WCWD expressed some additional concerns that prompted a second Technical Study which addressed those concerns. This initial planning effort, from initiating the stormwater sampling to the WCWD accepting the project design concept, took over3 years.

### 6.4.3 Facility Improvement

Due to the extensive deferred maintenance of the NRSPS, a portion of the stormwater diversion project resulted in improvements to the pump station facilities. Some of the costs that would be part of a stand-alone stormwater diversion project were identified as a facility improvement in the NRSPS project. However, in a typical stormwater diversion project many of those costs would be a project cost. For example, the cost of water control during construction was identified as a facility improvement in the NRSPS project, whereas a stand-alone stormwater diversion project would have to account for that type of cost.

### 6.4.4 Stormwater Diversion Project Costs

For the NRSPS project, the contract items were divided between those needed for the stormwater diversion and those that resulted in improvements to the existing pump station facility. However, the costs assigned to the stormwater diversion part of the project are not representative of a stand-alone stormwater diversion project. Using the construction contract for the NRSPS project and assigning costs to project elements for a more likely stormwater diversion project results and a more realistic cost estimate for a stand-alone stormwater diversion project. Table 5 above shows the cost split between stormwater diversion elements and facility improvement elements for the NRSPS Stormwater Diversion Project. Table 6 shows the contract costs associated with a more likely stand-alone stormwater diversion project. This estimated construction cost is based on the construction contract for the NRSPS Stormwater Diversion Project plus change orders associated with the stormwater diversion component of the project. The estimated construction contract cost (approximately $160,000) from Table 6 can be used to build a total project cost estimate for a stormwater diversion project using the costs of the project elements for the NRSPS Stormwater Diversion Project and adjusting them accordingly. For example, the $280,000 design cost for the full project was adjusted, proportionally, to $95,000 for a smaller stand-alone stormwater diversion project. The final project cost estimate for a stand-alone stormwater diversion project is shown on Table 7.

**Table 6 Most Likely Stormwater Diversion Construction Costs**

| Task | Description | Stormwater Costs | Diversion |
|---|---|---|---|
| 1 | Diversion pipes within building | $31,000 | |
| 2 | Diversion pipes outside building | $10,000 | |
| 3 | Electrical work | $32,500 | |
| 4 | 250 GPM pump | $15,410 | |
| 5 | Water control | $22,400 | |
| 6 | Miscellaneous | $8,918 | |
| 8 | Mobilization and Overhead | $33,920 | |
| 9 | Change Orders | $4,519 | |
| | **Total Construction Cost** | **$158,667** | |

### Table 7 North Richmond Stormwater Diversion Project Final Cost Estimate for Stormwater Diversion Only

| Task No. | Task Description | Notes | Cost Estimate |
|---|---|---|---|
| 1 | Project Management | 1 | $268,000.00 |
| 2 | Pre-project lab work | 2 | $137,000 |
| 3 | Monitoring | 3 | $150,000 |
| 4 | Diversion staff costs | 4 | $12,000 |
| 5 | Feasibility Report | 5 | $76,000 |
| 6 | Technical Report | 6 | $59,000 |
| 7 | Final Report | 7 | $10,000 |
| 8 | Design | 8 | $95,000 |
| 9 | Construction Contract | 9 | $160,000 |
| 10 | Construction Management | 10 | $16,000 |
| | | **TOTAL** | **$983,000** |

1. Project Management costs include pre-project work with SFEI and Wastewater District
2. Advance fieldwork and lab analysis performed by SFEI funded primarily with grants
3. Additional two years of monitoring funded by BASMAA
4. Estimated by the Wastewater District and includes $2000 County staff time
5. Feasibility Study completed on November 7, 2012
6. Technical Report completed on November 20, 2013
7. Final Report identifies how project objective was met and lessons learned
8. Design includes CEQA, permitting, right-of-way, and engineering and architectural work
9. Construction cost estimate taken from Table 1
10. Estimated to be 10% of construction contract amount

## 7.0 CONCLUSIONS AND LESSONS LEARNED

The magnitude of the diverted pollutant loads in this pilot test compared to regulatory mandates is sobering. Diverting almost a milligram of PCBs during a prolonged (9.5 days) diversion or a single (0.5 day) storm event achieves almost nothing compared to the current Baywide mandate of reducing 18,000 grams of PCBs (18 million milligrams) from all stormwater sources each year. This pilot test achieved a tiny fraction - about 0.00001 percent - of the 18 kg load reduction goal established by the TMDL for PCBs in San Francisco Bay.

Scaling the pilot up to the maximum diversion capacity, 250 gpm operated year-round, 24 hours a day seven days a week, would not extend the PCB load reductions by an appreciable amount. Note from Table 3 above that a theoretical wet weather diversion of 500 gpm captures only two to three percent of the storm flows modeled. It would take much larger diversion flows – i.e. thousands of gallons per minute – to capture appreciable amounts of storm flows. Diversions of that scale would require either separate offline high rate treatment, or offline storage and equalization so that WCWD could treat and use the water when it is needed by recycled water customers. Any such approach is a much more substantial and costly engineering endeavor than what has been achieved at the NRSPS through this pilot project.

Overall, stormwater diversion to sanitary does not appear to be a tool that will provide substantive progress towards meeting PCB load reduction goals established by the TMDL.

Monitoring at the NRSPS shows that the estimated watershed PCB load is no more than approximately 10 grams per year generated in that drainage (BASMAA, 2014; Hunt et al., 2012). Even with an impressive capture and use project that harvested nearly all stormwater from the NRSPS service area, 10 grams per year is a very small step towards attaining a load reduction goal of 18,000 grams per year.

From a cost perspective, a diversion project of this scale, implemented as a “stand-alone,” without including any infrastructure rehabilitation, would cost close to $1,000,000 for planning, design, construction, monitoring, project management, and reporting.

In summary, this project achieved the objective of installing and pilot testing urban runoff diversion infrastructure. Diversion of dry and wet weather urban runoff into the nearest water reclamation facility offers only incremental PCB load reduction benefits. Diversion is not a “silver bullet” that will make a significant difference to PCB loads; however, consideration of multiple water quality benefits, such as trash controls, water resource development, and reduction of bacteria, oil and grease, and other urban pollutants discharged to Wildcat Marsh and the Bay may motivate additional, expanded stormwater harvest and use projects in this watershed.

Water resource needs may be the overall driver. The newly installed diversion infrastructure can harvest and re-use approximately 50 million gallons[1] per year of urban runoff, primarily as dry weather urban runoff, should WCWD desire to use the infrastructure to implement longer term diversions. Overall, the immediate benefit of extending the useful life of the NRSPS and having diversion capabilities, opens longer term planning opportunities that makes this project a success.

On February 25, 2016, the NRSPS Stormwater Diversion Project was awarded the honor of Environmental Project of the Year by the Northern California Chapter of the American Public Works Association (Appendix A). The award named CCCWP as “an essential partner in the development and construction of this innovative project.”

## 8.0 REFERENCES


Applied Marine Sciences, 2015. Field Sampling Report, North Richmond Pump Station Dry Weather Diversion, Water Quality Monitoring, December 1, 2015 (Appendix F)

Amec Foster Wheeler, 2016. Field Sampling Report, Diversion – Wet Weather Monitoring. North Richmond Pump Station, Contra Costa County, California. January, 2016 (Appendix G).

Bay Area Stormwater Management Agencies Association (BASMAA), 2010. Stormwater Pump Station Diversions Feasibility Evaluation. Prepared by Brown and Caldwell for Bay Area Stormwater Management Agencies Association (BASMAA), December 1, 2010.


[1] This figure is based on an assumed 100 gpm of dry weather flow year-round, diverted 365 days per year, 24 hours a day, with 10 percent down time for storms and maintenance.

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East Bay Municipal Utility District, 2010. Environmental Enhancement Project and Supplemental Environmental Project: Characterization of Stormwater Flows, Diversion of Dry Weather and First Flush Flows to a Publicly Owned Treatment Works. July, 2010.

Hunt, J., Gluchowski, D., Gilbreath, A., and McKee, L.J., 2012. Pollutant Monitoring in the North Richmond Pump Station: A Pilot Study for Potential Dry Flow and Seasonal First Flush Diversion for Wastewater Treatment. A report for the Contra Costa County Watershed Program. Funded by a grant from the US Environmental Protection Agency, administered by the San Francisco Estuary Project. San Francisco Estuary Institute, Richmond, CA. http://www.sfei.org/sites/default/files/NorthRichmondPumpStation_Final_19112012_ToCCCWP.pdf

## APPENDIX A

Award - Environmental Project of the Year by the Northern California Chapter of the American Public Works Association (February 25, 2016)

NORTHERN CALIFORNIA CHAPTER

Northern California Chapter
Proudly Proclaims the

**NORTH RICHMOND PUMP STATION STORMWATER DIVERSION PROJECT**

as the

**2016**
**ENVIRONMENT PROJECT OF THE YEAR**

and Recognizes the

# Contra Costa Clean Water Program

As an Essential Partner in the Development and Construction of this Innovative Project

*Brian Balbas*
*2016 Chapter President*
*February 25, 2016*

**APPENDIX B**

Joint Exercise of Powers Agreement between Contra Costa County and the West County Wastewater District for Maintenance of the NRSPS (August 11, 1981)

Storm - Maintenance

# In the Board of Supervisors of Contra Costa County, State of California

August 11, 1981

RECEIVED
AUG 26 1981
WEST CONTRA COSTA SANITARY DISTRICT

In the Matter of

Approving and Authorizing Joint Exercise of Powers Agreement with West Contra Costa Sanitary District for Maintenance of the North Richmond Storm Drain Pump Station.
0330-6~~67331~~

The Public Works Director having recommended that the Board of Supervisors approve and authorize its Chairman to execute the revised Joint Exercise of Powers Agreement with the West Contra Costa Sanitary District (formerly the San Pablo Sanitary District) for the District to maintain the North Richmond Storm Drain Pump Station on behalf of the County; and

The Public Works Director having reported that this revised Agreement reflects changes in accounting and billing procedures and supersedes the original Agreement entered between the County and San Pablo Sanitary District on April 16, 1974;

IT IS BY THE BOARD ORDERED that the recommendation of the Public Works Director is APPROVED and the Chairman is AUTHORIZED to execute the Agreement.

PASSED by the Board on August 11, 1981 by the following vote:

AYES: Supervisors Fahden, Schroder, McPeak, Torlakson, Powers

NOES: None

ABSENT: None

I hereby certify that the foregoing is a true and correct copy of an order entered on the minutes of said Board of Supervisors on the date aforesaid.

Witness my hand and the Seal of the Board of Supervisors affixed this 11th day of August, 19 81

J. R. OLSSON, Clerk

By Linda L. Page, Deputy Clerk
Linda L. Page

Originator: Public Works Dept.
Maintenance Division

cc: County Administrator
Auditor-Controller
Public Works Director
Accounting Division
Maintenance
West Contra Costa Sanitary via Maintenance

AGREEMENT

(JOINT EXERCISE OF POWERS - NORTH RICHMOND STORM DRAIN PUMP STATION - MAINTENANCE)

1. PARTIES & DATE. Effective on August 11, 1981 the WEST CONTRA COSTA SANITARY DISTRICT, a political subdivision of the State of California, hereinafter referred to as "DISTRICT," and the COUNTY OF CONTRA COSTA, a political subdivision of the State of California, hereinafter referred to as "COUNTY," pursuant to Government Code Sections 6500 et seq., do mutually promise and agree as hereinafter set forth.

2. PURPOSE & SCOPE. This agreement supersedes the agreement entered into by SAN PABLO SANITARY DISTRICT and COUNTY OF CONTRA COSTA on April 16, 1974. COUNTY has constructed a storm drain system including a pumping station, in the unincorporated area of North Richmond on West Gertrude Avenue directly across from Deal Auto Wrecking at 400 West Gertrude, and has need to provide for the maintenance and operation of said pumping station, which DISTRICT is willing to provide.

3. MUTUAL PROMISES. DISTRICT shall be responsible for the maintenance and operation of said pumping station, in accordance with Paragraphs 4 and 5, below, COUNTY shall bear the cost of said maintenance and operation, including the cost of all utilities serving the pump station, such as electrical, telephone, water, sewers, natural gas, propane gas and telemetering. COUNTY also agrees to bear all costs associated with property ownership, such as frontage improvement costs and special assessments, which might be applicable.

4. DEFINITIONS.

a. "Maintenance" includes replacement and/or repair of all elements and components of the pumping station and appurtenances, including but not limited to the pumping units, engines, motors, structures, fuel storage, electrical panels, and piping, and routine maintenance such as cleaning, painting, lubrication, and maintenance of landscaping.

b. "Operation" includes operation of the pumping units and auxiliary facilities.

5. STANDARD. All operation and maintenance work shall be performed in accordance with good engineering practice and shall initially follow the Operation and Maintenance Manual to be prepared by County's consultant and furnished by COUNTY.

6. METHOD. DISTRICT will bill COUNTY every six months for actual direct labor costs, including reasonable overhead costs, the cost of supplies, and cost of services by others. DISTRICT will be allowed to add a surcharge which equals 5% of the total cost to cover the administrative and interest costs for funds advanced by DISTRICT. DISTRICT grants to the COUNTY the right to install monitoring

devices in DISTRICT'S treatment plant at locations designated by DISTRICT for the purpose of receiving monitoring signals originating at COUNTY'S pumping station. Except for emergency work, no single maintenance or operational task for which the estimated cost exceeds TWO THOUSAND FIVE HUNDRED DOLLARS ($2,500.00) shall be performed without first obtaining written approval from the appropriate COUNTY authority. In the event of emergency, DISTRICT shall notify COUNTY immediately of its repair work.

7. PAYMENT. COUNTY, upon being billed by DISTRICT for operation and maintenance costs, will reimburse DISTRICT within 30 days of receipt of invoice. DISTRICT annually will submit, no later than February 1 of each year, its estimate of annual operation and maintenance costs for COUNTY budgetary purposes. It is understood that the actual operation and maintenance costs from year to year may be greater or less than the estimated annual cost. The frequency of billing periods may be adjusted by mutual agreement of COUNTY and DISTRICT. There will be strict accountability of all DISTRICT costs and expenditures for operation and maintenance of the pump station. COUNTY reserves the right to review the financial books and records of DISTRICT with respect to charges invoiced to COUNTY.

8. INDEMNIFICATION. COUNTY, insofar as it may legally do so, shall indemnify and hold harmless DISTRICT, its officers, agents and employees from any and all liability, claims or losses resulting from, or associated with, DISTRICT'S maintenance of the pump station except where claim or damage results from negligence or willful misconduct on the part of DISTRICT, its officers, agents and employees. DISTRICT assumes responsibility for Workers' Compensation coverage and DISTRICT shall defend and indemnify COUNTY for and hold it harmless from any claims or losses on the part of DISTRICT'S employees which are governed by Workmens' Compensation. All other insurance coverage shall be furnished by COUNTY. DISTRICT shall not be liable for damage resulting from acts beyond its control, including labor strikes or stoppages, power outages, inability to procure fuel, and vandalism.

9. TERMINATION. This agreement will continue in full force and effect from year to year until rescinded or terminated. The agreement may be terminated at the end of any fiscal year by either party submitting written notification of termination to the other party on or before April 1 of the final year.

COUNTY OF CONTRA COSTA

By ______________________
Chairman, Board of Supervisors

ATTEST: J.R. Olsson
County Clerk

By ______________________
Deputy

Approved as to Form:
John B. Clausen, County Counsel

By ______________________

WEST CONTRA COSTA SANITARY DISTRICT

By ______________________
President

By ______________________
Secretary

Approved as to Form:
Robert W. Pelletreau, Board Attorney

By ______________________

## APPENDIX C

Waste Water Discharge Permit No. SD-019 (September 16, 2015)

# West County Wastewater District

## WASTEWATER DISCHARGE PERMIT

## PERMIT No. SD-019

In accordance with the West County Wastewater District (District) Wastewater Discharge Ordinance, No. 11-7-00 (Ordinance):

**Contra Costa Public Works Department**
**North Richmond Pump Station**
**Richmond Parkway at W. Gertrude Avenue**
**Richmond, CA 94801**

Is hereby authorized to discharge water from the North Richmond Pump Station into the District sewer system in accordance with the conditions set forth in this permit. Compliance with the Local Limits outlined in the Ordinance must be maintained for all discharges to the District's collection system and treatment plant. Compliance with this permit does not relieve the Contra Costa County Public Works Department (permittee) of its obligation to comply with any or all applicable pretreatment regulations, standards or requirements under local, State, and Federal laws, including any such regulations, standards, requirements, or laws that may become effective during the term of this permit.

Non-compliance with any term or condition of this permit shall constitute a violation of the District's Ordinance. Any person who violates permit conditions is subject to civil and criminal penalties and enforcement as outlined in the Ordinance and Federal pretreatment standards.

This permit shall become effective on **September 16, 2015** and shall expire at midnight on **September 15, 2018.** If the permittee wishes to continue to discharge wastestreams that are covered by the District's Ordinance, an application must be filed for renewal on or before February 28, 2018 (a minimum of 90 days before the permit expires).

Wastewater Discharge Permits are not transferable. The permittee shall notify the District prior to any change in ownership or operation, provide the succeeding owner or operator with a copy of this permit and notify them that an application for renewal of the permit may be required.

Brian E. Hill

Brian Hill
Water Pollution Control Plant Superintendant

## PART 1 – EFFLUENT LIMITATIONS

### A. Description of Discharge(s)

The permittee is authorized to discharge water from the connection listed below.

| Outfall # | Description |
|---|---|
| 1 | Runoff from the stormwater collection system at the North Richmond Pump Station into a manhole on W. Gertrude Avenue |

### B. Discharge Limits

During the term of this permit all water generated and discharged from the facility shall comply with the District's Ordinance and shall not exceed the District's Specific Discharge Limitations:

| Local Limits | | | |
|---|---|---|---|
| **Total Metals** | **Daily Maximum mg/L** | **Additional Parameters** | **Daily Maximum mg/L** |
| Arsenic (As) | 0.37 | Cyanide ($CN^-$)* | 0.4 |
| Cadmium (Cd) | 0.5 | Phenolic Compounds | 8.0 |
| Chrome (Cr) | 2.0 | Chloroform | 3.34 |
| Copper (Cu) | 3.0 | Methylene Chloride | 0.18 |
| Lead (Pb) | 2.0 | Tetrachloroethylene | 14.26 |
| Mercury (Hg) | 0.02 | Tributyltin | 0.19 |
| Nickel (Ni) | 0.8 | | |
| Selenium | 1.0 | pH | 6.0 – 12.0 units |
| Silver (Ag) | 0.3 | Temperature | < 130° F |
| Zinc (Zn) | 5.0 | | |

The permittee shall not discharge any wastewater that is prohibited under Section 2 of the District's Ordinance during the term of this permit.

The maximum flow of stormwater regulated by flow restrictor or pump capacity shall at no time exceed **400 gallons per minute** unless previous written authorization is provided by the District.

## PART 2 – MONITORING REQUIREMENTS

The permittee shall monitor this outfall for the following:

**Weekly and Monthly Monitoring Requirements**

| Sample Parameter(s) | Frequency | Sampling Period(s) | Sampling Method |
|---|---|---|---|
| pH[1] | 1x/week | October – December | Single Grab |
| Flow[2] | Continuous | October- December | Metered |

| | | | |
|---|---|---|---|
| Arsenic (As)(T) | 1x/week | October- December | Single Grab |
| Cadmium (Cd)(T) | 1x/week | October – December | Single Grab |
| Chromium (Cr)(T) | 1x/week | October – December | Single Grab |
| Copper (Cu)(T) | 1x/week | October – December | Single Grab |
| Lead (Pb)(T) | 1x/week | October- December | Single Grab |
| Mercury (Hg)(T) | 1x/week | October- December | Single Grab |
| Nickel (Ni)(T) | 1x/week | October- December | Single Grab |
| Selenium (Se)(T) | 1x/week | October – December | Single Grab |
| Silver (Ag)(T) | 1x/week | October – December | Single Grab |
| Zinc (Zn)(T) | 1x/week | October – December | Single Grab |

(T) = Total

**Quarterly Monitoring Requirements**

| Sample Parameter(s) | Frequency | Sampling Period(s) | Sampling Method |
|---|---|---|---|
| EPA Method 608 | Quarterly[3] | Jan-Mar; Apr-Jun; Jul-Sep; Oct-Dec | Composite[4] |
| EPA Method 624 | Quarterly[3] | Jan-Mar; Apr-Jun; Jul-Sep; Oct-Dec | Composite[4] |
| EPA Method 625 | Quarterly[3] | Jan-Mar; Apr-Jun; Jul-Sep; Oct-Dec | Composite[4] |
| Arsenic (As)(T) | Quarterly[3] | Jan-Mar; Apr-Jun; Jul-Sep; Oct-Dec | Composite[4] |
| Cadmium (Cd)(T) | Quarterly[3] | Jan-Mar; Apr-Jun; Jul-Sep; Oct-Dec | Composite[4] |
| Chromium (Cr)(T) | Quarterly[3] | Jan-Mar; Apr-Jun; Jul-Sep; Oct-Dec | Composite[4] |
| Copper (Cu)(T) | Quarterly[3] | Jan-Mar; Apr-Jun; Jul-Sep; Oct-Dec | Composite[4] |
| Lead (Pb)(T) | Quarterly[3] | Jan-Mar; Apr-Jun; Jul-Sep; Oct-Dec | Composite[4] |
| Mercury (Hg)(T) | Quarterly[3] | Jan-Mar; Apr-Jun; Jul-Sep; Oct-Dec | Composite[4] |
| Nickel (Ni)(T) | Quarterly[3] | Jan-Mar; Apr-Jun; Jul-Sep; Oct-Dec | Composite[4] |
| Selenium (Se)(T) | Quarterly[3] | Jan-Mar; Apr-Jun; Jul-Sep; Oct-Dec | Composite[4] |
| Silver (Ag)(T) | Quarterly[3] | Jan-Mar; Apr-Jun; Jul-Sep; Oct-Dec | Composite[4] |
| Zinc (Zn)(T) | Quarterly[3] | Jan-Mar; Apr-Jun; Jul-Sep; Oct-Dec | Composite[4] |

1. pH shall be measured in the field using a properly maintained and calibrated pH meter.

2. **Flow** - The permittee shall quantify the volume of water that is generated from regulated process operations, and is discharged to the sewer, using meters and/or totalizers, where feasible. Meter must be non-resettable; the total volume shall be recorded daily and record(s) submitted monthly.

3. Results from quarterly sampling may also be used to comply with the weekly sampling requirements for the week measurements are taken; only required for quarters when discharge occurs.

4. Composite grab sampling techniques shall be used and be representative of the total flow over a 24 hour discharge period.

**Sampling & Analyses** - All sampling and analyses required by the permit shall be performed in accordance with the techniques described in 40 CFR Part 136 and amendments thereto, using validated analytical methods approved by the EPA [40 CFR 403.12(g)] or by methods specified in the permit. Analyses shall use only wastewater methods.

The permittee shall maintain all equipment so that accurate and reliable readings are provided. Calibration of equipment shall be performed at a minimum of once per year and more often if/when necessary.

The permittee is responsible for monitoring discharge. The District will periodically monitor for compliance with the parameters outlined above and District's local limits.

## PART 3 – REPORTING REQUIREMENTS

All self-monitoring reports shall contain the following certification signed by a duly authorized representative using these words:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision and in accordance with the system designed to insure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person(s) who manage the system, or those 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 knowingly submitting false information, including the possibility of fine and imprisonment for knowing violations."

Unless otherwise stated all information and reports required by the District shall be submitted as follows:

| Information/Report for: | Due Before 5:00 p.m. |
|---|---|
| January | February 28th |
| February | March 30th |
| March | April 30th |
| April | May 30th |
| May | June 30th |
| June | July 30th |
| July | August 30th |
| August | September 30th |
| September | October 30th |
| October | November 30th |
| November | December 30th |
| December | January 30th |

1. **Flow Report** - submit monthly a report outlining daily flow meter readings, gallons discharged per day, the total volume discharged each month, and a summary of the results of monthly and weekly monitoring requirements.

2. **Flow Meter Calibration & Report** – A minimum of once every calendar year (January 1st – December 31st), the flow meter (and any associated monitoring and/or recording equipment) shall be calibrated by a qualified, independent third party and certified that they are operating within specifications. The calibration report shall be submitted before the 15th of the month following the month the calibration(s) are performed.

3. **pH Meter Calibration(s) & Report** – portable pH meter(s) should be calibrated prior to each use. Meters shall be calibrated according to equipment specifications and using buffers appropriate for proper measurement of the waste stream(s) being monitored. Logs shall be kept to verify: date of calibration, the initials and name of the technician performing the calibration(s), buffers used, the before & after pH readings, and any problems noted and/or maintenance, etc. Logs shall be kept onsite and available for review upon request.

   Failure to provide the required reports within 30 days after the due date will be considered as significant noncompliance as outlined in the District's Sewer User Ordinance [Section 1.2 (45) (f)]. Reports need to be submitted by mail, fax, or in-person. If the report is submitted electronically, the permittee must also submit by mail or fax a certification statement as is outlined in 40 CFR 403.6 (a) (2) (ii) and to be signed by an authorized representative of the facility.

4. **Sampling & Analyses:**

- Representative Sampling - Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge. All samples shall be taken at the monitoring points specified in the permit. All equipment used for sampling and analysis must be routinely calibrated, inspected and maintained to ensure its accuracy. Monitoring points shall not be changed without notification to and written approval by the District.

- Increased Sampling/Monitoring - In addition to any monitoring requirements of this permit, if the permittee monitors any pollutant at the point(s) of compliance more frequently than required by the permit, using test procedures prescribed in 40 CFR Part 136 and amendments thereto, or otherwise approved by EPA or as specified in the permit, the results of such monitoring shall be included in any calculations of the daily maximum and monthly averages. Pollutant discharge results shall be summarized and reported to the District; such increased monitoring frequency shall also be indicated in the report.

- Permit Violations and Automatic Re-sampling - If the results of analyses of the permittee's discharge indicate that a violation of the permit has occurred, the permittee, according to 40 CFR 403.12(g) must:

  a) Inform the District of the violation within 24 Hours of becoming aware of the violation and;
  b) The permittee shall also repeat the sampling and analysis and submit the results of the repeat analysis within 30 days after becoming aware of the violation.

  Exceptions to the requirement of repeat sampling and analysis are if the District samples the facility at least once per month, and/or, if the District performs sampling at the facility between the time the initial sample was collected (that indicated there was a violation) and when the results of that sample event were received.

- Record Contents - Facilities shall maintain records of all information resulting from any monitoring activities, including documentation associated with Best Management Practices. Copies of records shall be submitted to the District and originals shall be kept by the permittee; records of sampling and analysis shall include:

  a) The date, the exact place(s), time(s), and methods of sampling or measurements, and sample preservation techniques or procedures;
  b) Who performed the sampling or measurement (name and company);
  c) The date(s) analyses were performed;
  d) The person(s) who performed the analysis;
  e) The analytical technique(s)/method(s) used;
  f) The results of such analyses;
  g) Laboratory Quality Assurance and Quality Control reports (QA/QC);
  h) A record of sample possession from the time the sample was collected to the time the report of analysis was completed (Chain of Custody).

5. **Changes**

The facility is required to notify the District, in writing, of any significant changes to the User's operations or system which might alter the nature, quality, or volume of its discharge at least 90 days before the change. The facility is required to submit such information as may be deemed necessary to evaluate the changed condition, including submission of an updated wastewater discharge application. The District may modify this permit in response to changed conditions or anticipated changes in conditions.

6. **Retention of Records** – The facility shall maintain records of all information resulting from any monitoring activities, including documentation associated with Best Management Practices. Copies of records shall be submitted to the District and originals shall be kept by the permittee; records of sampling and analysis shall include:

   i) The date, the exact place(s), time(s), and methods of sampling or measurements, and sample preservation techniques or procedures;
   j) Who performed the sampling or measurement (name and company);
   k) The date(s) analyses were performed;
   l) The person(s) who performed the analysis;
   m) The analytical technique(s)/method(s) used;
   n) The results of such analyses;
   o) Laboratory Quality Assurance and Quality Control reports (QA/QC);
   p) A record of sample possession from the time the sample was collected to the time the report of analysis was completed (Chain of Custody).

7. **Waste Disposal** - The permittee shall maintain records to verify that any hazardous materials and/or wastes that are prohibited from discharge to the sanitary were disposed of properly. Wastes must be handled, stored, and disposed of according to applicable local, state, and federal regulations. Records of disposal and/or recycling of such wastes must be retained by the permittee for a period of three years. These records shall include the amount of waste generated and the method of final disposal (including appropriate waste manifests).

## PART 4 – NOTIFICATION OF SLUG DISCHARGE AND BYPASS

The permittee shall notify the District immediately of any changes at the facility affecting the potential for a slug discharge and bypass.

The permittee shall notify the District immediately upon the occurrence of an accidental discharge of substances prohibited by Section 2 of the District's Ordinance or any slug loads or spills that may enter the sewer.

1. Bypass – the intentional diversion of wastestreams from any portion of an Industrial User's treatment facility [40 CFR 403.17 (a)].

2. Slug Discharge(s) - any discharge of a non-routine, episodic nature, including but not limited to an accidental spill or a non-customary batch Discharge, which has a reasonable potential to cause Interference or Pass Through, or in any other way violate the POTW's regulations, local limits or permit conditions. The results of such activities shall be available to the District upon request.

The permittee is required to notify the District immediately of any changes at the facility affecting the potential for a slug discharge, and if the District determines a plan is required, the permittee shall develop a plan that contains, at a minimum, the following:

a) Description of discharge practices, including non-routine batch Discharges;
b) Description of stored chemicals;
c) Procedures for immediately notifying the POTW of Slug Discharges, including any Discharge that would violate a prohibition under 40 CFR Part§ 403.5(b) with procedures for follow-up written notification within five days;
d) If necessary, procedures to prevent adverse impact from accidental spills, including inspection and maintenance of storage areas, handling and transfer of materials, loading and unloading operations, control of plant site run-off, worker training, building of containment structures or equipment, measures for containing toxic organic pollutants (including solvents), and/or measures and equipment for emergency response.

## PART 5 – STANDARD CONDITIONS

The permittee shall comply with all requirements of this permit, all conditions specified in the District's Wastewater Discharge Ordinance (11-7-00).

## PART 6 – CIVIL AND CRIMINAL PENALTIES

The facility is subject to civil and criminal penalties for violation(s) of Pretreatment Standards and requirements, and any applicable compliance schedule(s); reference Section 5 of the District's Wastewater Discharge Ordinance.

## PART 7 - PERMIT EXTENSION

The District reserves the right to extend the permit if necessary. The District must provide a written notice to the permittee at least 90 days before the permit expires. The permit cannot be extended beyond the maximum of five years permit limit [40 CFR 403.8 (f1) (iii) (A)].

**End of Permit**

amec foster wheeler

**APPENDIX D**

SWMM Modeling for North Richmond Pump Station, Options for Minimizing Stormwater Discharge into the Bay (March 4, 2016)

**Memo**

To: Mitch Avalon
Contra Costa County
Project Manager of the
NRSPS Diversion Pilot

From: Sandy Chang
Dr. Khalil E.P. Abusaba

Tel: (510) 663-4100

Project: 5025153001.01

Fax: (510) 663-4141

cc: Cece Sellgren, Contra Costa County Watershed Program

Rob Carson, Contra Costa Clean Water Program

Date: March 4, 2016

**Subject: SWMM Modeling for North Richmond Pump Station, Options for Minimizing Stormwater Discharge into the Bay**

## 1.0 EXECUTIVE SUMMARY

The estimated dry weather flow rate for the NRSPS ranges from 80 gpm to 140 gpm. The percentage of stormwater that could be treated by using diversion pumps of varying size to provide onsite or offsite treatment is summarized in Table 1 below.

**Table 1. Percent of stormwater that could be treated at the NRSPS under various assumed treatment capacities.**

| Treatment capacity (gpm) | % stormwater treated | | |
|---|---|---|---|
| | April 4, 2013 | September 21, 2013 | February 2005-October 2013 |
| 500 | 3 | 2 | 2 |
| 1400 | 68 | 25 | 36 |
| 1900 | 84 | 44 | 44 |

## 2.0 INTRODUCTION

The purpose of this memorandum is to document the approach and findings of flow modeling applied to the sub-watershed that drains into the North Richmond Pump Station (NRPS) (Fig. 1). This work is being done to assist Contra Costa County, as one of the NRSPS co-owners, who is taking the lead on a pilot project with the consent of the other co-owner, the City of Richmond. This modeling work has been done to support the design of a pilot project to divert stormwater from the NRSPS into the nearby West County Wastewater District (WCWD) sewage treatment plant (CCCWP, 2012).

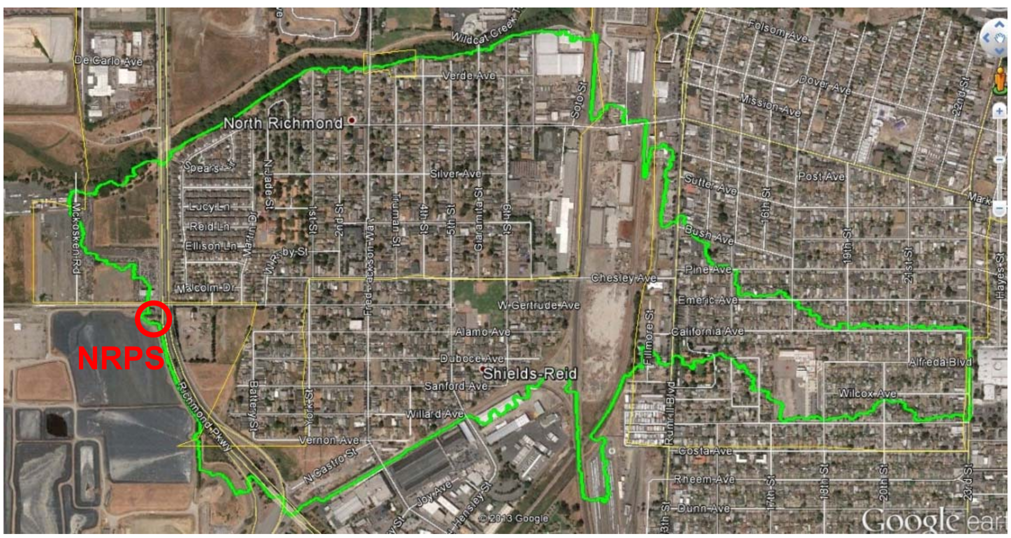


Figure 1: Delineation of sub-catchment drainage into NRPS (Contra Costa County).

The pilot diversion project is one of several pollutant reduction pilot projects required by the San Francisco Bay Regional Water Quality Control Board (SFRWQCB) through the Municipal Regional Stormwater National Pollutant Discharge Elimination System (NPDES) Permit (Order No. R2-2009-0074, a.k.a. “the MRP”). The goal of pollutant reduction pilot projects required under the MRP is to evaluate the feasibility, costs, and benefits of different approaches to reducing stormwater loads of polychlorinated biphenyls (PCBs) and mercury discharged into the Bay. This pilot project evaluates the circumstances under which it may be feasible and cost effective to co-manage stormwater discharges from the NRSPS with municipal sanitary sewage using treatment capacity available at WCWD.

The NRPS was originally designed with four high flow pumps, each with a rated capacity of 45,000 gpm. Three of the pumps are duty pumps, one is a standby, giving the NRSPS a capacity of 135,000 gpm. The original design also included two smaller pumps for lower flows, each rated at 3500 gpm. Currently, only the three high flow pumps are functional. During periods of low flows, including both light rainfall events and prolonged periods of dry weather urban runoff that occur in the summer, the collection system upstream of the NRSPS are filled and emptied every one to two days by the high flow pumps operating in short bursts lasting no more than a few minutes. The current mode of operation is less than ideal, because of excessive use of the high flow pumps in a manner different from the design intent, and because of potential problems caused by accumulation of standing, stagnant water in the collection system.

As part of implementing this pilot project, low flow pumping capacity will be restored. Dry weather flow rates were likely higher in the early 1970s, when the NRSPS was designed, compared to current dry weather flow rates. Present-day dry weather inflow rates were estimated using modeling to support design of the diversion. In addition to estimating dry weather inflow rates, modeling is used to forecast how much stormwater can be diverted to either WCWD and/or an onsite stormwater that may be constructed in the future.

This study modeled five scenarios:

**Scenario 1:** The current system (with no low flow pumps operational). This scenario was used to estimate current dry weather inflow rates.

**Scenario 2:** The current system with 400 gpm low flow pumping capacity. This scenario was used to model dry weather and first flush diversions to WCWD.

**Scenario 3:** 400 gpm diversion to WCWD along with onsite treatment capacity of 100 gpm

**Scenario 4:** 400 gpm diversion to WCWD along with onsite treatment capacity of 1000 gpm

**Scenario 5:** 400 gpm diversion to WCWD along with onsite treatment capacity of 1500 gpm

These five scenarios address two key questions that need to be answered prior to proceeding with design of the pilot diversion project:

***What is the current dry weather flow rate into the NRSPS?***

***How much stormwater can be treated, either onsite or by WCWD, under different design scenarios?***

## 3.0 APPROACH

The NRPS was modeled using the EPA Storm Water Management Model (SWMM 5.0), a dynamic rainfall-runoff simulation model specifically adapted for designs related to urban storm water runoff, sanitary sewers, and other drainage systems. SWMM 5.0 has the capability to include pollutant loading and other water quality parameters, climate inputs such as precipitation and evaporation, groundwater interactions, as well as hydraulic mass balancing. The scope of this work was limited to analysis of water quantities.

Model design relied on specifications as outlined in the North Richmond Storm Drain Project Storm Drain System & Outfall Channel as-built[1] (Fig. 2) and the Pump Station and Discharge System design plans[2]. Using these drawings for guidance, a detailed model domain was created (Fig. 3) to mimic the stormwater conveyance system. Additional model inputs include the sub-watershed delineation as provided by Contra Costa County (Fig. 1) and rainfall data from the Richmond City Hall rain gauge[3] operated by the County.

Continuous water level monitoring data from the time period September 27, 2012 to May 21, 2013 were provided by the San Francisco Estuary Institute (SFEI), who has been monitoring flow and water quality at the NRSPS since 2010. Water level variation was used in Scenario 1 (existing conditions) to estimate dry weather inflow rates. Model dry weather inflow rates were varied until the timing of the rise and fall of water levels most closely matched the frequency of pump operation based on the continuous monitoring observations made by SFEI staff.

The three operational pumps were modeled as a single pump that varies between 7000 gpm (ramp up speed) and 135,000 gpm to match the inflow rates. This is not an exact replica of actual pump operations; the pumps turn on and off and ramp up and down their operating speeds in response to changing water levels. As a result, actual operations involve a certain lag time for the discharge pumps to match water inflow rates. In the model, the pumps respond to changing water levels instantaneously. This approximation is not thought to be a significant factor affecting the findings presented in this memorandum.

In the model, dry weather diversions and wet weather diversions (to WCWD) were assigned unique pumps. This was simply a modeling convenience to tabulate separately the volumes of stormwater vs. dry weather flows diverted – in the actual design of the pilot project, the same pump would be used to divert low flows as would be used to divert storm flows.

The models for each scenario are provided in a companion thumb drive to this memorandum.

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1 Contra Costa County Flood Control & Water Conservation District, 1972. Contra Costa county North Richmond Storm Drain Project, Project No. W.S.-Calif.-436, Storm Drain System & Outfall Channel, November 21.

2 Brown and Caldwell, 1972. Contra Costa County, North Richmond Storm Drain Project HUD Project No. W.W.-Calif.-436, Pump Station and Discharge System. November.

3 The Richmond City Hall (RHL) rain gauge data, operated by Contra Costa County with website maintained by the California Department of Water Resources, is available at: http://cdec.water.ca.gov/cgi-progs/selectQuery?station_id=RHL&sensor_num=16&dur_code=E&start_date=&end_date=now

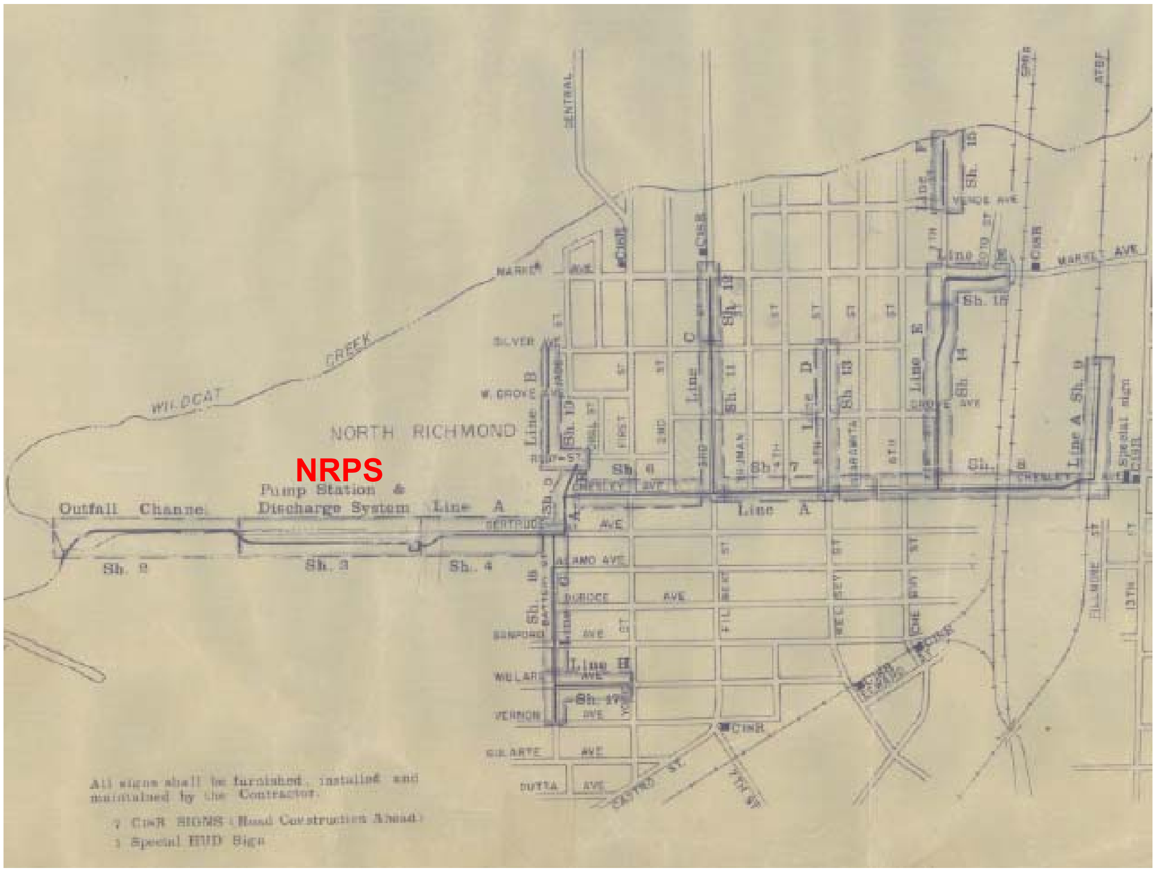



Figure 2: Storm Drain System of North Richmond Storm Drain Project (1972).

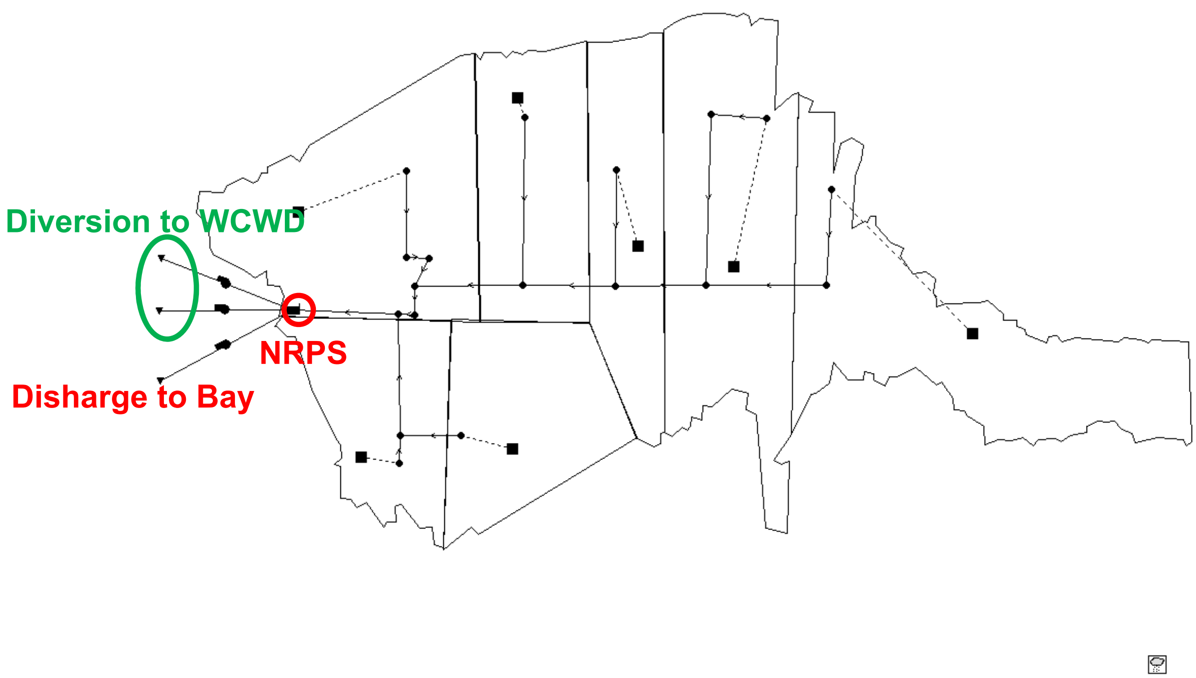



Figure 3: Watershed model with drainage system and diversion.

# 4.0 RESULTS

## 4.1 Scenario 1: Existing Conditions

The purpose of this base case is to estimate the dry weather inflow rate. Important calibrating observations include measurements made by San Francisco Estuary Institute (SFEI). Dry weather flow rates can be estimated with the following approaches:

1) The storage volume of the system when full and after pumps turn off can be calculated form geometry, and the dry weather inflow rate estimated based on the change in storage volume over time.
2) Alternatively, dry weather flow rates can be varied in the SWMM 5.0 model to find the closest match in model performance to the observed water level oscillations.
3) The volume pumped out on any particular pump run can be estimated based on pump run times and estimates or measurements of pump run speeds (rpm) and wet well

levels. This latter approach was piloted by SFEI in the 2012 -2013 through their monitoring on behalf of the San Francisco Bay Regional Monitoring Program.

Results from first two approaches are compared below. Comparisons to the third approach, using pump run times and speeds in conjunction with water level data, are deferred until completion of the annual monitoring reports for NRPS monitoring by SFEI.

The NRPS design plans show that when water elevation reaches -9.46 ft, water backs up into the upstream conveyance system – in other words, the conveyance system is design to provide storage buffer. Considering the volume of the pipe that is below elevation -2.83 ft (when the storm pumps are configured to turn on according to the NRPS manual), the system has an estimated storage capacity of 412,500 gal, including the pump station, when the conveyance system is full. The pumps are configured to switch off at elevation -5.58 ft. The storage volume in the system that is below elevation -5.58 feet is 205,300 gal. By difference, the amount of water pumped out each time the pumps switch on during dry weather flows is approximately 207,000 gal.

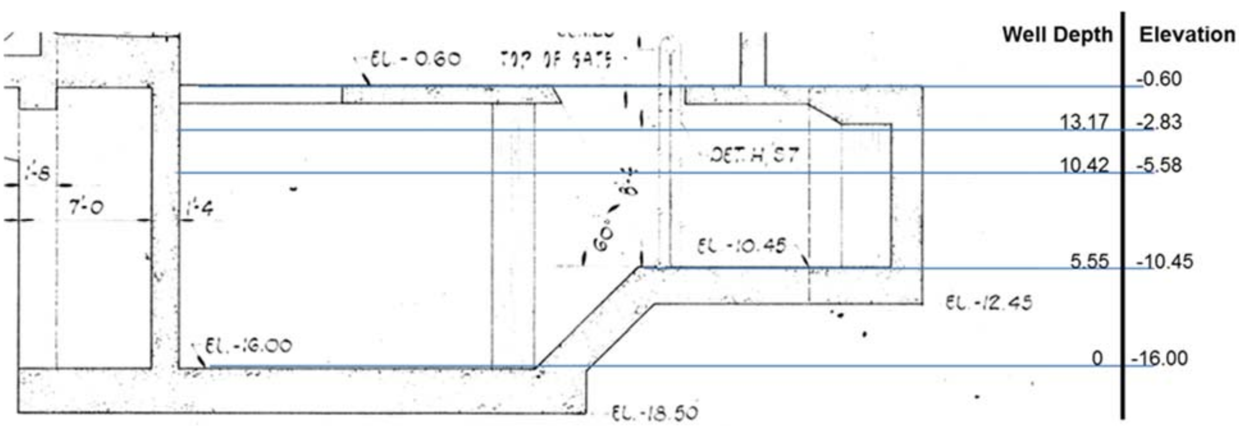



Figure 4: Cross-sectional view of wet well (Brown and Caldwell, 1972).

Based on SFEI's well level data from September 27, 2012 to October 10, 2013, before the first storm event, the pump turned on at an average interval of 1.52 days, ranging between 1.39 days to 1.80 days during the dry season (i.e., between seven weeks after the last rain event of the season to the first rain event of the next season). This corresponds to an estimated dry weather inflow rate of 95 gpm, with a likely range from 80 gpm to 100 gpm.

For comparison, the modeled dry weather flow that predicts a pump cycling frequency of 1.52 days is 130 gpm. Modeling dry weather flows ranging from 110 gpm to 140 gpm predicts pump cycling frequencies of 1.80 days to 1.39 days. One key difference is that according to SFEI, their depth gage was located on the elevated platform of the wet well, at elevation -10.45 (Fig. 5). If that is the case, the pump start up and shut off depths would appear to be at depths 12.5 ft and 9 ft, respectively, in contrast to 13.17 ft and 10.42 ft according to the NRPS manual. To replicate the SFEI data, the pump trigger depths were adjusted accordingly to the observed depth for comparison (Fig.6).The modeled water level variations closely match observed water level oscillations as reported by SFEI during both dry and wet weather conditions, as seen in Figure 5 and 6 for October 3-23, 2012.

In summary, the estimated dry weather inflow rate to the NRSPS is at least 80 gpm and could be as much as 140 gpm.

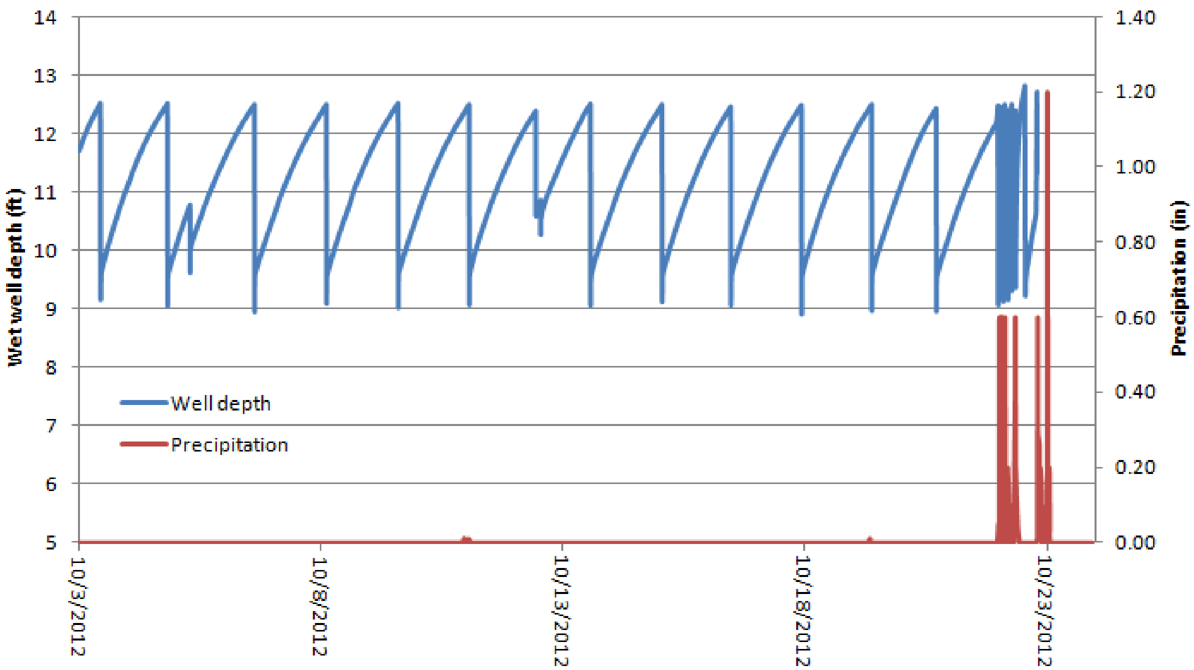



Figure 5: Wet well depth as observed by SFEI and rainfall as recorded by the Richmond City Hall rain gauge.

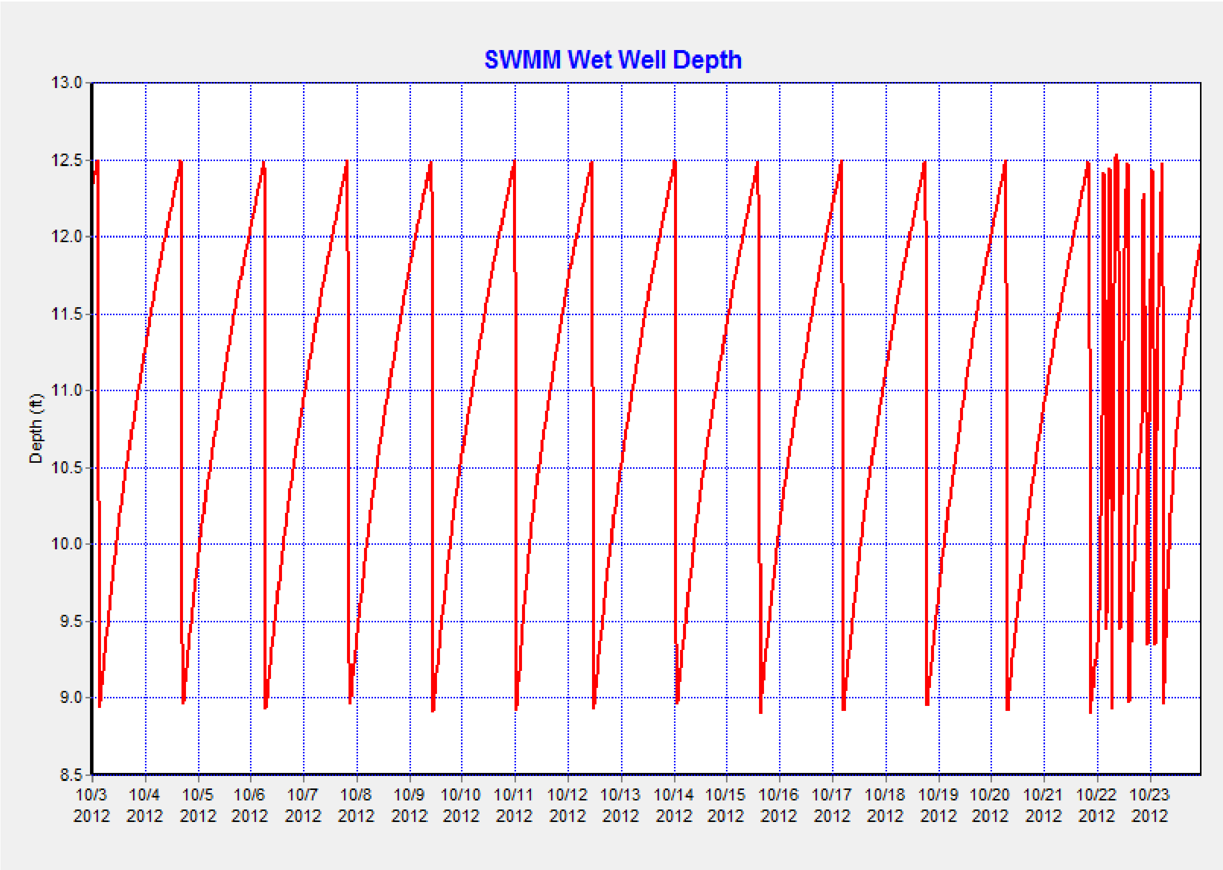



Figure 6: Wet well depth as modeled by SWMM using dry weather flow of 130 gpm and start up and shut off depth of 12.5 ft and 9 ft, respectively.

While there are some differences between the two dry weather flow estimates, with volume estimation method resulting in 80 gpm to 104 gpm while the model method resulting in 110 gpm to 140 gpm, there were several approximations that may lead to this discrepancy. One that is readily observed in figure 5 is the inconsistency of the pump in terms of shut off of the pump, which makes replicating the pump action difficult. Additionally, the range in estimated dry weather flow rates reflects the fact that dry weather flow rates are not expected to be constant. Furthermore, estimation of very low (i.e., three digit) dry weather flow rates based on variations of relatively large (i.e., six digit) storage volumes in an irregularly shaped conveyance system will have limited precision and accuracy. If more precise and accurate estimates of dry weather flow rate are desired, direct measurement in the conveyance channel using weirs or flumes would be necessary.

### 4.2 Scenario 2: Current System with Diversion to WCWD

This scenario evaluates a pilot project to divert up to 400 gpm dry weather flows and stormwater into WCWD. A diversion pump with a capacity of 400 gpm[4] was added to the model in Scenario 1, using the start up and shut off depths as specified in the original manual. The pump was programmed in the model to turn on at a water elevation of –4.5 ft and turn off at a water elevation of –5.58 ft. Considering the geometry of the collection system, this corresponds to a volume interval of 81,000 gallons. The recent September 21, 2013 rain event was examined as an example of how a pilot diversion during dry weather prior to an early season storm might operate.

When the model assumed a dry weather flow rate of 130 gpm, the storm pump is only on approximately 30 minutes every two days, equivalent to 0.89% utilization. This means that if the maximum diversion flow rate permitted is 400 gpm, then the time needed to drain the collection system to the shut off level each day in dry weather conditions is 13.3 hrs. Diversion capacity will be overwhelmed when inflow to NRPS exceed 260 gpm.

This would be the case for the most recent storm event on September 21, 2013. Unlike rain events most common in the Bay Area, the rain intensity was very high over a short period of time, with 0.66 in of rain over 2.5 hours (Fig. 7). This resulted in a spike in the wet well since the drainage system did not have the time to absorb and equilibrate the additional water (Fig. 8). Prior to this event, there had been no rainfall for three months. The steady oscillation of the wet well water elevation as seen in Figure 8 represents the accumulating and dry weather flow and subsequent draining of the well via the 400 gpm diversion pump, without any contribution from the storm pump.

At the onset of the rain event, the WCWD “wet” pump was activated due to the increased inflow into the well (Fig. 9). Sustained in the first hour of the rain event, the “wet” diversion pump only turns off when the storm pump turned on to prevent the wet well from flooding. This is also reflected in the depth of the wet well with the steep elevation drop after the initial peak in Figure 8. Since the diversion pump was not able to keep ahead of the storm, a single pulse was discharged into the Bay (Fig. 10). If total outflow from the rain event is defined as the combined discharge to the Bay and the wet weather diversion to WCWD, this set up was able to treat **32%** of the stormwater for this particular event, equivalent to the fuchsia portion of Figure 10.

[4] 400 gpm was selected based on the capacity of the nearby 36 inch sanitary sewage conveyance to WCWD. WCWD has provided information showing that during a five year, 24 storm event, the available capacity is 0.6 to 1.4 mgd. This corresponds to available capacity of approximately 400 to 1,100 gpm.

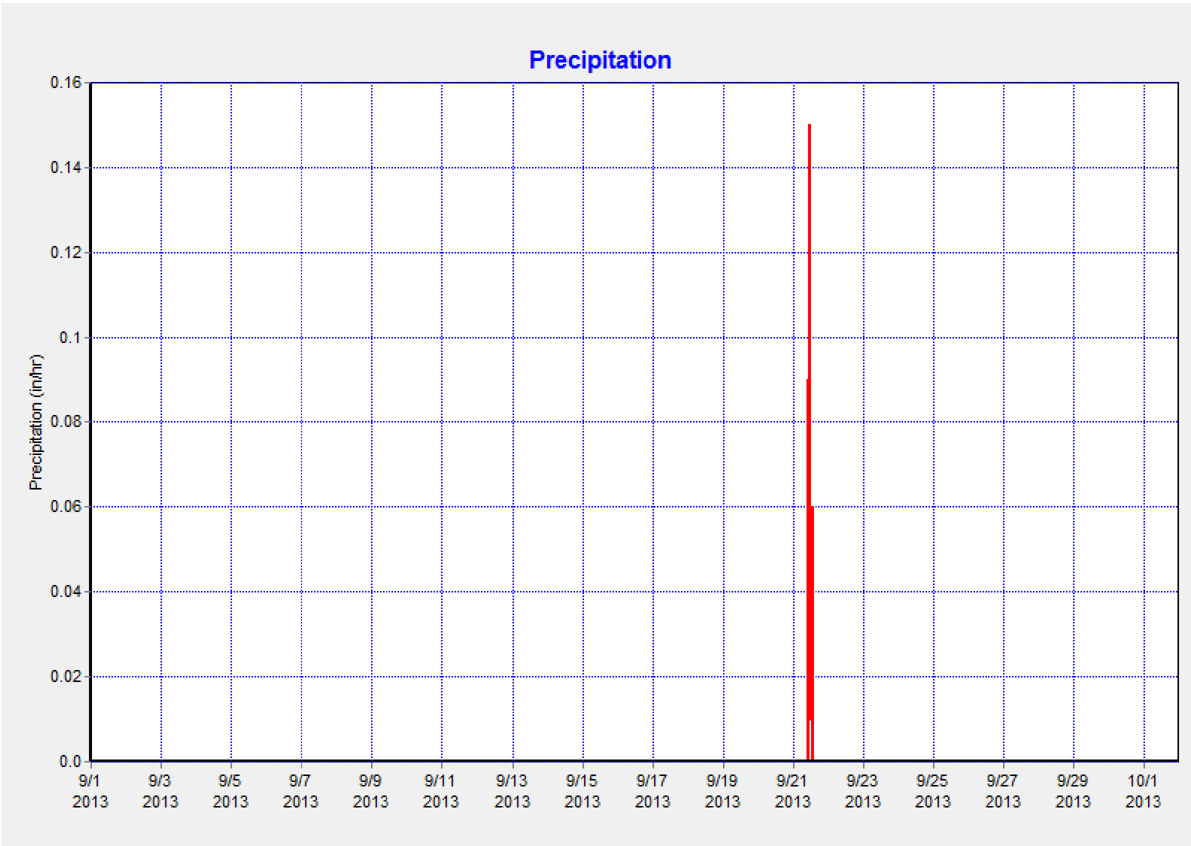



Figure 7: Precipitation as measured by Richmond City Hall rain gauge for September 2013.

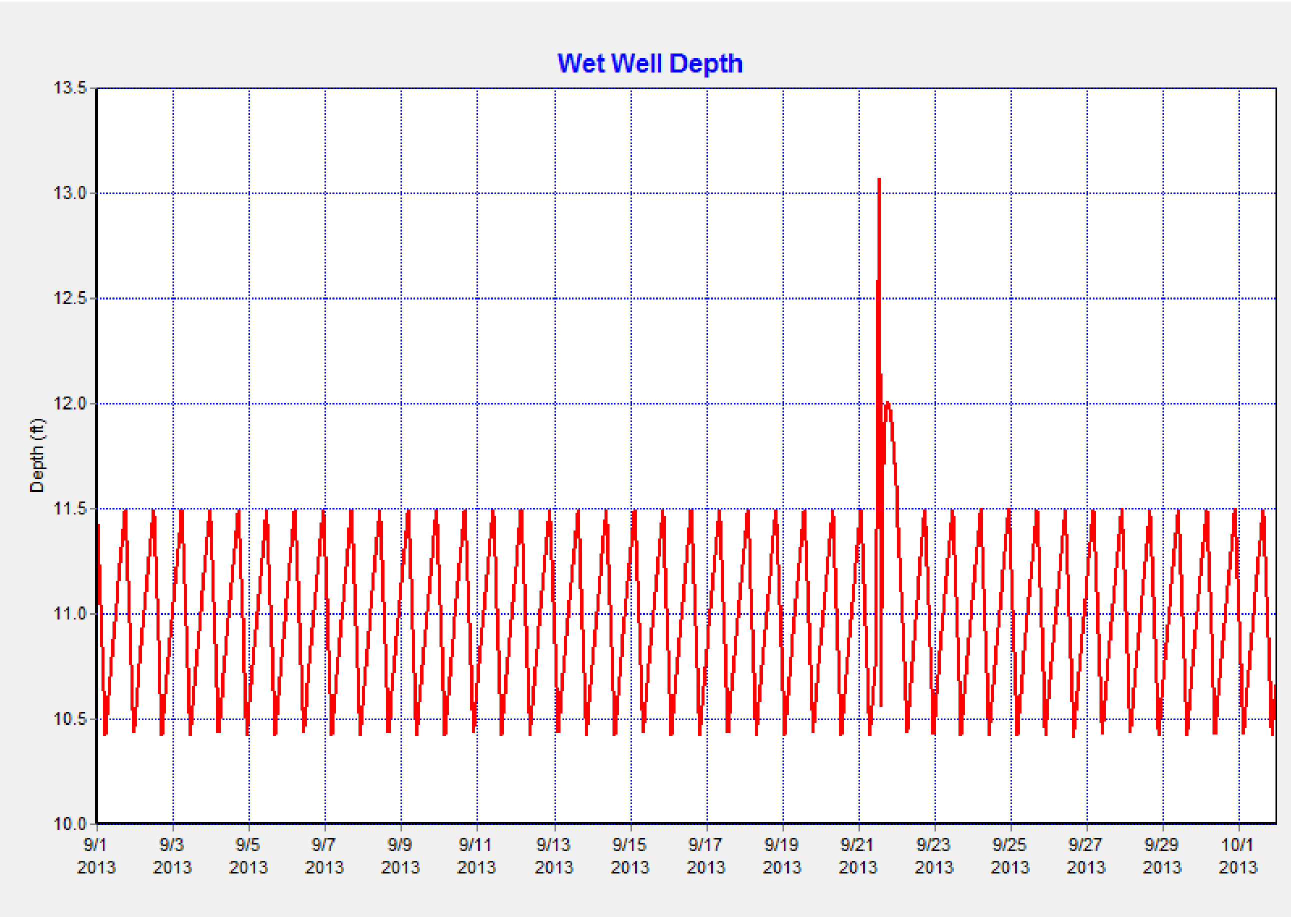



Figure 8: Depth of wet well for September 2013.

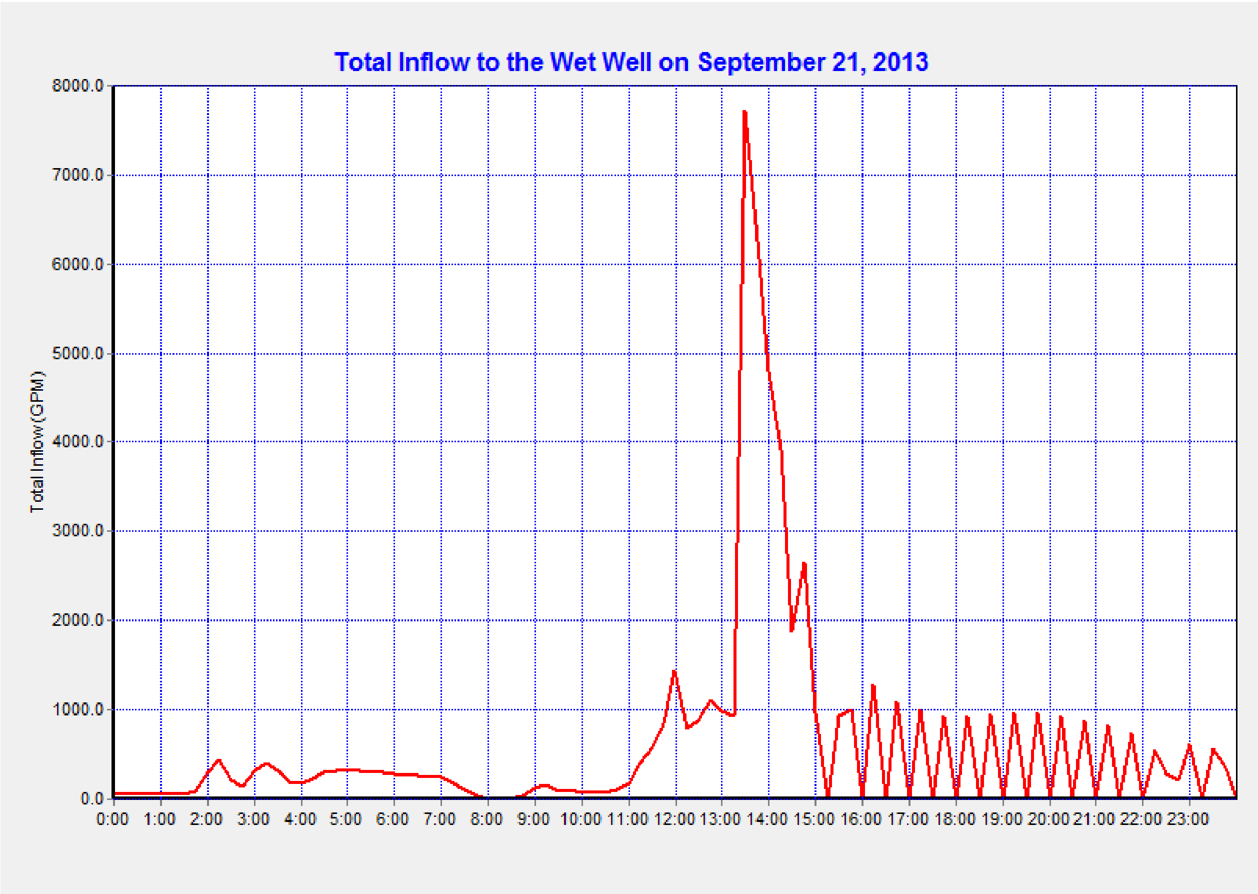
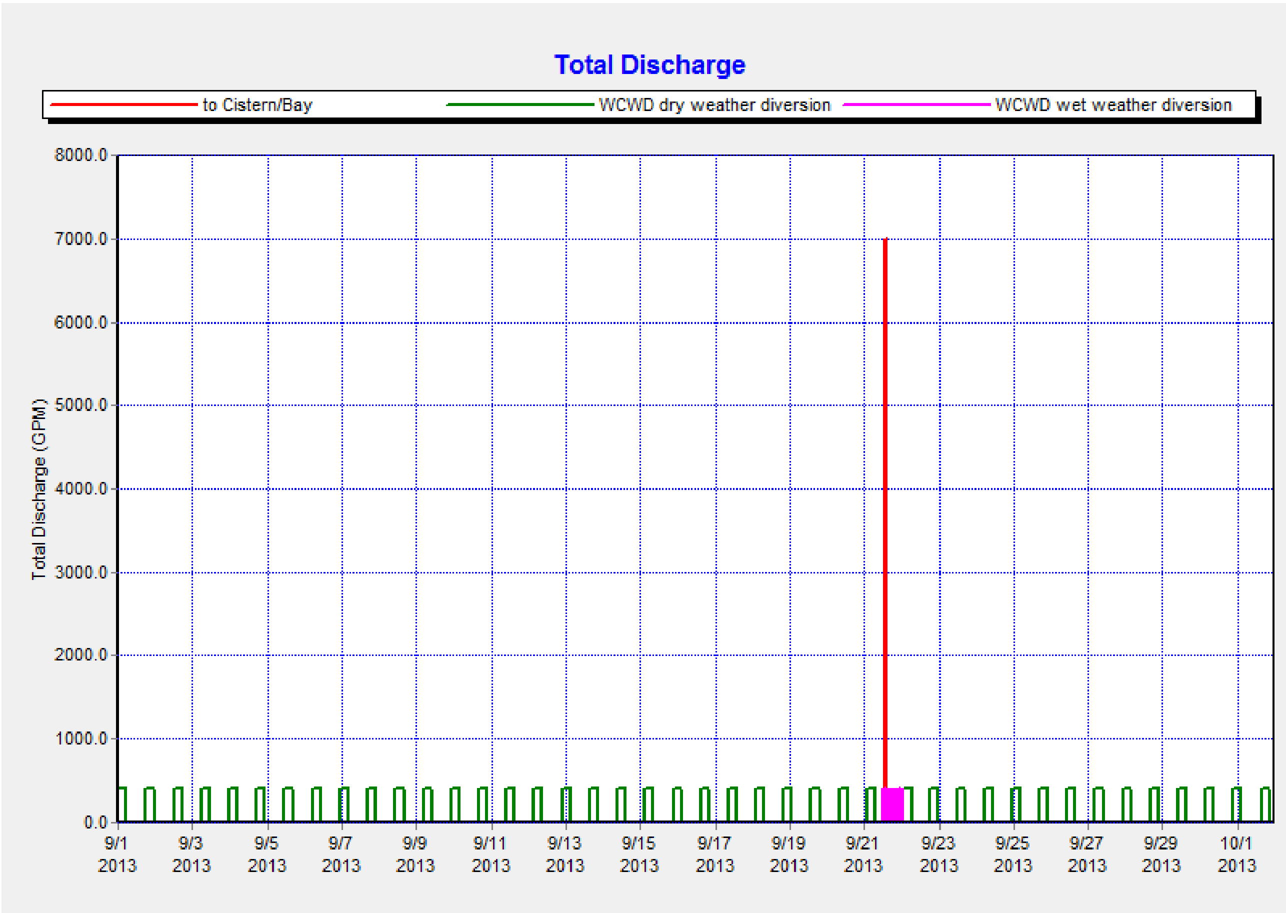



Figure 9: Flow into the wet well


Total Discharge
to Cistern/Bay
WCWD dry weather diversion
WCWD wet weather diversion
Total Discharge (GPM)
8000.0
7000.0
6000.0
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
9/1 2013
9/3 2013
9/5 2013
9/7 2013
9/9 2013
9/11 2013
9/13 2013
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9/29 2013
10/1 2013

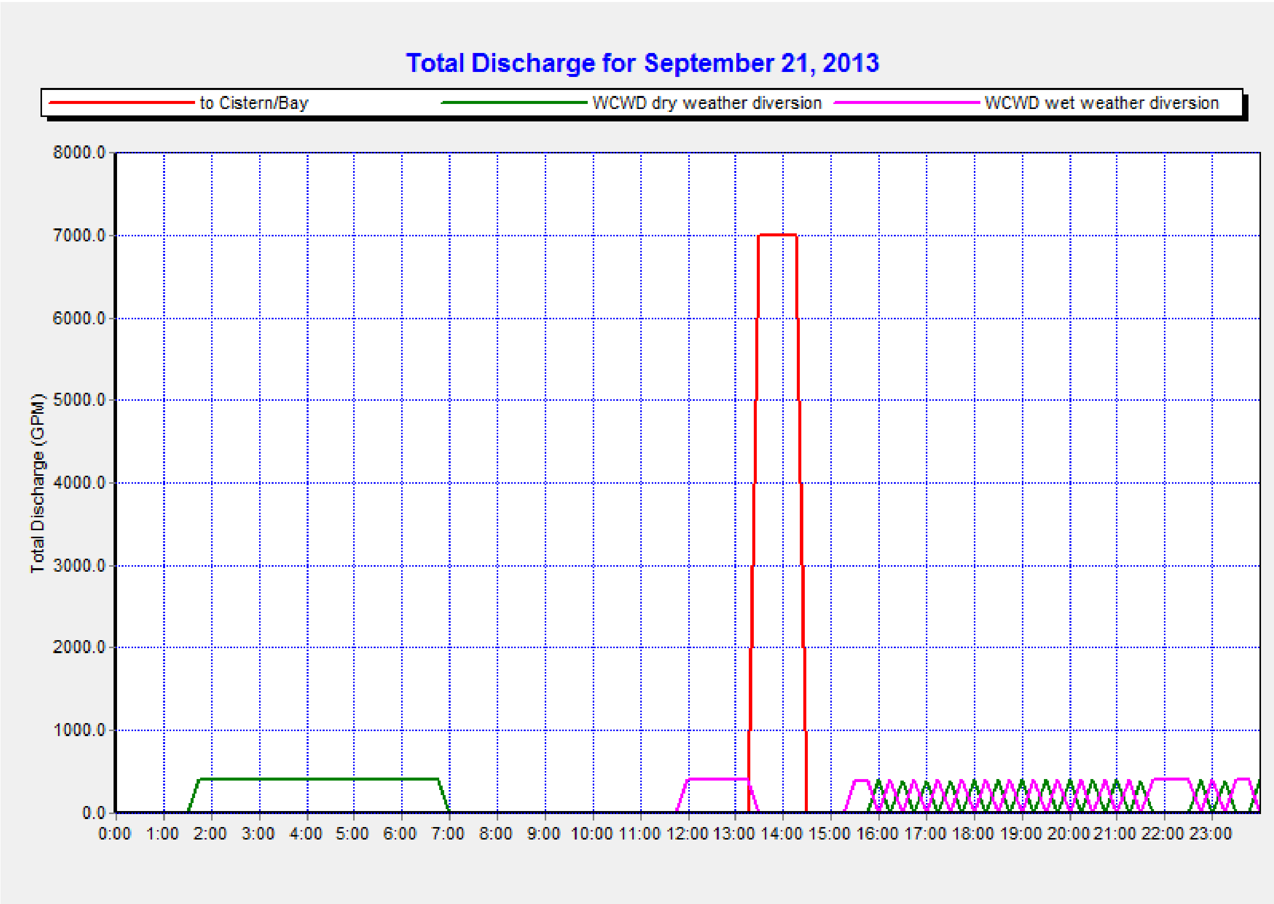


Figure 10: Discharge distribution for September 2013, first flush event for the entire month (top) and zoomed in to the rain event (bottom).

Note the switching between the “dry” and “wet” pumps in the bottom figure of Figure 10. This is due to the significant oscillation in the modeled inflow, as seen in Figure 6. This is likely a modeling artifact, resulting from the fact that modeled pumps do not have ramp-up or ramp down times, and that their flow rates do not vary with dynamic head, as they do in the real world. This could be improved with a more detailed modeling approach, but the presented simple approximation is sufficient to understand how a pump sized small enough to avoid overwhelming WCWD conveyance capacity would function during an early season storm.

From February 1, 2005 to October 1, 2013, having a continuously running 400gpm diversion pump would result in diverting **51% of total inflow** (combined wet and dry weather). If only the wet weather flow and the storm pump outflow were considered, **30% of storm flow** was diverted to WCWD in the model.

### 4.3 Scenario 3: Current System with Diversion and 100 gpm Onsite Treatment Capacity

An onsite treatment system was added to Scenario 3 by replacing the “wet” diversion pump with a small pump with a rated capacity of 100 gpm and startup depth of 12.5 ft. In this scenario, the onsite treatment was only active after the diversion pump shut off, though it was still the first line of defense during the wet season and served the important role of peak shaving. For the period between February 1, 2005 and October 1, 2013, **62% of total flow was diverted**, and approximately **2% of storm water was treated** onsite.

The storm on September 21, 2013 is examined as a point of comparison to Scenario 2. Recalling it was a high intensity storm where 0.66 inches of rain was produced over 2 hours (Fig. 11), the storm pumps had to turn on to mitigate the rainfall. Because the onsite pump as specified here is very small, only **2%** of the rain event was captured and treated onsite for this storm (Fig. 12).

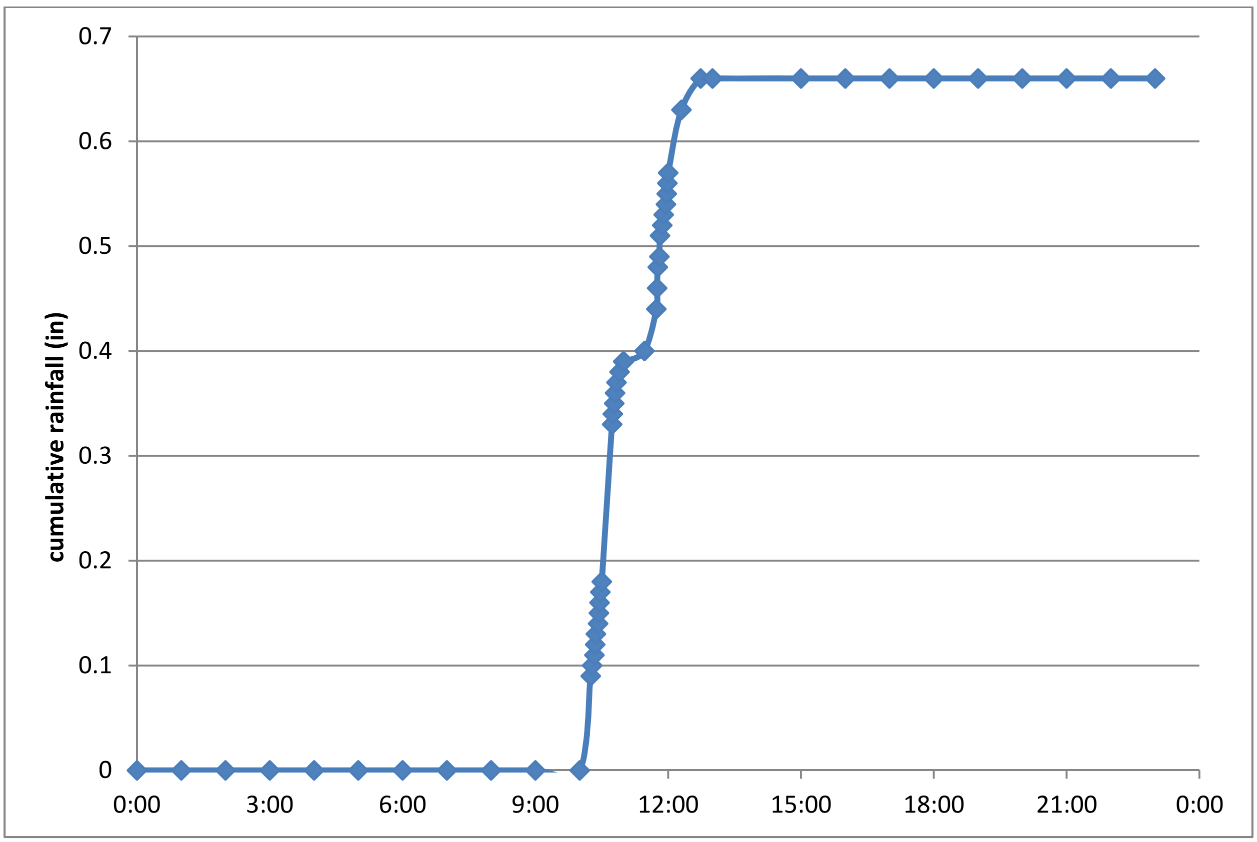


Figure 11: Cumulative rainfall as measured at Richmond City Hall for September 21, 2013.

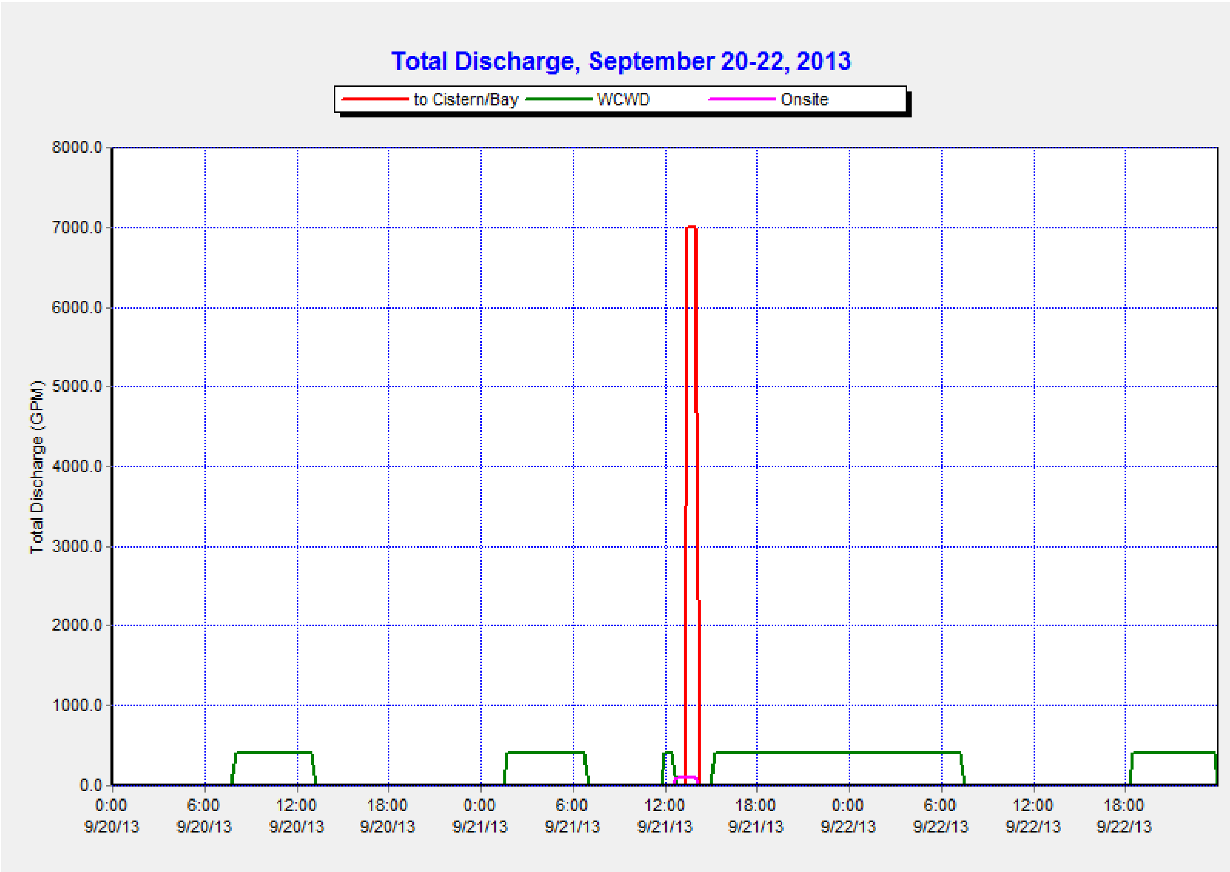


Figure 12: September 21, 2013 storm event outflow for 100 gpm onsite treatment.

In contrast to the September 21 flashy storm event, the April 4, 2013 storm event was more representative of typical storms in the Bay Area, with lower intensity over a longer duration (Fig. 13). In this case, 0.62 inches of rain fell over 11 hours. Because of the lower rain intensity, the diversion pump to WCWD would still turn on during the rain event because of the low inflow into the wet well. When the inflow rate exceeds typical dry flow rate, the onsite system cannot keep up with wet well elevation rise and the storm pump must turn on accordingly (Fig. 14). In this event, the **3%** of storm water treated onsite.

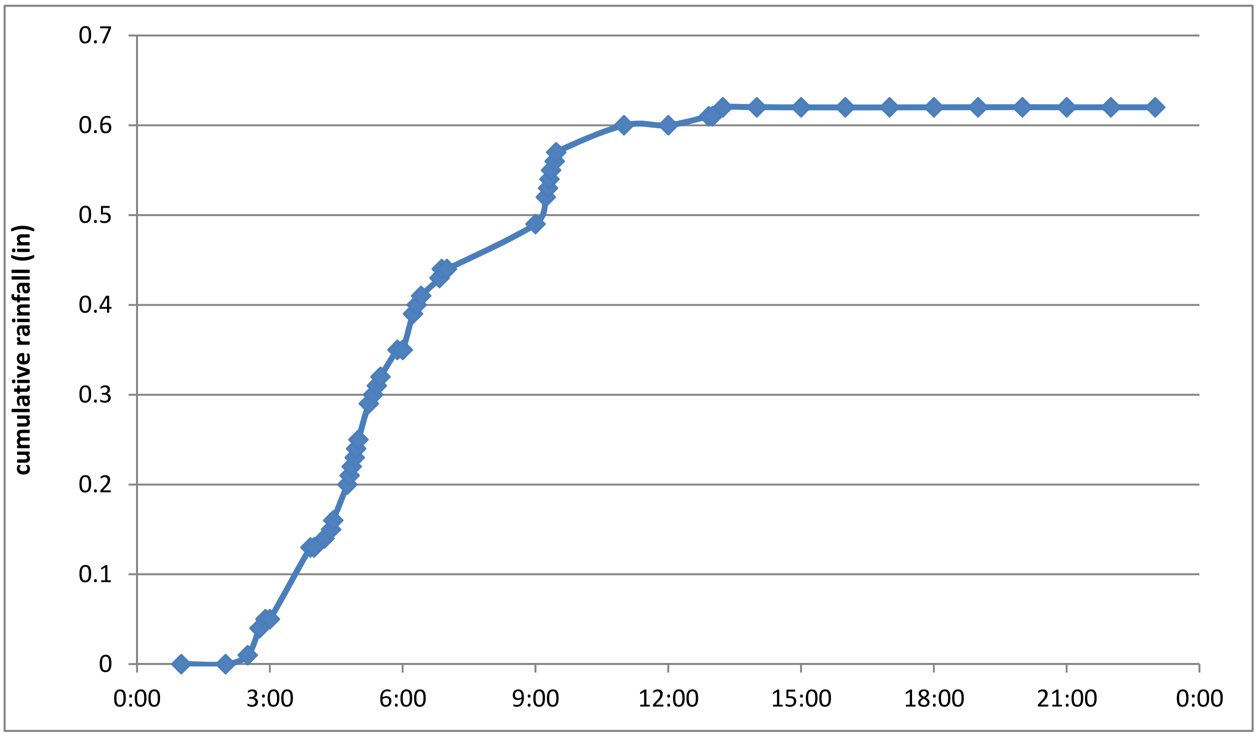


Figure 13: Cumulative rainfall as measured at Richmond City Hall for April 4, 2013.

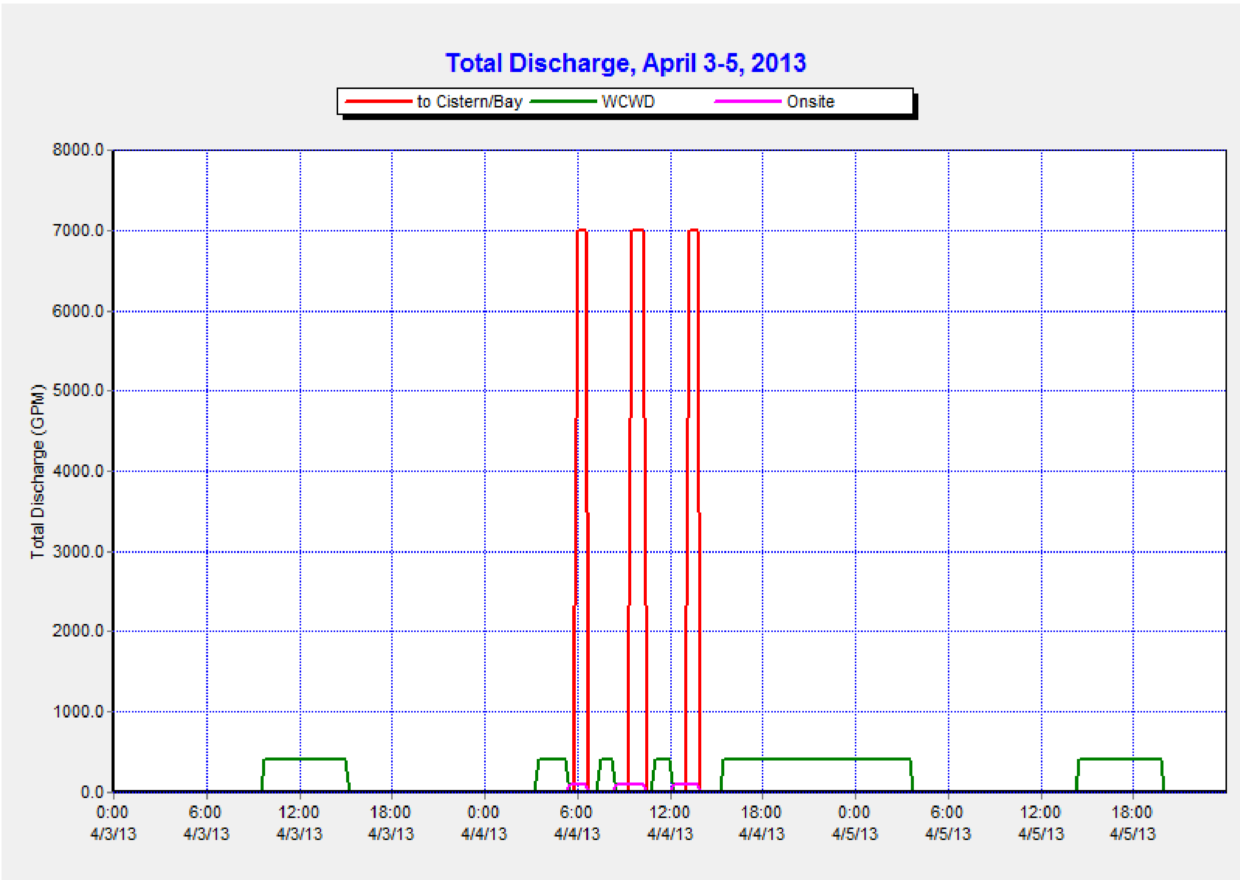


Figure 14: April 4, 2013 storm event outflow for 100 gpm onsite treatment.

## 4.4 Scenario 4: Current System with Diversion and 1000 gpm Onsite Treatment Capacity

In this Scenario, the onsite treatment capacity was increased to 1000 gpm. The diversion pump was designed such that it shuts off if either the onsite or storm pump was on, or if the flow into the well was greater than the dry weather flow rate. For the period between February 1, 2005 and October 1, 2013, **59% of total flow was diverted**, and approximately **36% of storm water was treated** onsite. Note that in Scenario 3, a slightly higher amount of flow was diverted in comparison to this scenario. This is because the diversion would take up some of the rainfall after rain event or during rain events when the rainfall intensity is low, as seen in the April storm.

The discharge distribution from the September and April storms from this scenario was to compared to the 100 gpm onsite treatment option. Once again, because of the high intensity of the September rain event, the 1000 gpm onsite pump was not able to capture the inflow and the storm pump had to turn on for support (Fig. 15). As a consequence, the outflow profile looked similar to that of the 100 gpm onsite treatment except with a shorter duration diversion to WCWD following the rain event, resulting in **25%** treatment. In contrast, the 1000 gpm pump was able to capture enough flow in the April event to decrease the number of storm pump activations from three to two (Fig. 16), resulting in **68%** treatment. Note that the onsite pump remained on for a long enough duration such that when the diversion pump turned back on, it returned to its normal duration, rather than elongated to accommodate the residual rainfall that subsequently infiltrated into the sub catchment system.

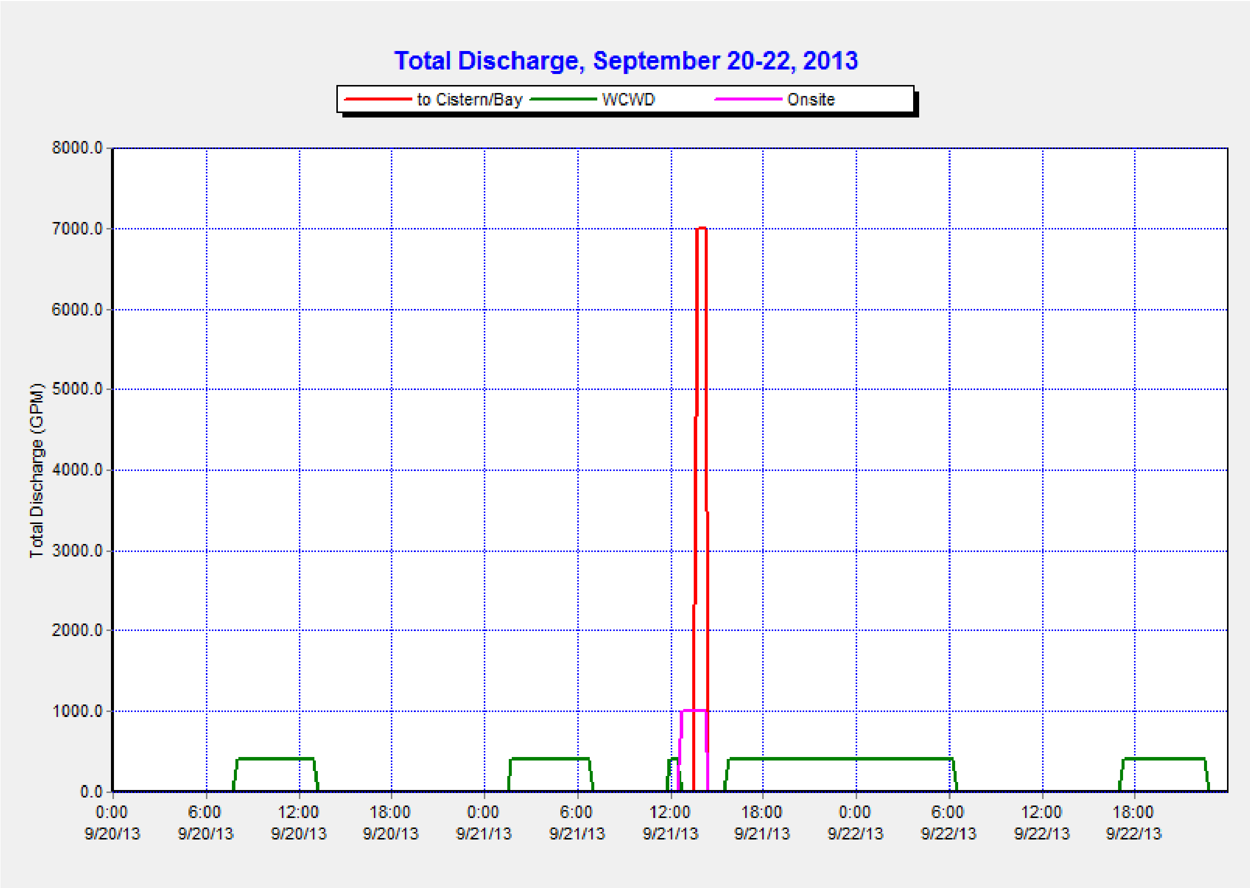


Figure 15: September 21, 2013 storm event outflow for 1000 gpm onsite treatment.

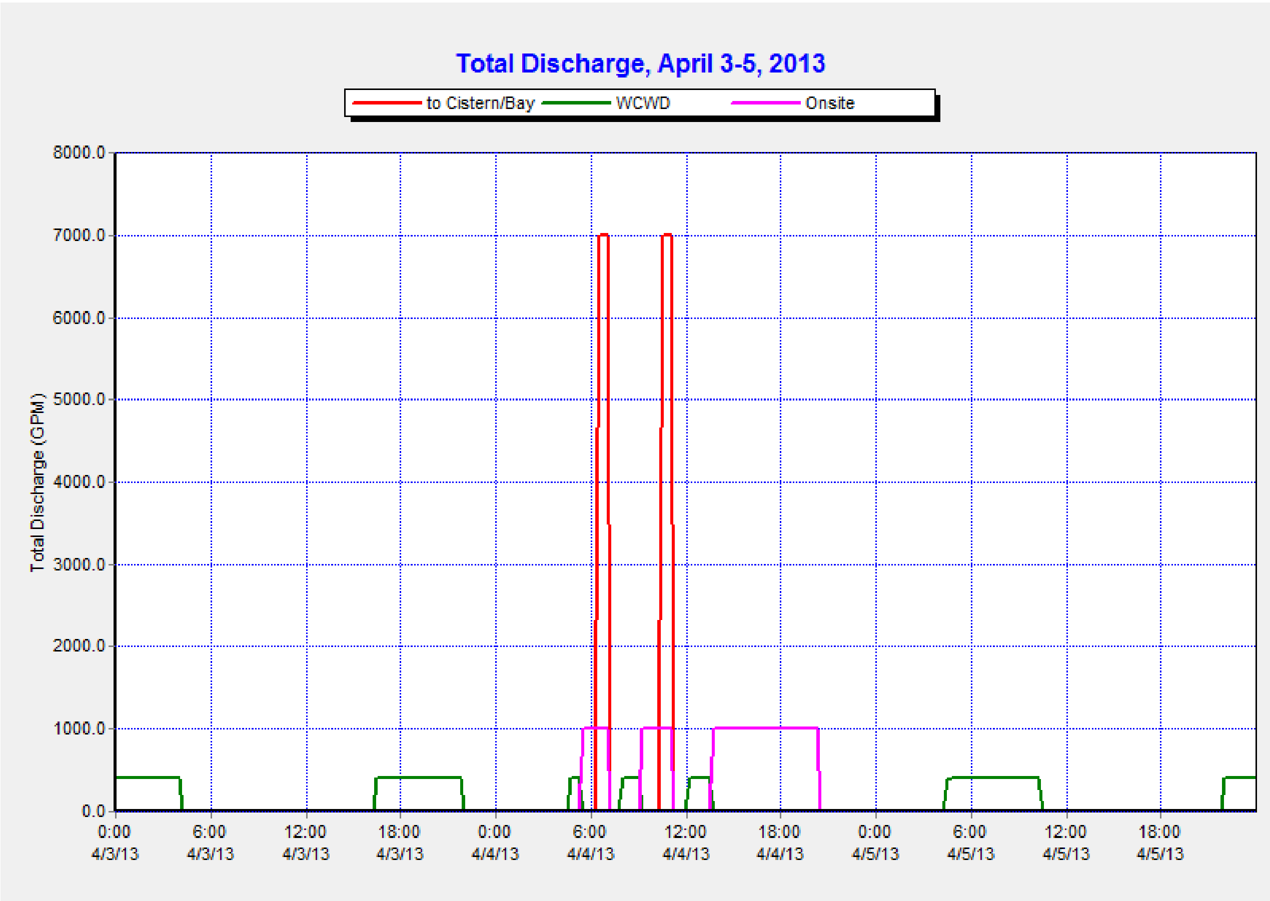


Figure 16: April 4, 2013 storm event outflow for 1000 gpm onsite treatment.

### 4.5 Scenario 5: Current System with Diversion and 1500 gpm Onsite Treatment Capacity

In this Scenario, the onsite treatment capacity was increased to 1500 gpm. The diversion pump was designed such that it shuts off if either the onsite or storm pump was on, or if the flow into the well was greater than the dry weather flow rate. For the period between February 1, 2005 and October 1, 2013, **60% of total flow was diverted**, and approximately **44% of storm water was treated** onsite. While the September rain event did not change much with this upgrade (Fig. 17), with **44%** of the stormwater was treated. The change in pump capacity resulted in only one storm pump start up during the April event (Fig. 18) and **84%** treatment, as well as less diversion to WCWD during the period.

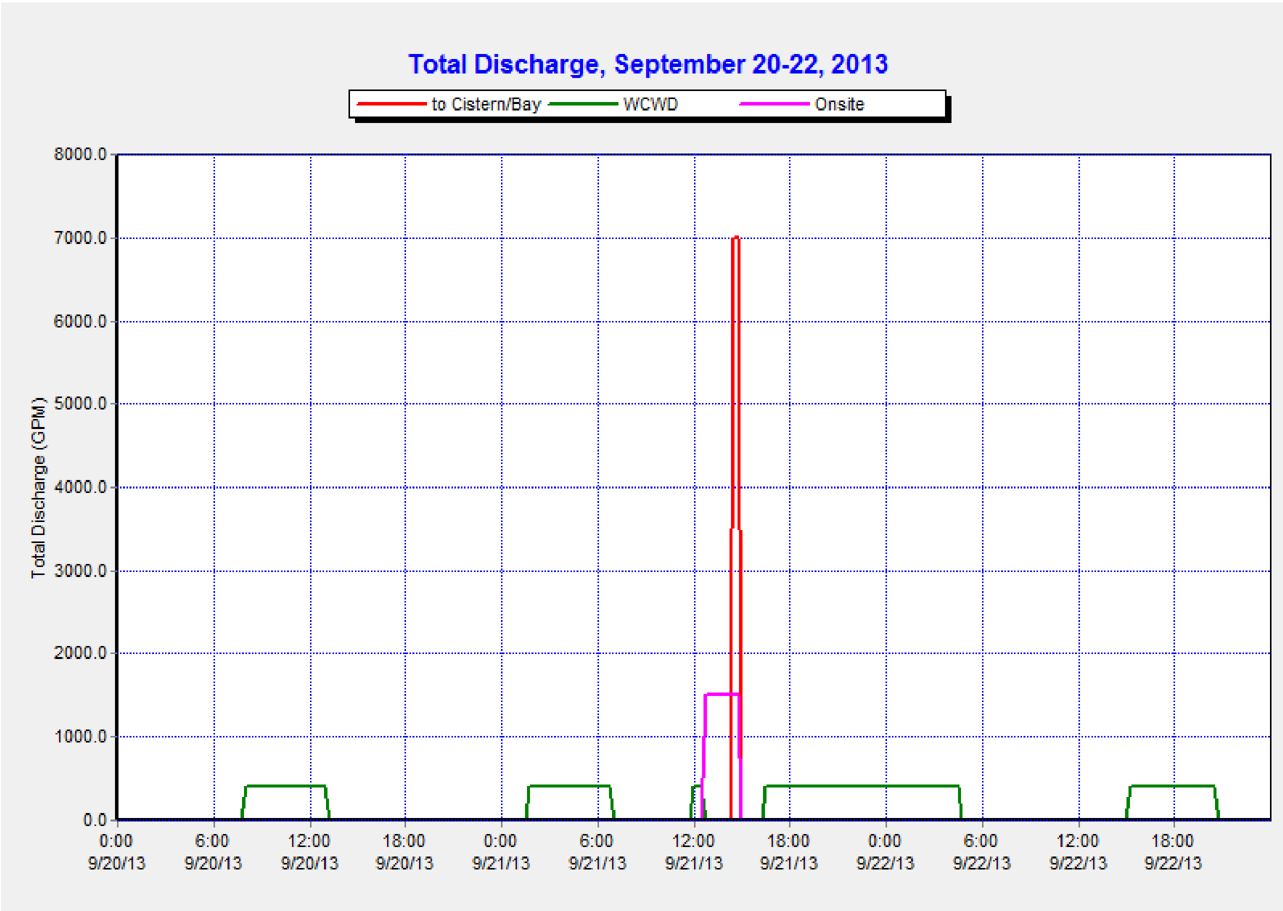


Figure 17: September 21, 2013 storm event outflow for 1500 gpm onsite treatment

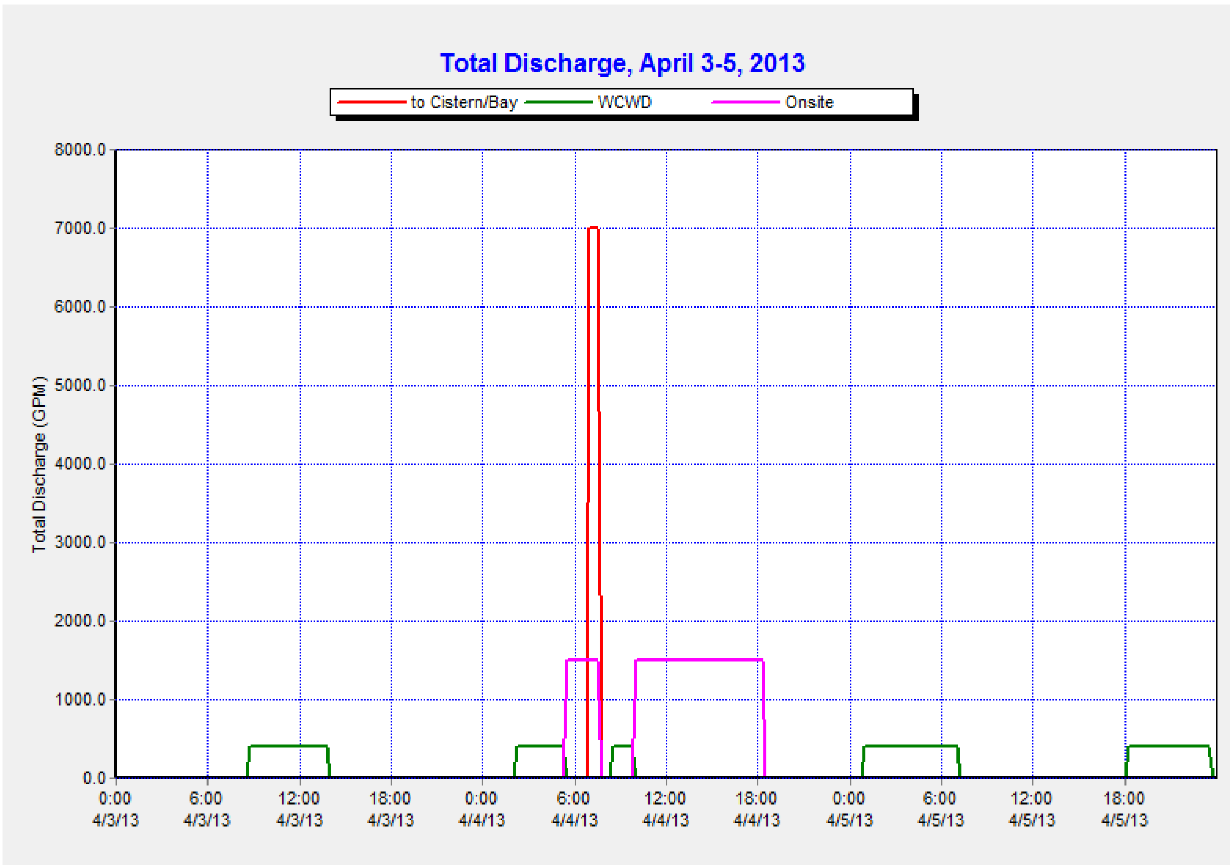


Figure 18: April 4, 2013 storm event outflow for 1500 gpm onsite treatment.

To capture the September event, the onsite treatment had to increase incrementally only to 1550 gpm, which resulted in **100%** treatment for that event (Fig. 19). This is possible because the event is short, even though the intensity was high.

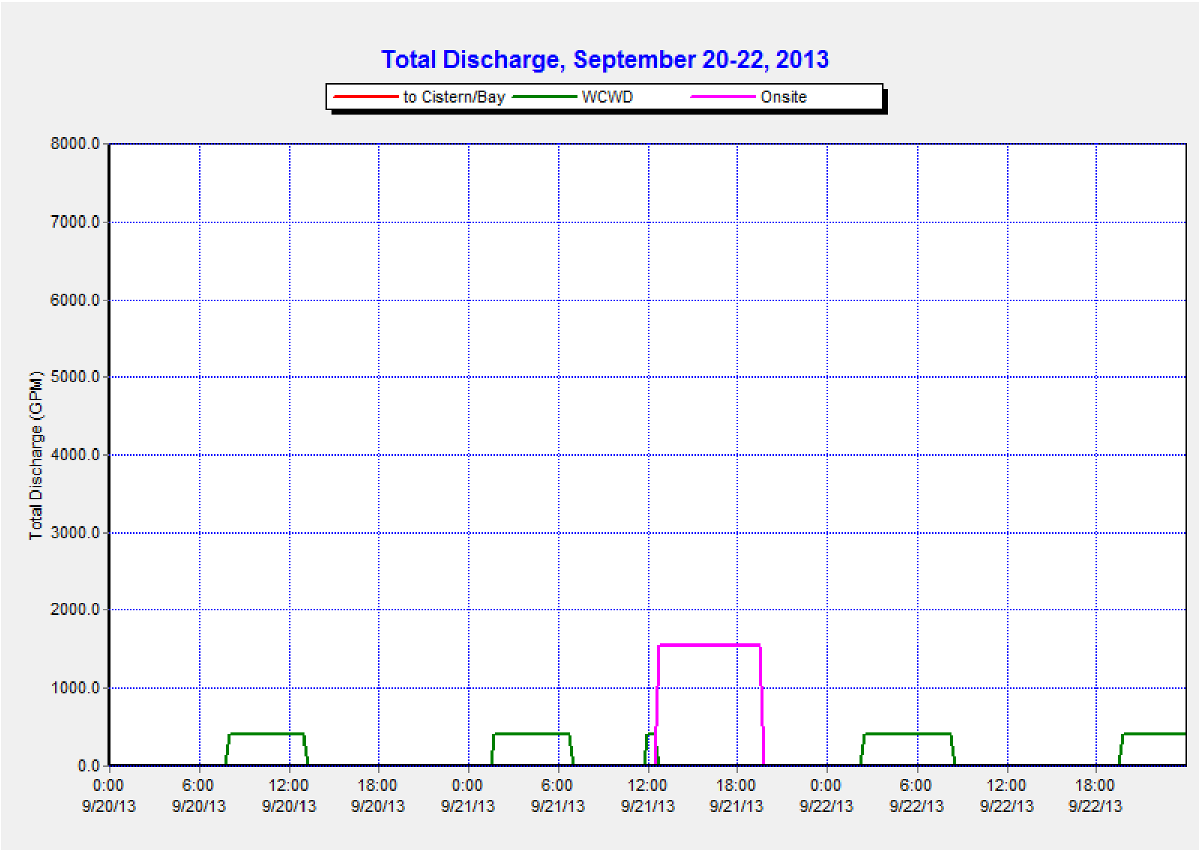


Figure 19: September 21, 2013 storm event outflow for 1550 gpm onsite treatment

## 5.0 SUMMARY

The estimated dry weather flow rate for the NRSPS ranges from 80 gpm to 140 gpm. The percentage of stormwater that could be treated by using diversion pumps of varying size to provide onsite or offsite treatment is summarized in Table 1 below.

**Table 1. Percent of stormwater that could be treated at the NRSPS under various assumed treatment capacities.**

| Treatment capacity (gpm) | % stormwater treated | | |
|---|---|---|---|
| | April 4, 2013 | September 21, 2013 | February 2005-October 2013 |
| 500 | 3 | 2 | 2 |
| 1400 | 68 | 25 | 36 |
| 1900 | 84 | 44 | 44 |

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# APPENDIX E

Field Sampling Report, North Richmond Pump Station Dry Weather Diversion, Water Quality Monitoring (December 1, 2015)

# Field Sampling Report

## North Richmond Pump Station Dry Weather Diversion, Water Quality Monitoring

**December 1, 2015**

**Submitted to:**

Ms. Cece Sellgren
Stormwater Manager
Contra Costa County Watershed Program

**Submitted by:**


APPLIED marine SCIENCES

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# 1. Introduction

This report details activities associated with implementation of dry weather diversion water quality monitoring component of the North Richmond Pump Station (NRPS) Stormwater Diversion Project – Low Flow Sediment and Stormwater Sampling and Analysis. All sampling was conducted by Applied Marine Sciences, Inc. (AMS) personnel between September 10, 2015 and September 23, 2015.

# 2. Field Sampling Report

## 2.1. Objectives

The objectives of the sampling effort were as follows:

1. Collect up to ten water quality samples for analysis of PCB congeners, total mercury (Hg), total methyl-mercury (meHg) total organic carbon (TOC), and suspended sediment concentration (SSC) by ALS Group (ALS).
2. Collect required quality assurance (QA) samples consistent with California Surface Water Ambient Monitoring Program (SWAMP) Measurement Quality Objectives (MQOs) methods and frequencies.
3. Assess laboratory data quality using relevant SWAMP MQOs (SWAMP 2008).

## 2.2. Sampling Activities

Sampling activities for the NRPS dry diversion water quality monitoring study are summarized in Table 1. In total, AMS monitored nine of the ten possible diversion days; one day was intentionally skipped to be consistent with the original scope of work, which called for monitoring up to seven days of the target ten diversion days. Upon receiving direction to sample beyond the original seven days contracted, AMS then monitored each of the remaining diversion dates.

All field samples were collected from the diversion pipe exiting the NRPS. Field personnel filled sample containers using a new hose (25’ drinking water quality) attached to a spigot in the PVC diversion pipe that was installed by the construction contractor for monitoring purposes (Figure 1). Sampling personnel flushed the hose for a minimum of one minute prior to sample collection and used standard “clean hands / dirty hands” protocols for sample collection.

Field monitoring incorporated two types of field blanks in order to assess possible effects of the sampling protocols on the analytical results: (1) a bottle blank for which laboratory-provided blank water was transferred at the NRPS from its container of origin to a field sample container in order to assess effect of environmental conditions present and “clean hands / dirty hands” sampling, and (2) an equipment blank for which blank water was rinsed through a sampling hose in a laboratory setting in order to assess any contamination associated with the equipment used and “clean hands / dirty hands” sampling protocol.

**Table 1. Sampling Activities for NRPS Dry Weather Diversion Water Quality Monitoring Study.**

| Sampling Event | Sample Date | Sample Time | Field Samples | Field Blanks | Field Dup | Comments |
|---|---|---|---|---|---|---|
| NRP-D-01 | 10/Sep/2015 | 10:30 | X | | | |
| NRP-D-02 | 11/Sep/2015 | 08:15 | X | | | |
| NRP-D-03 | 14/Sep/2015 | 08:30 | X | | | |
| NRP-D-04 | 15/Sep/2015 | NA | | | | No samples collected |
| NRP-D-05 | 16/Sep/2015 | 08:45 | X | X | | Bottle blank |
| NRP-D-06 | 17/Sep/2015 | 08:15 | X | | X | |
| NRP-D-07 | 18/Sep/2015 | 08:40 | X | | | |
| NRP-D-08 | 21/Sep/2015 | 08:45 | X | X | | Equipment blank |
| NRP-D-09 | 22/Sep/2015 | 08:35 | X | | | |
| NRP-D-10 | 23/Sep/2015 | 08:35 | X | | | |


**Figure 1. Monitoring Spigot at Diversion Pipe**

## 2.3. Sample Labeling

The sample ID labeling system used for water quality samples is as follows:

WWW- E-DD

Where:

| | | |
|---|---|---|
| WWW | = | Watershed / site identifier (i.e., NRP) |
| E | = | Event type (i.e., D for dry diversion) |
| DD | = | Diversion day # (e.g., 10 for the $10^{th}$ day of the diversion) |

Field duplicate samples were indicated by use of a "5" in the tens place of the diversion date (e.g., NRP-D-56 indicates a field duplicate sample collected on the $6^{th}$ diversion day). Field blank samples were labeled by the laboratory prior to delivery to AMS.

## 2.4. Results

Analyte concentrations reported by ALS are summarized in Table 2. As is typical for laboratory analytical reports, especially those associated with analysis of organic pollutants, some proportion of analytical results are flagged with qualifiers to be used in association with data interpretation. For that reason, the user should reference the spreadsheet Electronic Data Deliverable (EDD) for concentration data to be used in higher-level analyses and interpretation.

It should be noted that the laboratory reported PCB concentration data for individual congeners only. The summaries presented below were calculated by AMS and make use of a substitution of ½ of the method detection limit (MDL) for any congeners or other analytes (i.e., SSC) reported as non-detects (NDs). Any data reported between the MDL and Reporting Limit (RL) were quantified as reported by the lab for calculation of totals and basic statistics. Also any data that are qualified but not rejected outright are included in calculation of the total PCBs.

**Table 2. Summary of NRPS Dry Weather Diversion Analytical Results.**

| Sampling Event | Hg (ng/L) | meHg (ng/L) | PCBs (pg/L) | SSC (mg/L) | Comments |
|---|---|---|---|---|---|
| NRP-D-01 | 6.65 | 0.08 | 191 | 91.5 | |
| NRP-D-02 | 7.96 | 0.07 | 431 | 93.8 | |
| NRP-D-03 | 8.07 | 0.07 | 174 | 90.4 | |
| NRP-D-05 | 6.90 | 0.06 | 271 | <1.8 | Non-detect on SSC |
| NRP-D-06 | 8.85 | 0.06 | 415 | 3.1 | |
| NRP-D-07 | 11.60 | 0.05 | 218 | <1.9 | Non-detect on SSC |
| NRP-D-08 | 12.50 | 0.06 | 509 | 16.7 | |
| NRP-D-09 | 10.00 | 0.04 | 596 | 5.3 | |
| NRP-D-10 | 9.65 | 0.03 | 548 | 1.9 | |
| Avg. | 9.1 | 0.06 | 373 | 34 | |
| Min. | 6.65 | 0.03 | 174 | <1.8 | |
| Max. | 12.50 | 0.08 | 596 | 93.8 | |

# 3. Quality Assurance

All monitoring results were checked against SWAMP MQOs and qualified, as required, consistent with applicable California Environmental Data Exchange Network (CEDEN) QA codes.[1] A brief summary of data quality review follows by analyte type:

### *3.1.1. Inorganics (meHg and Hg)*

In general, all measurements for Hg and meHg met SWAMP MQOs. The main exception to this is in the case of field blanks collected for analysis of meHg. For both Hg and meHg analyses, both of the field blanks collected resulted in concentrations exceeding laboratory RLs, resulting in a qualifier of "VIP" being applied to the affected field blank data. In the case of Hg, blank concentrations were relatively low compared with all field sample data (i.e., < 5x the concentration of the field samples). In the case of meHg, however, the highest concentration reported for all Project data is associated with the equipment blank field blank collected on Sept 21; for this reason both the affected field blank and field sample data are qualified with "VIP." All other field sample and field blank data was reported below laboratory RLs, suggesting that the detectable presence of meHg at low concentrations in field samples may be an artifact of sampling protocols.

The Hg field sample / field duplicate pair collected on September 17$^{th}$ was slightly outside of SWAMP MQO control limits (CLs) for precision, with a calculated relative percent difference (RPD) of 26% vs. the CL of 25%. Both the field sample and field duplicate of this pair were flagged with a "VFDP" qualifier to indicate this, but this outcome is not expected to greatly alter the interpretation of the data.

### *3.1.2. Synthetic Organics (PCBs)*

For several of the PCB congeners analyzed, minor blank contamination was identified associated with analysis of field blank or lab blank samples. QA samples reported at concentrations greater than RLs, as well as associated field sample data for which concentrations were reported as less than five times (5x) greater than associated blank concentrations, were flagged with a "VIP" qualifier, indicating a possible high bias. As the sums of the concentration of qualified blank data (approx 40 pg/L for lab blank samples and approx 30 pg/L for field blank samples) were relatively low compared to sum of the individual PCB congeners in the field samples (Table 2), this issue does not appear to provide much of a high bias to the calculated sums of PCBs.

There were also a small number of PCB congeners for which the field duplicate samples did not meet the typically-used SWAMP MQO for precision (RPD <25%). Affected congener data, both within the field sample and field duplicate, were flagged with a "VFDP" qualifier in these situations. Similar to the case for Hg discussed above, this outcome is not expected to greatly alter the interpretation of the data. It should be noted that the sum of PCBs reported for the field sample / field duplicate pair showed consistency, with an associated RPD of 1.5%.

As is typical for analysis of organic compounds, a small number of surrogate analyses fell outside of SWAMP MQO recommended control limits. These QA samples were flagged with a "VGN" qualifier to indicate this, but it is again not expected to affect the interpretation of data.

[1] http://ceden.waterboards.ca.gov/Metadata/ControlledVocab.php

#### *3.1.3.Conventional Parameters (SSC)*

All SSC data met recommended SWAMP MQOs.

# 4. Discussion

AMS field personnel coordinated with CCCWP and construction contractor to arrange sampling access at the pump station. Due to the uncertain duration of diversion activities, AMS targeted sample collection activities to coincide with the initiation of the diversion process each monitoring day. It is unknown how long contractors continued pumping each day before there was insufficient water to continue diversions, but there was sufficient flow each day to support sampling activities.

There was minimal rainfall reported and no observable runoff during the monitoring period. Between 9pm and 11pm on September 16, 2015, 0.02" of rainfall was reported at Weather Underground monitoring station KCARICHM24[2], which is located approximately 0.5 mi to the northeast of the NRPS.

# 5. References

SWAMP 2008. Surface Water Ambient Monitoring Program Quality Assurance Project Plan, Version 1.0. Prepared for the California State Water Quality Control Board by the SWAMP Quality Assurance Team. September 1, 2008.

[2] http://www.wunderground.com/personal-weather-station/dashboard?ID=KCARICHM24#history/s20150916/e20150916/mdaily

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# APPENDIX F

Field Sampling Report, Diversion – Wet Weather Monitoring.
North Richmond Pump Station, Contra Costa County, California (January, 2016)

# FIELD SAMPLING REPORT
# DIVERSION – WET WEATHER MONITORING

North Richmond Pump Station
Contra Costa County, California

*Prepared for:*

**Contra Costa County Watershed Program**
Martinez, California

*Prepared by:*


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180 Grand Avenue, Suite 1100
Oakland, California  94612


January 2016

Project No. 5025153002.04

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# FIELD SAMPLING REPORT
# DIVERSION – WET WEATHER MONITORING
North Richmond Pump Station
Contra Costa County, California

## 1.0 INTRODUCTION

This report summarizes the activities and results of monitoring a wet weather stormwater diversion from the North Richmond Stormwater Pump Station ("NRPS"), to the West County Wastewater District (WCWD) conducted by Amec Foster Wheeler Environment & Infrastructure, Inc. ("Amec Foster Wheeler") on November 2, 2015. The diversion was a pilot project required under provision C.11.f and C.12.f of the Municipal Regional Stormwater NPDES Permit issued to the 18 permittees of the Contra Costa Clean Water Program (Clean Water Program). The Contra Costa County Watersheds Program, a permittee of the Clean Water Program, carried out this diversion pilot on behalf of all permittees of the Clean Water Program, in fulfillment of commitments made under a United States Environmental Protection Agency Water Quality Improvement Fund grant.

The NRPS has been renovated with new low-flow pumps and other improvements by the Valentine Corporation (Valentine), a general engineering contractor. Valentine provided Amec Foster Wheeler access to the NRPS during this stormwater diversion pilot; Valentine also installed an operated a temporary sump pump that was used for the pilot diversion. Amec Foster Wheeler sampled diverted stormwater and submitted samples for analysis of total mercury, methylmercury, polychlorinated biphenyls (PCBs), and suspended sediment concentrations (SSC).

## 2.0 FIELD SAMPLING REPORT

This section summarizes the field effort. The objectives, activities, and quality assurance / quality control measures implemented in the field are described in the subsections below.

### 2.1 OBJECTIVES

The objectives of the sampling program were:

- Collect up to ten samples at different times intervals spaced roughly across the hydrograph of the storm event.
- Collect one time interval sample in duplicate and up to three field blanks.
- Sample analysis for PCB, total mercury, total methylmercury and SSC by McCambell Analytical, Inc. of Pittsburg, CA (Table 1).

## 2.2 SAMPLING ACTIVITIES

A suitable storm event for the diversion monitoring program began at approximately 11:00 pm on Sunday, November 1st. The Richmond City Hall station recorded 0.62 inch of rain by the end of the event at approximately 5:00 pm November 2nd (California Department of Water Resources, 2015). Figure 1 plots rainfall measured at the Richmond City Hall for the storm event. Most of the rain fell between 4 and 8 am on the morning of November 2nd. Watershed Program staff contacted Amec Foster Wheeler at about 6 AM to initiate sampling.

After testing for toxicity to activated sludge bacteria and finding no impairment of respiratory activity by the water in the pump station wet well, WCWD approved diversion of stormwater at approximately 9:00 am on November 2, 2015, and Valentine began pumping stormwater from the NRPS wet well to the sanitary sewer system via a system of PVC pipes. The initial stormwater diversion flow from the wet well was “choppy” due to debris such as leaves clogging the screen protecting the diversion intake pipes. After adjusting the height of the intake, a steady pumped flow rate of approximately 212 gallons per minute (gpm) was recorded after 9:30 am and maintained for the duration of the diversion. The large 45,000 gpm wet weather pumps did not turn on during the diversion sampling event. According to onsite Valentine staff, the large diversion pumps did operate several times during the storm event prior to diversion, so this was not a true “first flush” diversion pilot.

Amec Foster Wheeler staff completed field sampling of diverted stormwater between 9:30 and 11:30 am. Nine samples were collected: five stormwater samples, one field duplicate, and three field blanks (Table 2). To facilitate collection of stormwater diversion monitoring samples, Valentine installed a gate valve and spigot in the piping. A hose was attached to the spigot and flushed with diverted stormwater prior to collecting each sample. Stormwater samples were collected directly into sampling bottles from the hose. Field blanks used laboratory-provided blank water to fill the sample bottles. The field blank bottles were filled at the same location as the stormwater samples after the flow was turned off.

All samples were analyzed for total mercury, methylmercury and total PCB concentrations. Suspended sediment concentrations were measured in all samples except the field blanks.

## 2.3 QUALITY ASSURANCE

Monitoring results were checked against SWAMP MQOs. In general, all measurements met SWAMP MQOs with a few exceptions.

The calculation of the relative percent difference (RPD) for the field sample/ field duplicate pair were less than the SWAMP MQO control limits for precision of 25%, for all parameters including individual PCB congeners, except methylmercury. The methylmercury RPD was 31% versus the control limit of 25%. However, given the narrow range of data, this result is not expected to greatly alter the interpretation of the data.

The field blanks returned non-detectable concentrations of mercury, methylmercury and PCBs.

## 2.4 RESULTS

Analyte concentrations reported by McCambell Analytical are summarized in Table 3. Complete results, including any flagged or qualified results, are included as Appendix A. Total PCB concentrations were calculated from individual congeners. Congener concentrations reported as non-detects were replaced with one half of the method detection limit. This is consistent with the NRSPS Dry Weather Diversion Field Sampling report (Applied Marine Sciences, 2015), and reporting procedures established by the Bay Area Stormwater Management Agencies Association Regional Monitoring Coalition.

Measured concentrations of SSC, total Hg, methylmercury, and PCBs showed low variability across the 2.5 hour diversion monitoring event. Total mercury concentrations ranged from a minimum of 31 ng/L to a maximum of 42 ng/L. Methylmercury concentrations ranged from 0.4 ng/L to 0.51 ng/L. Total PCB concentrations ranged from a minimum of 4,671 pg/L to a maximum of 8,562 pg/L. Suspended sediment concentrations ranged from 49.3 mg/L to 53.9 mg/L.

Figures 2 through 4 show total mercury, methylmercury, and PCB concentrations plotted against SSC. As these parameters are generally associated with fine particulate matter in stormwater the small range of SSC in diverted stormwater is reflected in the small range of total mercury, methylmercury and PCB concentrations. The correlation between SSC and total Hg and PCB is not statistically significant for the sample size (critical correlation coefficient = 0.81 for $n = 6$ at $\alpha = 0.05$). There was a significant correlation between SSC and methylmercury. For all correlation analyses, poor correlations with SSC are expected because the range of SSC measurements in the data set is small – i.e., less than 10 percent variation from the lowest SSC measurement to the highest SSC measurement. Robust correlations of pollutants with SSC are best derived when the measured SSC varies between less than 10 mg/L up to 100 mg / L or greater, with several intermediate samples of differing SSC concentrations.

The purpose of regression analysis vs. SSC is to estimate the ratio of pollutants to suspended sediments based on the slope of the regression line. An alternative approach is to calculate individual pollutant to SSC ratios for each sample, and then determine the average ratio, as shown in Table 3. The mercury / SSC ratio of suspended sediments at the NRSPS wet weather event averaged 0.7 +/- 0.07 µg/g (ppm). For context, this is consistent with the expected concentration of mercury in urban sediments; stormwater from the 1$^{st}$ and Cutting area in Richmond were recently shown to have mercury / SSC ratios of approximately 1 (Contra Costa Clean Water Program, 2015). Suspended sediments in the NRSPS had approximately 9 +/- 2 ng/g (ppb) methylmercury; this is approximately ten time greater than watershed background methylmercury to suspended sediment concentrations recently measured by the Contra Costa Clean Water Program (2015). PCB to suspended sediment ratios at the NRSPS average 135 +/- 26 ng/g (ppb); this is typical of older urban areas of the Bay (Contra Costa Clean Water Program, 2013).

## 3.0 DIVERSION VOLUME AND MASS

As noted above, diversion of stormwater was approved by WCWD staff at approximately 9 am. A steady state pumping rate of 212 gpm was reached at about 9:30 am. An estimate of the total volume of stormwater diverted to the WCWD and the associated mass load of SSC, total mercury and PCB is presented in Table 4. Assuming a constant pumping rate, and that each stormwater sample was representative of the water quality for a given time interval, it is possible to calculate the mass diverted for each parameter by multiplying the flow rate times the elapsed time between samples, and the concentration. Based on this calculation approximately 32,012 gallons of stormwater, 4.2 mg of Hg, 0.05 mg of methylmercury, 0.80 mg of PCBs, and 6.2 kg of suspended sediment were diverted into the WCWD sewer system during the wet weather diversion monitoring program (Table 4).

## 4.0 DISCUSSION

Amec Foster Wheeler completed a wet weather diversion monitoring program at the NRSPS on November 2, 2015. Nine samples were collected and analyzed for SSC, total and methylmercury, and 40 PCB congeners. Analytical results showed that there was little variability across time for the diversion monitoring program for SSC, total mercury and PCBs. No methylmercury was detected in any stormwater sample.

Results of the diversion monitoring indicate that approximately 32,012 gallons of stormwater, 4.2 mg of Hg, 0.05 mg of methylmercury, 0.80 mg of PCBs, and 6.2 kg of suspended sediment were diverted into the WCWD sewer system between 9 and 11:30 am on November 2, 2015.

## 5.0 REFERENCES

Applied Marine Sciences, 2015. Field Sampling Report, North Richmond Pump Station Dry Weather Diversion, Water Quality Monitoring, December 1, 2015.

California Department of Water Resources. Retrieved January 3, 2016, from http://cdec.water.ca.gov/cgiprogs/selectQuery?station_id=RHL&sensor_num=16&dur_code=E&start_date=2015-11-01&end_date=2015-11-03&geom

Contra Costa Clean Water Program, 2014. Integrated Monitoring Report, Part C: Pollutants of Concern Implementation Plan. Submitted to the San Francisco Bay Regional Water Quality Control Board April 1, 2014.

Contra Costa Clean Water Program, 2015. Delta Methylmercury Control Study Preliminary Data Report. Submitted to the Central Valley Regional Water Quality Control Board, October 15, 2015.

**TABLES**

## TABLE 1

## ANALYTICAL METHODS

North Richmond Pump Station
Contra Costa County, California

| Analyte | Method | Reporting Limit | Units |
|---|---|---|---|
| Mercury | EPA E1631E | 0.5 | ng/L |
| Methyl Mercury | EPA 1630/FGS-070 | 0.05 | ng/L |
| Total PCBs | EPA E1668C | Variable | pg/L |
| Suspended Sediment Concentration | ASTM D3977-B | 1 | mg/L |

Abbreviations
ASTM = American Society for Testing and Materials
EPA = Environmental Protection Agency
mg/L = milligrams per liter
NA = not analyzed
ng/L = nanograms per liter
PCB = polychlorinated biphenyl
pg/L = picograms per liter

**TABLE 2**

**SAMPLES AND ANALYTICAL METHODS**
North Richmond Pump Station
Contra Costa County, California

| Sample ID | Sample Type | Analyte and Method | | | |
|---|---|---|---|---|---|
| | | **Mercury by EPA E1631E** | **Methyl Mercury by EPA 1630/FGS-070** | **PCBs by EPA E1668C** | **Suspended Sediment Concentration by ASTM D3977-B** |
| NRPS15-001 | Stormwater | X | X | X | X |
| NRPS15-002 | Stormwater | X | X | X | X |
| NRPS15-003 | Field Duplicate | X | X | X | X |
| NRPS15-004 | Field Blank | X | X | X | NA |
| NRPS15-005 | Stormwater | X | X | X | X |
| NRPS15-006 | Stormwater | X | X | X | X |
| NRPS15-007 | Field Blank | X | X | X | NA |
| NRPS15-008 | Stormwater | X | X | X | X |
| NRPS15-009 | Field Blank | X | X | X | NA |

Abbreviations
ASTM = American Society for Testing and Materials
EPA = Environmental Protection Agency
NA = not analyzed
PCB = polychlorinated biphenyl

## TABLE 3

## SUMMARY ANALYTICAL RESULTS

North Richmond Pump Station
Contra Costa County, California

| | | | Parameters | | | | Ratios | | |
|---|---|---|---|---|---|---|---|---|---|
| Sample ID | Type | Time | Mercury (ng/L) | Methyl Mercury (ng/L) | Total PCBs (pg/L) | SSC (mg/L) | Hg/SSC (µg/g) | MeHg/SSC (ng/g) | PCB/SSC (ng/g) |
| NRPS15-001 | Stormwater | 9:37 | 37 | 0.51 | 8293 | 54 | 1 | 9 | 154 |
| NRPS15-002 | Stormwater | 9:52 | 36 | 0.51 | 7763 | 54 | 1 | 9 | 145 |
| NRPS15-003 | Field Duplicate | 9:56 | 42 | 0.70 | 8342 | 53 | 1 | 13 | 158 |
| NRPS15-004 | Field Blank | 10:10 | ND | ND | 68 * | NA | NA | NA | NA |
| NRPS15-005 | Stormwater | 10:28 | 37 | 0.40 | 6371 | 50 | 1 | 8 | 129 |
| NRPS15-006 | Stormwater | 10:56 | 31 | 0.42 | 6664 | 49 | 1 | 8 | 135 |
| NRPS15-007 | Field Blank | 11:00 | ND | ND | 68 * | NA | NA | NA | NA |
| NRPS15-008 | Stormwater | 11:31 | 32 | 0.42 | 4418 | 50 | 1 | 8 | 88 |
| NRPS15-009 | Field Blank | 11:24 | ND | ND | 68 * | NA | NA | NA | NA |
| | | Average | 36 | 0.49 | 4673 | 52 | 0.69 | 9 | 135 |
| | | Standard Deviation | 4.0 | 0.11 | 3651 | 2.1 | 0.07 | 2 | 26 |

Notes

* Calculation of total PCBs used 1/2 the method detection limit for ND congeners

Abbreviations:

mg/L = miligrams per liter
NA = not analyzed
ND = not detected
ng/L = nanograms per liter
PCB = polychlorinated biphenyl
pg/L = picograms per liter
SSC = suspended sediment concentration

## TABLE 4

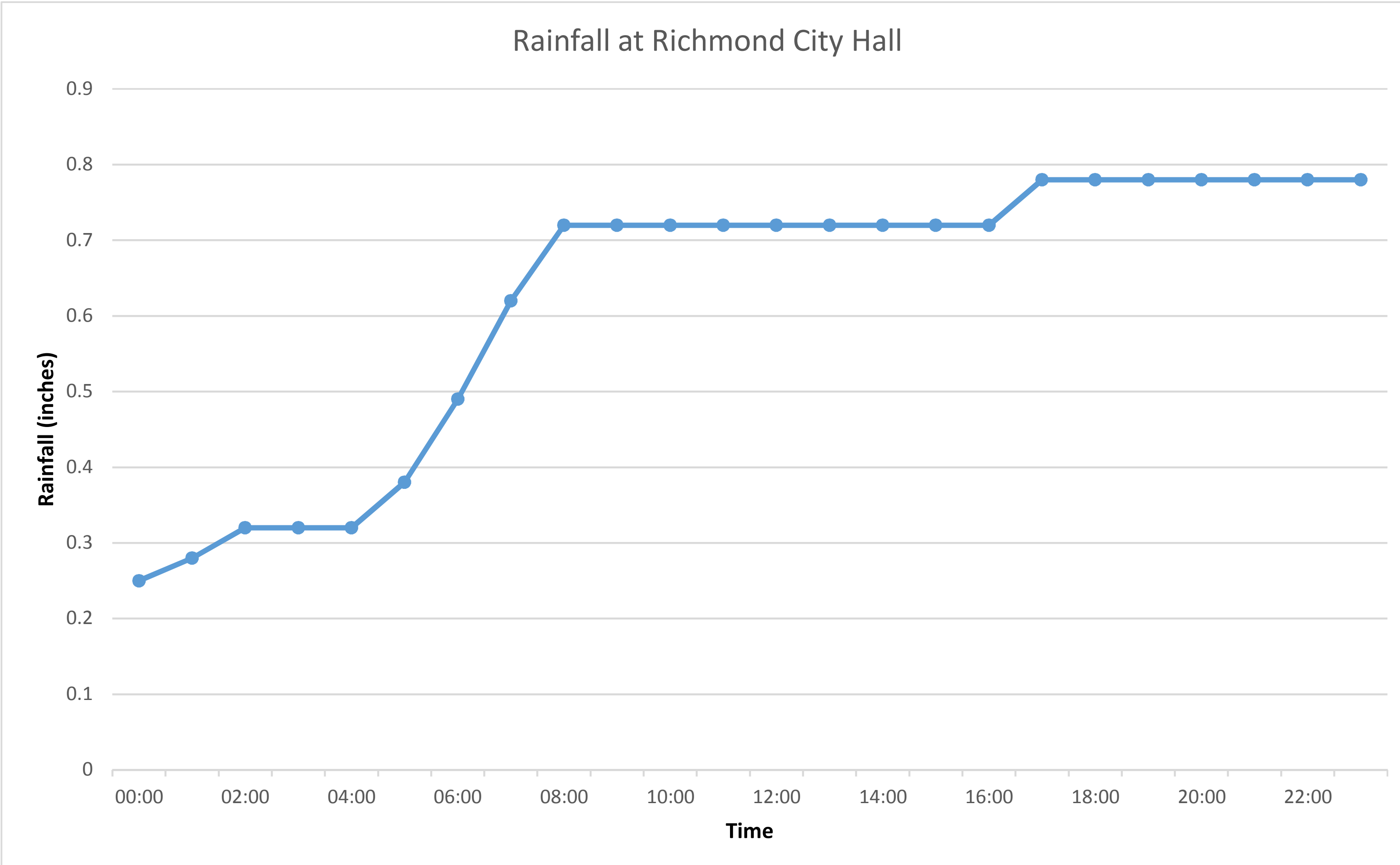
## VOLUME AND MASS ESTIMATES
North Richmond Pump Station
Contra Costa County, California

| Sample ID | Time | Elapsed Time (min) | Volume Diverted (gallons) [1] | Concentration | | | | Mass | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Hg (ng/L) | MeHg (ng/L) | PCBs (pg/L) | SSC (mg/L) | Hg ng | MeHg ng | PCBs pg | SSC mg | Hg mg | MeHg mg | PCBs mg | SSC kg |
| Start Diversion | 9:00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| NRPS15-001 | 9:37 | 37 | 7844 | 37 | 0.506 | 8292.55 | 53.9 | 1,098,623 | 15,024 | 246,226,541 | 1,600,426 | 1.10 | 0.02 | 0.25 | 1.60 |
| NRPS15-002 | 9:52 | 15 | 3180 | 36 | 0.507 | 7763.25 | 53.5 | 433,350 | 6,103 | 93,450,122 | 644,006 | 0.43 | 0.01 | 0.09 | 0.64 |
| NRPS15-005 | 10:28 | 36 | 7632 | 37 | 0.401 | 6371.3 | 49.5 | 1,068,930 | 11,585 | 184,066,857 | 1,430,055 | 1.07 | 0.01 | 0.18 | 1.43 |
| NRPS15-006 | 10:56 | 28 | 5936 | 31 | 0.417 | 6663.75 | 49.3 | 696,570 | 9,370 | 149,734,463 | 1,107,771 | 0.70 | 0.01 | 0.15 | 1.11 |
| NRPS15-008 | 11:31 | 35 | 7420 | 32 | 0.415 | 4418.1 | 50.4 | 898,800 | 11,656 | 124,093,384 | 1,415,610 | 0.90 | 0.01 | 0.12 | 1.42 |
| | | **TOTALS** | **32,012** | **--** | **--** | **--** | **--** | **--** | **--** | **--** | **--** | **4.20** | **0.05** | **0.80** | **6.20** |

Notes:
1. 212 gpm steady state flow rate from diversion pump.

Abbreviations:
- -- = not applicable
- kg = kilograms
- MeHg = methyl mercury
- mg = miligrams
- mg/L = miligrams per liter
- min = minutes
- ng = nanograms
- ng/L = nanograms per liter
- PCB = polychlorinated biphenyl
- pg = picograms
- pg/L = picograms per liter
- SSC = suspended sediment concentration

# FIGURES




RAINFALL MEASURED AT RICHMOND CITY HALL, NOVEMBER 2, 2015
North Richmond Pump Station
Contra Costa County, California

amec foster wheeler

| | | | |
|---|---|---|---|
| Date: 1/12/16 | Project No. | 5025153002.04 | Figure 1 |

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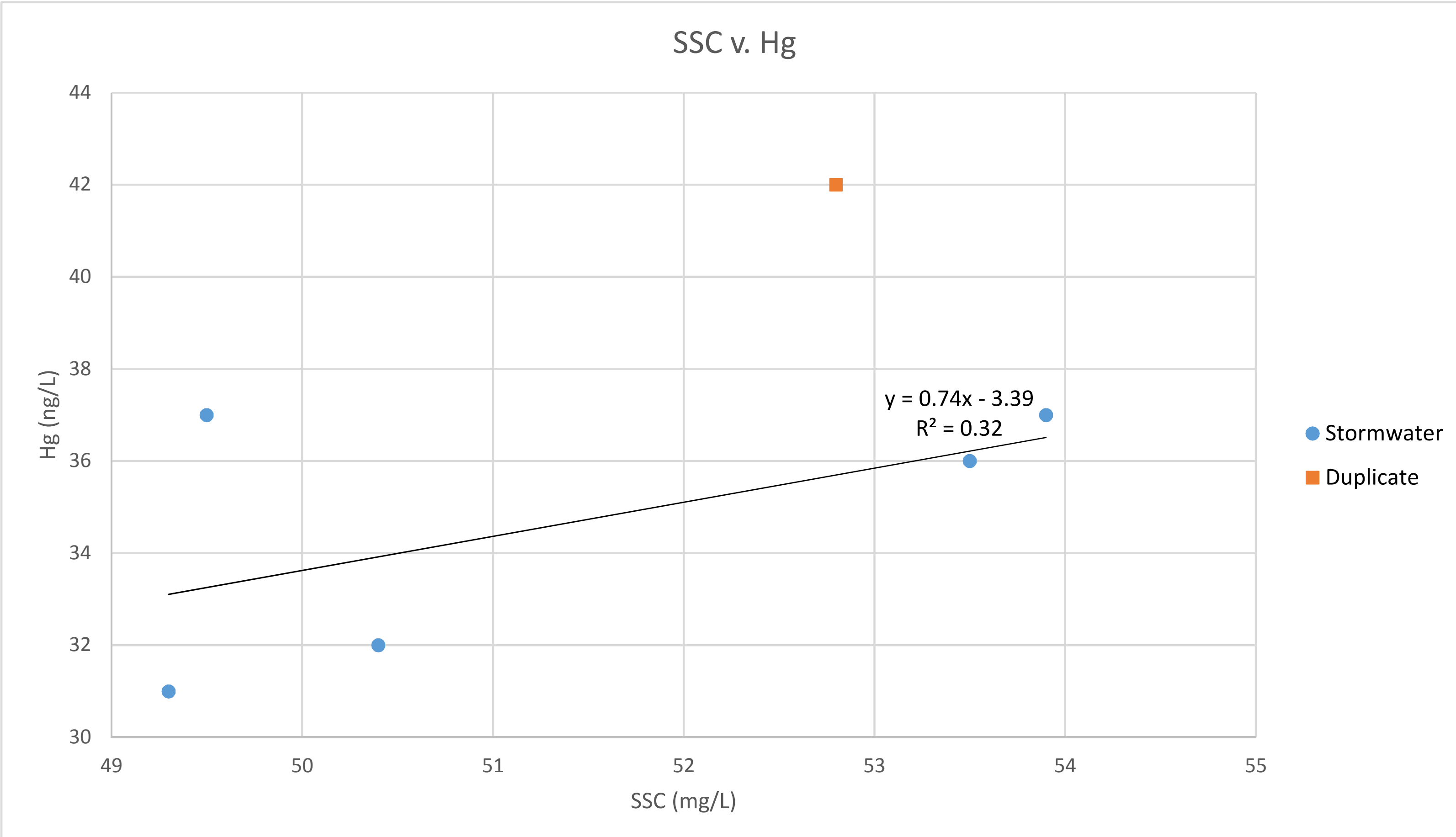
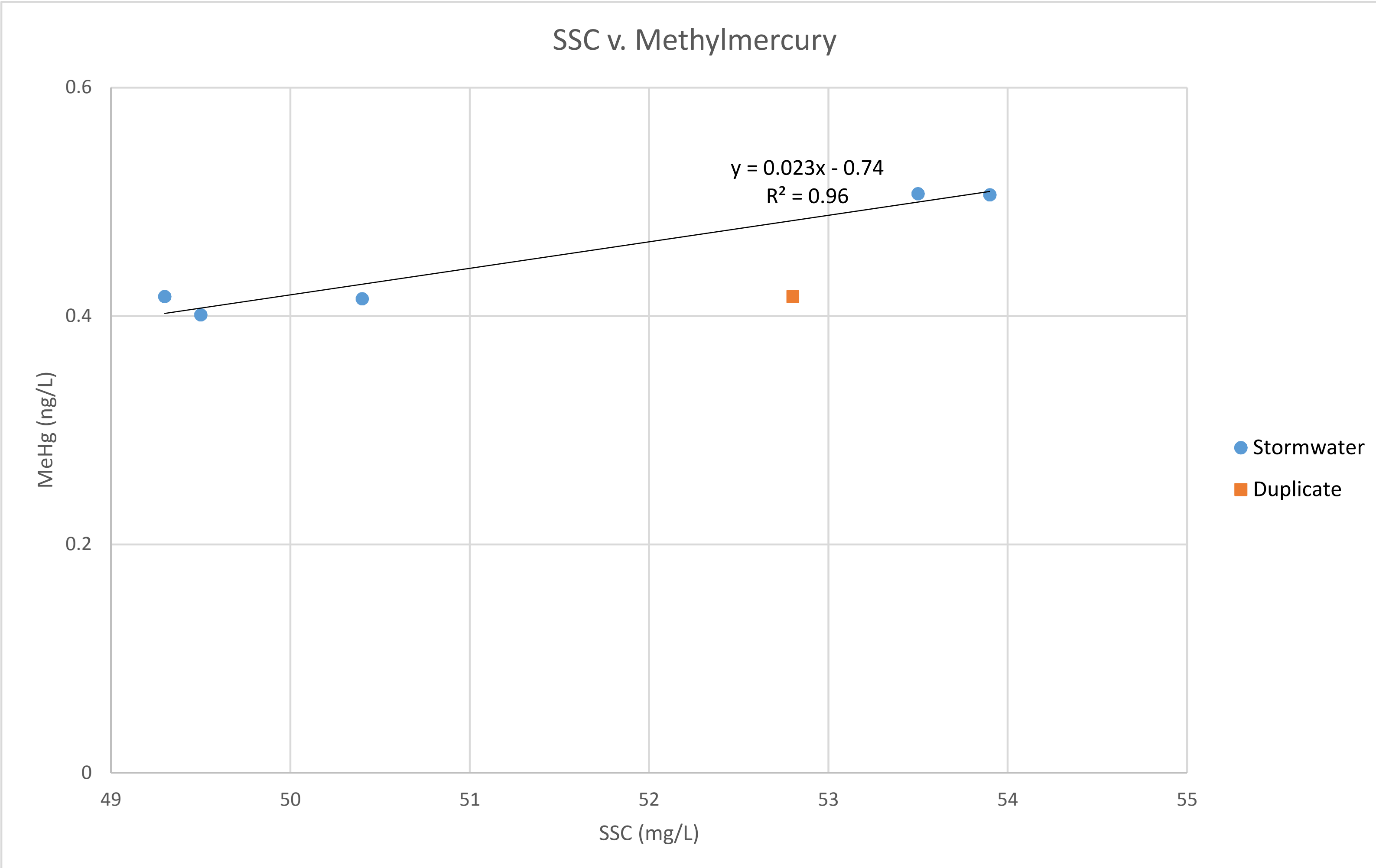



SCATTER PLOT OF SSC
AND TOTAL MERCURY
North Richmond Pump Station
Contra Costa County, California

amec foster wheeler

| | | | |
|---|---|---|---|
| Date: 1/12/16 | Project No. | 5025153002.04 | Figure 2 |




SCATTER PLOT OF SSC AND METHYLMERCURY
North Richmond Pump Station
Contra Costa County, California

amec foster wheeler

| Date: 1/12/16 | Project No. | 5025153002.04 | Figure 3 |
|---|---|---|---|

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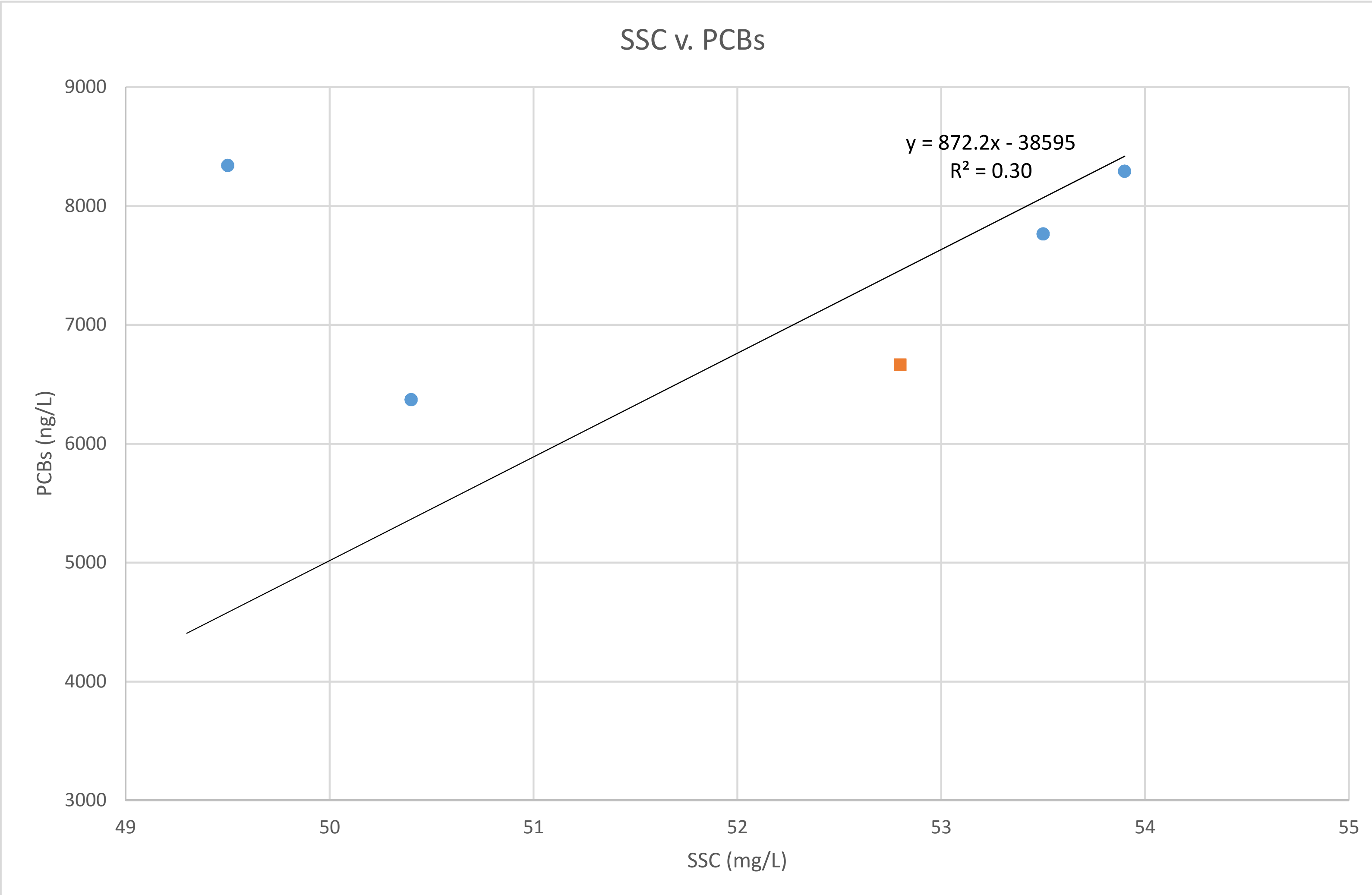


| SCATTER PLOT OF SSC AND TOTAL PCBs<br>North Richmond Pump Station<br>Contra Costa County, California | | | amec foster wheeler |
|---|---|---|---|
| Date: 1/12/16 | Project No. | 5025153002.04 | Figure **4** |

\\Oad-fs1\doc_safe\5000s\5025153002\3000 rpt\Field Sampling Report_011216\02 tbls-figs\

## APPENDIX A

Laboratory Certificates

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425.686.1996 Phone
425.686.3096 Fax

19 November 2015

Rosa Venegas
McCampbell Analytical, Inc
1534 Willow Pass Rd
Pittsburg, CA 94565

RE: MMHg

Enclosed are the analytical results for samples received by Eurofins Frontier Global Sciences. All quality control measurements are within established control limits and there were no analytical difficulties encountered with the exception of those listed in the case narrative section of this report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Amy Goodall
Project Manager

eurofins | Frontier Global Sciences

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Bothell, WA 98011
425.686.1996 Phone
425.686.3096 Fax

| | | |
|---|---|---|
| McCampbell Analytical, Inc | Project: MMHg | |
| 1534 Willow Pass Rd | Project Number: North Richmond Pump Station | **Reported:** |
| Pittsburg CA, 94565 | Project Manager: Rosa Venegas | 19-Nov-15 15:09 |

## ANALYTICAL REPORT FOR SAMPLES

| Sample ID | Laboratory ID | Matrix | Date Sampled | Date Received |
|---|---|---|---|---|
| 1511071-001C NRPSIS-001 | 1511087-01 | Water | 02-Nov-15 09:37 | 04-Nov-15 09:30 |
| 1511071-002C NRPSIS-002 | 1511087-02 | Water | 02-Nov-15 09:52 | 04-Nov-15 09:30 |
| 1511071-003C NRPSIS-003 | 1511087-03 | Water | 02-Nov-15 09:56 | 04-Nov-15 09:30 |
| 1511071-004C NRPSIS-004 | 1511087-04 | Water | 02-Nov-15 10:10 | 04-Nov-15 09:30 |
| 1511071-005C NRPSIS-005 | 1511087-05 | Water | 02-Nov-15 10:28 | 04-Nov-15 09:30 |
| 1511071-006C NRPSIS-006 | 1511087-06 | Water | 02-Nov-15 10:56 | 04-Nov-15 09:30 |
| 1511071-007C NRPSIS-007 | 1511087-07 | Water | 02-Nov-15 11:00 | 04-Nov-15 09:30 |
| 1511071-008C NRPSIS-008 | 1511087-08 | Water | 02-Nov-15 11:31 | 04-Nov-15 09:30 |
| 1511071-009C NRPSIS-009 | 1511087-09 | Water | 02-Nov-15 11:24 | 04-Nov-15 09:30 |

Eurofins Frontier Global Sciences, Inc.

*The results in this report only apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.*

Amy Goodall

Amy Goodall, Project Manager

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| | | |
|---|---|---|
| McCampbell Analytical, Inc | Project: MMHg | |
| 1534 Willow Pass Rd | Project Number: North Richmond Pump Station | **Reported:** |
| Pittsburg CA, 94565 | Project Manager: Rosa Venegas | 19-Nov-15 15:09 |

SAMPLE RECEIPT

Samples were received at Eurofins Frontier Global Sciences (EFGS) on 11/4/2015 9:30:00 AM . The samples were received intact, on-ice within a sealed cooler at 1.4 degrees Celsius.

SAMPLE PREPARATION AND ANALYSIS

Samples were prepared and analyzed for methyl mercury by cold vapor gas chromatography atomic fluorescence spectrometry (CV-GC-AFS) in accordance with EPA 1630 (EFGS-070).

ANALYTICAL AND QUALITY CONTROL ISSUES

Method blanks were prepared for every preparation to assess possible blank contribution from the sample preparation procedure. The method blanks were carried through the entire analytical procedure. All blanks fell within the established acceptance criteria with the exception of any items narrated above or flagged and described in the notes and definitions section of the report.

Liquid spikes, certified reference material (CRM) or a quality control samples (QCS) were prepared for every preparation as a measure of accuracy. All liquid spikes, CRMs and/or QCS samples fell within the established acceptance criteria with the exception of any items narrated above or flagged and described in the notes and definitions section of the report.

As an additional measure of the accuracy of the methods used and to check for matrix interference, matrix spikes (MS) and matrix spike duplicates (MSD) were digested and analyzed. All of the matrix spike recoveries fell within the established acceptance criteria with the exception of any items flagged and described in the notes and definitions section of the report.

A reasonable measure of the precision of the analytical methods is the relative percent difference (RPD) between a matrix spike recovery and a matrix spike duplicate recovery and between laboratory control sample recovery and laboratory control sample duplicate recoveries. All of the relative percent differences established acceptance criteria with the exception of any items flagged and described in the notes and definitions section of the report.

eurofins

Frontier Global Sciences

# Sample Receipt Checklist

**EFGS Work Order:** 1511087

Client: McCampbell Analytical

Date & Time Received: 11/4/15 10:00

Date Labeled: 11/4/15 Labeled By: [illegible]

Project: 

Received By: LM

Label Verified By: CMK

\# of Coolers Received: 1

Samples Arrived By: ✓ Shipping Service ___ Courier ___ Hand ___ Other (Specify: ___)

Coolant: ☐ None/Ambient ☑ Loose Ice ☐ Gel Ice ☐ Dry Ice   Coolant Required: (Y)/N   Temp Blank Used: Y/(N) for Cooler(s): ___

Notify Project Manager if packages/coolers are received without coolant or with thawed coolant and at a temperature in excess of 6°C. PM notified: Y/N

| **Cooler Information:** | Y/N/NA | Comments |
|---|---|---|
| The coolers do not appear to be tampered with: | ✓ | |
| Custody Seals are present and intact: | N | |
| Custody seals signed: | N | |

| **TID:** 43/50 | **CF:** -0.3 °C | **Date/time:** 11/4/15 10:00 | **By:** LM |
|---|---|---|---|
| Cooler 1: 1.7 °C | w/ CF: 1.4 °C | Cooler 4: °C | w/ CF: °C |
| Cooler 2: °C | w/ CF: °C | Cooler 5: °C | w/ CF: °C |
| Cooler 3: °C | w/ CF: °C | Cooler 6: °C | w/ CF: °C |

| **Chain of Custody:** | Y/N/NA | Comments |
|---|---|---|
| Sample ID/Description: | Y | |
| Date and time of collection: | Y | |
| Sampled by: | N | |
| Preservation type: | N | |
| Requested analyses: | Y | |
| Required signatures: | Y | |
| Internal COC required: | N | |

| **Sample Condition/Integrity:** | Y/N/NA | Comments |
|---|---|---|
| Sample containers intact/present: | Y | |
| Sample labels are present and legible: | Y | |
| Sample ID on container/bag matches COC: | Y | |
| Correct sample containers used: | Y | |
| Samples received within holding times: | Y | |
| Sample volume sufficient for requested analyses: | Y | |
| Correct preservative used for requested analyses: | Y | |

Anomalies/Non-conformances (attach additional pages if needed):

1511087

McCampbell Analytical, Inc.

1534 Willow Pass Rd
Pittsburg, CA 94565-1701
Phone: (925) 252-9262
Fax: (925) 252-9269

# SUB CHAIN-OF-CUSTODY RECORD



**WorkOrder: 1511071** **ClientCode: AMEC** **EDF: NO**

**Subcontractor:**

Eurofins Frontier Global Sciences
11720 Northcreek Pkwy N, Suite 400
Bothell, WA 98011

TEL: (425) 686-1996
FAX: (425) 686-3096
ProjectNo: North Richmond Pump Station
Acct #:

**Subcontractor Standard TAT:**

***Date Received:*** **11/02/2015**

| | | | | | Requested Tests | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Lab ID** | **Client ID** | **Matrix** | **Collection Date** | **TAT** | **E1630** | | | | |
| 1511071-001C | NRPSIS-001 | Water | 11/2/2015 9:37 | 5 day(s) | 1 | | | | |
| 1511071-002C | NRPSIS-002 | Water | 11/2/2015 9:52 | 5 day(s) | 1 | | | | |
| 1511071-003C | NRPSIS-003 | Water | 11/2/2015 9:56 | 5 day(s) | 1 | | | | |
| 1511071-004C | NRPSIS-004 | Water | 11/2/2015 10:10 | 5 day(s) | 1 | | | | |
| 1511071-005C | NRPSIS-005 | Water | 11/2/2015 10:28 | 5 day(s) | 1 | | | | |
| 1511071-006C | NRPSIS-006 | Water | 11/2/2015 10:56 | 5 day(s) | 1 | | | | |
| 1511071-007C | NRPSIS-007 | Water | 11/2/2015 11:00 | 5 day(s) | 1 | | | | |
| 1511071-008C | NRPSIS-008 | Water | 11/2/2015 11:31 | 5 day(s) | 1 | | | | |
| 1511071-009C | NRPSIS-009 | Water | 11/2/2015 11:24 | 5 day(s) | 1 | | | | |

**Comments:** **PLEASE USE 'CLIENT ID' AS THE SAMPLE ID AND EMAIL ASAP!**

Please email results to Maria Venegas at subdata@mccampbell.com upon completion.

| | | Date/Time | | | Date/Time |
|---|---|---|---|---|---|
| **Relinquished by:** | [signature] | 11/3 | **Received by:** | [signature] Lars Moffet | 11/4/15 10:00 |
| **Relinquished by:** | | | **Received by:** | EPSS | |

No Seal
UPS
12 885 54E 01
1.4°C
11/4/15 SCM
~~444~~ 4460
4789

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| | | |
|---|---|---|
| McCampbell Analytical, Inc | Project: MMHg | |
| 1534 Willow Pass Rd | Project Number: North Richmond Pump Station | **Reported:** |
| Pittsburg CA, 94565 | Project Manager: Rosa Venegas | 19-Nov-15 15:09 |

**1511071-001C NRPSIS-001**

**1511087-01**

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Batch | Prepared | Sequence | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Preparation: EFGS-013 Methyl Hg Distillation for Water** | | | | | | | | | | | |
| **Methyl Mercury (as Mercury)** | **0.506** | 0.026 | 0.050 | ng/L | 1.25 | F511180 | 13-Nov-15 | 5K16026 | 14-Nov-15 | EPA 1630/FGS-070 | |

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Amy Goodall, Project Manager

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| | | |
|---|---|---|
| McCampbell Analytical, Inc<br>1534 Willow Pass Rd<br>Pittsburg CA, 94565 | Project: MMHg<br>Project Number: North Richmond Pump Station<br>Project Manager: Rosa Venegas | **Reported:**<br>19-Nov-15 15:09 |

**1511071-002C NRPSIS-002**

**1511087-02**

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Batch | Prepared | Sequence | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Preparation: EFGS-013 Methyl Hg Distillation for Water** | | | | | | | | | | | |
| **Methyl Mercury (as Mercury)** | **0.507** | 0.026 | 0.050 | ng/L | 1.25 | F511180 | 13-Nov-15 | 5K16026 | 14-Nov-15 | EPA 1630/FGS-070 | |

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| | | |
|---|---|---|
| McCampbell Analytical, Inc | Project: MMHg | |
| 1534 Willow Pass Rd | Project Number: North Richmond Pump Station | **Reported:** |
| Pittsburg CA, 94565 | Project Manager: Rosa Venegas | 19-Nov-15 15:09 |

**1511071-003C NRPSIS-003**

**1511087-03**

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Batch | Prepared | Sequence | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Preparation: EFGS-013 Methyl Hg Distillation for Water** | | | | | | | | | | | |
| **Methyl Mercury (as Mercury)** | **0.696** | 0.026 | 0.050 | ng/L | 1.25 | F511180 | 13-Nov-15 | 5K16026 | 14-Nov-15 | EPA 1630/FGS-070 | |

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| | | |
|---|---|---|
| McCampbell Analytical, Inc | Project: MMHg | |
| 1534 Willow Pass Rd | Project Number: North Richmond Pump Station | **Reported:** |
| Pittsburg CA, 94565 | Project Manager: Rosa Venegas | 19-Nov-15 15:09 |

**1511071-004C NRPSIS-004**

**1511087-04**

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Batch | Prepared | Sequence | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Preparation: EFGS-013 Methyl Hg Distillation for Water** | | | | | | | | | | | |
| Methyl Mercury (as Mercury) | ND | 0.026 | 0.050 | ng/L | 1.25 | F511180 | 13-Nov-15 | 5K16026 | 14-Nov-15 | EPA 1630/FGS-070 | U |

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Amy Goodall

Amy Goodall, Project Manager

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| | | |
|---|---|---|
| McCampbell Analytical, Inc | Project: MMHg | |
| 1534 Willow Pass Rd | Project Number: North Richmond Pump Station | **Reported:** |
| Pittsburg CA, 94565 | Project Manager: Rosa Venegas | 19-Nov-15 15:09 |

**1511071-005C NRPSIS-005**

**1511087-05**

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Batch | Prepared | Sequence | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Preparation: EFGS-013 Methyl Hg Distillation for Water** | | | | | | | | | | | |
| **Methyl Mercury (as Mercury)** | **0.401** | 0.026 | 0.050 | ng/L | 1.25 | F511180 | 13-Nov-15 | 5K16026 | 14-Nov-15 | EPA 1630/FGS-070 | |

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Amy Goodall, Project Manager

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| | | |
|---|---|---|
| McCampbell Analytical, Inc | Project: MMHg | |
| 1534 Willow Pass Rd | Project Number: North Richmond Pump Station | **Reported:** |
| Pittsburg CA, 94565 | Project Manager: Rosa Venegas | 19-Nov-15 15:09 |

## 1511071-006C NRPSIS-006

## 1511087-06

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Batch | Prepared | Sequence | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Preparation: EFGS-013 Methyl Hg Distillation for Water** | | | | | | | | | | | |
| **Methyl Mercury (as Mercury)** | **0.417** | 0.026 | 0.050 | ng/L | 1.25 | F511180 | 13-Nov-15 | 5K16026 | 14-Nov-15 | EPA 1630/FGS-070 | |

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| | | |
|---|---|---|
| McCampbell Analytical, Inc | Project: MMHg | |
| 1534 Willow Pass Rd | Project Number: North Richmond Pump Station | **Reported:** |
| Pittsburg CA, 94565 | Project Manager: Rosa Venegas | 19-Nov-15 15:09 |

**1511071-007C NRPSIS-007**

**1511087-07**

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Batch | Prepared | Sequence | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Preparation: EFGS-013 Methyl Hg Distillation for Water** | | | | | | | | | | | |
| Methyl Mercury (as Mercury) | ND | 0.026 | 0.050 | ng/L | 1.25 | F511180 | 13-Nov-15 | 5K16026 | 14-Nov-15 | EPA 1630/FGS-070 | U |

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Amy Goodall, Project Manager

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| | | |
|---|---|---|
| McCampbell Analytical, Inc | Project: MMHg | |
| 1534 Willow Pass Rd | Project Number: North Richmond Pump Station | **Reported:** |
| Pittsburg CA, 94565 | Project Manager: Rosa Venegas | 19-Nov-15 15:09 |

**1511071-008C NRPSIS-008**

**1511087-08**

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Batch | Prepared | Sequence | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Preparation: EFGS-013 Methyl Hg Distillation for Water** | | | | | | | | | | | |
| **Methyl Mercury (as Mercury)** | **0.415** | 0.026 | 0.050 | ng/L | 1.25 | F511180 | 13-Nov-15 | 5K16026 | 14-Nov-15 | EPA 1630/FGS-070 | |

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| | | |
|---|---|---|
| McCampbell Analytical, Inc<br>1534 Willow Pass Rd<br>Pittsburg CA, 94565 | Project: MMHg<br>Project Number: North Richmond Pump Station<br>Project Manager: Rosa Venegas | **Reported:**<br>19-Nov-15 15:09 |

**1511071-009C NRPSIS-009**

**1511087-09**

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Batch | Prepared | Sequence | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Preparation: EFGS-013 Methyl Hg Distillation for Water** | | | | | | | | | | | |
| Methyl Mercury (as Mercury) | ND | 0.026 | 0.050 | ng/L | 1.25 | F511180 | 13-Nov-15 | 5K16026 | 14-Nov-15 | EPA 1630/FGS-070 | U |

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**Bothell, WA 98011**
**425.686.1996 Phone**
**425.686.3096 Fax**

| | | |
|---|---|---|
| McCampbell Analytical, Inc | Project: MMHg | |
| 1534 Willow Pass Rd | Project Number: North Richmond Pump Station | **Reported:** |
| Pittsburg CA, 94565 | Project Manager: Rosa Venegas | 19-Nov-15 15:09 |

## Quality Control Data

| Analyte | Result | Detection Limit | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Batch F511180 - EFGS-013 Methyl Hg Distillation for Water** | | | | | | | | | | | |
| **Blank (F511180-BLK1)** | | | | | Prepared & Analyzed: 13-Nov-15 | | | | | | |
| Methyl Mercury (as Mercury) | 0.032 | 0.026 | 0.050 | ng/L | | | | | | | J |
| **Blank (F511180-BLK2)** | | | | | Prepared: 13-Nov-15 Analyzed: 14-Nov-15 | | | | | | |
| Methyl Mercury (as Mercury) | ND | 0.026 | 0.050 | ng/L | | | | | | | U |
| **Blank (F511180-BLK3)** | | | | | Prepared: 13-Nov-15 Analyzed: 14-Nov-15 | | | | | | |
| Methyl Mercury (as Mercury) | ND | 0.026 | 0.050 | ng/L | | | | | | | U |
| **LCS (F511180-BS1)** | | | | | Prepared & Analyzed: 13-Nov-15 | | | | | | |
| Methyl Mercury (as Mercury) | 1.168 | 0.026 | 0.050 | ng/L | 1.0010 | | 117 | 70-130 | | | |
| **LCS Dup (F511180-BSD1)** | | | | | Prepared & Analyzed: 13-Nov-15 | | | | | | |
| Methyl Mercury (as Mercury) | 1.168 | 0.026 | 0.050 | ng/L | 1.0010 | | 117 | 70-130 | 0.0104 | 25 | |
| **Duplicate (F511180-DUP1)** | | **Source: 1510485-02RE1** | | | Prepared: 13-Nov-15 Analyzed: 14-Nov-15 | | | | | | |
| Methyl Mercury (as Mercury) | 0.319 | 0.026 | 0.050 | ng/L | | 0.317 | | | 0.703 | 35 | |
| **Matrix Spike (F511180-MS1)** | | **Source: 1510485-05RE1** | | | Prepared: 13-Nov-15 Analyzed: 14-Nov-15 | | | | | | |
| Methyl Mercury (as Mercury) | 1.922 | 0.026 | 0.050 | ng/L | 1.0010 | 0.423 | 150 | 65-130 | | | QM-07 |
| **Matrix Spike (F511180-MS2)** | | **Source: 1511087-02RE1** | | | Prepared: 13-Nov-15 Analyzed: 14-Nov-15 | | | | | | |
| Methyl Mercury (as Mercury) | 1.915 | 0.026 | 0.050 | ng/L | 1.0010 | 0.507 | 141 | 65-130 | | | QM-07 |
| **Matrix Spike Dup (F511180-MSD1)** | | **Source: 1510485-05RE1** | | | Prepared: 13-Nov-15 Analyzed: 14-Nov-15 | | | | | | |
| Methyl Mercury (as Mercury) | 1.917 | 0.026 | 0.050 | ng/L | 1.0010 | 0.423 | 149 | 65-130 | 0.271 | 35 | QM-07 |
| **Matrix Spike Dup (F511180-MSD2)** | | **Source: 1511087-02RE1** | | | Prepared: 13-Nov-15 Analyzed: 14-Nov-15 | | | | | | |
| Methyl Mercury (as Mercury) | 1.973 | 0.026 | 0.050 | ng/L | 1.0010 | 0.507 | 146 | 65-130 | 2.95 | 35 | QM-07 |

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| | | |
|---|---|---|
| McCampbell Analytical, Inc | Project: MMHg | |
| 1534 Willow Pass Rd | Project Number: North Richmond Pump Station | **Reported:** |
| Pittsburg CA, 94565 | Project Manager: Rosa Venegas | 19-Nov-15 15:09 |

## Notes and Definitions

| | |
|---|---|
| U | Analyte was not detected and is reported as less than the LOD or as defined by the client. The LOD has been adjusted for any dilution or concentration of the sample. |
| QM-07 | The spike recovery was outside control limits for the MS and/or MSD. The batch was accepted based on LCS and LCSD recoveries within control limits and, when analysis permits, acceptable AS/ASD. |
| J | The result is an estimated concentration. |
| DET | Analyte DETECTED |
| ND | Analyte NOT DETECTED at or above the reporting limit |
| NR | Not Reported |
| dry | Sample results reported on a dry weight basis |
| RPD | Relative Percent Difference |

McCampbell Analytical, Inc.

*"When Quality Counts"*

# Analytical Report

**WorkOrder:** 1511071 **Amended:** 01/06/2016

**Report Created for:** AMEC

2101 Webster Street, 12th Floor
Oakland, CA 94612

**Project Contact:** Emily Sportsman
**Project P.O.:**
**Project Name:** North Richmond Pump Station

**Project Received:** 11/02/2015

Analytical Report reviewed & approved for release on 11/10/2015 by:

Angela Rydelius,
Laboratory Manager

***The report shall not be reproduced except in full, without the written approval of the laboratory. The analytical results relate only to the items tested. Results reported conform to the most current NELAP standards, where applicable, unless otherwise stated in the case narrative.***

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# Glossary of Terms & Qualifier Definitions

**Client:** AMEC
**Project:** North Richmond Pump Station
**WorkOrder:** 1511071

## Glossary Abbreviation

| | |
|---|---|
| 95% Interval | 95% Confident Interval |
| DF | Dilution Factor |
| DI WET | (DISTLC) Waste Extraction Test using DI water |
| DISS | Dissolved (direct analysis of 0.45 µm filtered and acidified water sample) |
| DLT | Dilution Test |
| DUP | Duplicate |
| EDL | Estimated Detection Limit |
| ITEF | International Toxicity Equivalence Factor |
| LCS | Laboratory Control Sample |
| MB | Method Blank |
| MB % Rec | % Recovery of Surrogate in Method Blank, if applicable |
| MDL | Method Detection Limit |
| ML | Minimum Level of Quantitation |
| MS | Matrix Spike |
| MSD | Matrix Spike Duplicate |
| N/A | Not Applicable |
| ND | Not detected at or above the indicated MDL or RL |
| NR | Data Not Reported due to matrix interference or insufficient sample amount. |
| PDS | Post Digestion Spike |
| PDSD | Post Digestion Spike Duplicate |
| PF | Prep Factor |
| RD | Relative Difference |
| RL | Reporting Limit (The RL is the lowest calibration standard in a multipoint calibration.) |
| RPD | Relative Percent Deviation |
| RRT | Relative Retention Time |
| SPK Val | Spike Value |
| SPKRef Val | Spike Reference Value |
| SPLP | Synthetic Precipitation Leachate Procedure |
| TCLP | Toxicity Characteristic Leachate Procedure |
| TEQ | Toxicity Equivalents |
| WET (STLC) | Waste Extraction Test (Soluble Threshold Limit Concentration) |

## Analytical Qualifiers

| | |
|---|---|
| B | analyte detected in the associated Method Blank and in the sample |
| J | Result is less than the RL/ML but greater than the MDL. The reported concentration is an estimated value. |
| S | spike recovery outside accepted recovery limits |
| M | Estimated Maximum Possible Concentration |

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# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-001** | **1511071-001A** | **Water** | **11/02/2015 09:37** | **GC36** | **113093** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB 008 | | ND | | 4.0 | 50 | 1 | | | | 11/18/2015 13:14 |
| PCB 018/030 | | **62** | | 3.2 | 50 | 1 | 1.12 | 0.92 | | 11/18/2015 13:14 |
| PCB 020/028 | | **110** | | 3.7 | 50 | 1 | 1.02 | 0.85 | | 11/18/2015 13:14 |
| PCB 031 | | **95** | | 2.2 | 50 | 1 | 1.01 | 0.82 | | 11/18/2015 13:14 |
| PCB 033 | | ND | | 2.4 | 50 | 1 | | | | 11/18/2015 13:14 |
| PCB 044/047/065 | | **120** | | 9.9 | 100 | 1 | 0.77 | 1.01 | | 11/18/2015 13:14 |
| PCB 049/069 | | **58** | J | 4.4 | 100 | 1 | 0.81 | 0.96 | | 11/18/2015 13:14 |
| PCB 052 | | **170** | | 3.2 | 50 | 1 | 0.8 | 1 | | 11/18/2015 13:14 |
| PCB 056 | | **60** | | 3.3 | 50 | 1 | 0.78 | 0.92 | | 11/18/2015 13:14 |
| PCB 060 | | **31** | J | 3.3 | 50 | 1 | 0.73 | 0.94 | | 11/18/2015 13:14 |
| PCB 066 | | **110** | | 2.5 | 50 | 1 | 0.70 | 0.87 | | 11/18/2015 13:14 |
| PCB 070/074/076 | | **230** | | 8.2 | 200 | 1 | 0.75 | 0.84 | | 11/18/2015 13:14 |
| PCB 086/097/109/119 | | **94** | J | 5.6 | 200 | 1 | 1.58 | 0.94 | | 11/18/2015 13:14 |
| PCB 087/125 | | ND | | 5.7 | 200 | 1 | | | | 11/18/2015 13:14 |
| PCB 090/101/113 | | **370** | | 5.4 | 200 | 1 | 1.59 | 1 | | 11/18/2015 13:14 |
| PCB 095 | | **300** | | 2.4 | 200 | 1 | 1.59 | 1.19 | | 11/18/2015 13:14 |
| PCB 099 | | **150** | | 2.5 | 100 | 1 | 1.57 | 1.05 | | 11/18/2015 13:14 |
| PCB 105 | 0.00003 | **180** | | 2.6 | 50 | 1 | 1.54 | 1 | 0.0054 | 11/18/2015 13:14 |
| PCB 110/115 | | **520** | | 4.5 | 100 | 1 | 1.61 | 1 | | 11/18/2015 13:14 |
| PCB 118 | 0.00003 | **390** | | 2.6 | 100 | 1 | 1.58 | 1 | 0.0117 | 11/18/2015 13:14 |
| PCB 128/166 | | **130** | | 3.3 | 100 | 1 | 1.22 | 1.05 | | 11/18/2015 13:14 |
| PCB 129/138/163 | | **890** | | 5.7 | 200 | 1 | 1.23 | 1 | | 11/18/2015 13:14 |
| PCB 132 | | **230** | | 2.5 | 50 | 1 | 1.21 | 1.01 | | 11/18/2015 13:14 |
| PCB 135/151 | | **250** | | 3.9 | 100 | 1 | 1.26 | 1.02 | | 11/18/2015 13:14 |
| PCB 141 | | **160** | | 2.4 | 50 | 1 | 1.21 | 0.96 | | 11/18/2015 13:14 |
| PCB 147/149 | | **550** | | 2.8 | 100 | 1 | 1.25 | 0.97 | | 11/18/2015 13:14 |
| PCB 153/168 | | **650** | | 4.3 | 100 | 1 | 1.24 | 0.96 | | 11/18/2015 13:14 |
| PCB 156/157 | 0.00003 | **100** | | 4.9 | 100 | 1 | 1.3 | 1 | 0.003 | 11/18/2015 13:14 |
| PCB 158 | | **97** | | 1.9 | 50 | 1 | 1.21 | 1.02 | | 11/18/2015 13:14 |
| PCB 170 | | **270** | | 1.5 | 50 | 1 | 1.07 | 0.99 | | 11/18/2015 13:14 |
| PCB 174 | | **390** | | 3.4 | 50 | 1 | 1.05 | 0.97 | | 11/18/2015 13:14 |
| PCB 177 | | **230** | | 1.7 | 50 | 1 | 1.09 | 0.99 | | 11/18/2015 13:14 |
| PCB 180/193 | | **660** | | 4.1 | 100 | 1 | 1.07 | 0.97 | | 11/18/2015 13:14 |
| PCB 183/185 | | **250** | | 3.5 | 100 | 1 | 1.06 | 0.97 | | 11/18/2015 13:14 |
| PCB 187 | | **400** | | 2.1 | 50 | 1 | 1.05 | 1.06 | | 11/18/2015 13:14 |

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# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-001** | **1511071-001A** | **Water** | **11/02/2015 09:37** | **GC36** | **113093** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB 194 | | **89** | | 1.6 | 50 | 1 | 0.99 | 1 | | 11/18/2015 13:14 |
| PCB 195 | | **36** | J | 1.8 | 50 | 1 | 0.93 | 0.97 | | 11/18/2015 13:14 |
| PCB 201 | | **21** | J | 1.9 | 50 | 1 | 0.89 | 1.04 | | 11/18/2015 13:14 |
| PCB 203 | | **65** | | 1.7 | 50 | 1 | 0.92 | 0.96 | | 11/18/2015 13:14 |
| | | | | | | | | Total TEQ: | 0.0201 | |

| Isotope Dilution | REC (%) | Limits | |
|---|---|---|---|
| 13C-PCB 028 | 99 | 5-145 | 11/18/2015 13:14 |
| 13C-PCB 111 | 77 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 178 | 74 | 10-145 | 11/18/2015 13:14 |
| Surrogate | | | |
| 13C-PCB 001 | 12 | 5-145 | 11/18/2015 13:14 |
| 13C-PCB 003 | 30 | 5-145 | 11/18/2015 13:14 |
| 13C-PCB 004 | 30 | 5-145 | 11/18/2015 13:14 |
| 13C-PCB 015 | 53 | 5-145 | 11/18/2015 13:14 |
| 13C-PCB 019 | 33 | 5-145 | 11/18/2015 13:14 |
| 13C-PCB 037 | 74 | 5-145 | 11/18/2015 13:14 |
| 13C-PCB 054 | 46 | 5-145 | 11/18/2015 13:14 |
| 13C-PCB 077 | 67 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 081 | 70 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 104 | 59 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 105 | 62 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 114 | 60 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 118 | 64 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 123 | 66 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 126 | 68 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 155 | 65 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 156/157 | 60 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 167 | 77 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 169 | 44 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 188 | 99 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 189 | 68 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 202 | 111 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 205 | 49 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 206 | 42 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 208 | 52 | 10-145 | 11/18/2015 13:14 |
| 13C-PCB 209 | 37 | 10-145 | 11/18/2015 13:14 |

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http://www.mccampbell.com / E-mail: main@mccampbell.com

# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-001** | **1511071-001A** | **Water** | **11/02/2015 09:37** | **GC36** | **113093** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|

Analyst(s): MG

*(Cont.)*

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Toll Free Telephone: (877) 252-9262 / Fax: (925) 252-9269
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# Analytical Report

**Client:** AMEC
**Date Received:** 11/2/15 20:38
**Date Prepared:** 11/18/15-11/23/15
**Project:** North Richmond Pump Station
**WorkOrder:** 1511071
**Extraction Method:** E1668C
**Analytical Method:** E1668C
**Unit:** pg/L

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| NRPSIS-002 | 1511071-002A | Water | 11/02/2015 09:52 | GC36 | 113093 |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB 008 | | ND | | 4.0 | 50 | 1 | | | | 11/18/2015 14:22 |
| PCB 018/030 | | **47** | J | 3.2 | 50 | 1 | 1.07 | 0.92 | | 11/18/2015 14:22 |
| PCB 020/028 | | **92** | | 3.7 | 50 | 1 | 1.07 | 0.85 | | 11/18/2015 14:22 |
| PCB 031 | | **74** | | 2.2 | 50 | 1 | 1.01 | 0.82 | | 11/18/2015 14:22 |
| PCB 033 | | ND | | 2.4 | 50 | 1 | | | | 11/18/2015 14:22 |
| PCB 044/047/065 | | **100** | | 9.9 | 100 | 1 | 0.8 | 1.01 | | 11/18/2015 14:22 |
| PCB 049/069 | | **46** | J | 4.4 | 100 | 1 | 0.8 | 0.96 | | 11/18/2015 14:22 |
| PCB 052 | | **130** | | 3.2 | 50 | 1 | 0.78 | 1 | | 11/18/2015 14:22 |
| PCB 056 | | **54** | | 3.3 | 50 | 1 | 0.79 | 0.92 | | 11/18/2015 14:22 |
| PCB 060 | | **25** | J | 3.3 | 50 | 1 | 0.77 | 0.94 | | 11/18/2015 14:22 |
| PCB 066 | | **91** | | 2.5 | 50 | 1 | 0.75 | 0.87 | | 11/18/2015 14:22 |
| PCB 070/074/076 | | **200** | J | 8.3 | 200 | 1 | 0.76 | 0.84 | | 11/18/2015 14:22 |
| PCB 086/097/109/119 | | **79** | J | 5.7 | 200 | 1 | 1.75 | 0.94 | | 11/18/2015 14:22 |
| PCB 087/125 | | ND | | 5.8 | 200 | 1 | | | | 11/18/2015 14:22 |
| PCB 090/101/113 | | **370** | | 5.4 | 200 | 1 | 1.63 | 1 | | 11/18/2015 14:22 |
| PCB 095 | | **260** | | 2.4 | 200 | 1 | 1.62 | 1.19 | | 11/18/2015 14:22 |
| PCB 099 | | **130** | | 2.5 | 100 | 1 | 1.64 | 1.05 | | 11/18/2015 14:22 |
| PCB 105 | 0.00003 | **170** | | 2.6 | 50 | 1 | 1.49 | 1 | 0.0051 | 11/18/2015 14:22 |
| PCB 110/115 | | **470** | | 4.5 | 100 | 1 | 1.64 | 1 | | 11/18/2015 14:22 |
| PCB 118 | 0.00003 | **360** | | 2.6 | 100 | 1 | 1.55 | 1 | 0.0108 | 11/18/2015 14:22 |
| PCB 128/166 | | **120** | | 3.3 | 100 | 1 | 1.22 | 1.05 | | 11/18/2015 14:22 |
| PCB 129/138/163 | | **870** | | 5.8 | 200 | 1 | 1.22 | 1 | | 11/18/2015 14:22 |
| PCB 132 | | **220** | | 2.5 | 50 | 1 | 1.24 | 1.01 | | 11/18/2015 14:22 |
| PCB 135/151 | | **240** | | 3.9 | 100 | 1 | 1.23 | 1.02 | | 11/18/2015 14:22 |
| PCB 141 | | **160** | | 2.4 | 50 | 1 | 1.27 | 0.96 | | 11/18/2015 14:22 |
| PCB 147/149 | | **540** | | 2.8 | 100 | 1 | 1.23 | 0.97 | | 11/18/2015 14:22 |
| PCB 153/168 | | **630** | | 4.3 | 100 | 1 | 1.26 | 0.96 | | 11/18/2015 14:22 |
| PCB 156/157 | 0.00003 | **100** | | 4.9 | 100 | 1 | 1.28 | 1 | 0.003 | 11/18/2015 14:22 |
| PCB 158 | | **86** | | 1.9 | 50 | 1 | 1.25 | 1.02 | | 11/18/2015 14:22 |
| PCB 170 | | **280** | | 1.5 | 50 | 1 | 1.01 | 0.99 | | 11/18/2015 14:22 |
| PCB 174 | | **420** | | 3.5 | 50 | 1 | 1.06 | 0.97 | | 11/18/2015 14:22 |
| PCB 177 | | **240** | | 1.7 | 50 | 1 | 1.07 | 0.99 | | 11/18/2015 14:22 |
| PCB 180/193 | | **700** | | 4.1 | 100 | 1 | 1.07 | 0.97 | | 11/18/2015 14:22 |
| PCB 183/185 | | **260** | | 3.6 | 100 | 1 | 1.07 | 0.97 | | 11/18/2015 14:22 |
| PCB 187 | | **410** | | 2.1 | 50 | 1 | 1.03 | 1.06 | | 11/18/2015 14:22 |

*(Cont.)*

# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-002** | **1511071-002A** | **Water** | **11/02/2015 09:52** | **GC36** | **113093** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB 194 | | **96** | | 1.6 | 50 | 1 | 0.9 | 1 | | 11/18/2015 14:22 |
| PCB 195 | | **40** | J | 1.8 | 50 | 1 | 0.89 | 0.97 | | 11/18/2015 14:22 |
| PCB 201 | | **20** | J | 1.9 | 50 | 1 | 0.84 | 1.04 | | 11/18/2015 14:22 |
| PCB 203 | | **70** | | 1.7 | 50 | 1 | 0.90 | 0.96 | | 11/18/2015 14:22 |
| | | | | | | | Total TEQ: | | 0.0189 | |

| Isotope Dilution | REC (%) | Limits | Date Analyzed |
|---|---|---|---|
| 13C-PCB 028 | 109 | 5-145 | 11/18/2015 14:22 |
| 13C-PCB 111 | 75 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 178 | 77 | 10-145 | 11/18/2015 14:22 |
| Surrogate | | | |
| 13C-PCB 001 | 9 | 5-145 | 11/18/2015 14:22 |
| 13C-PCB 003 | 30 | 5-145 | 11/18/2015 14:22 |
| 13C-PCB 004 | 30 | 5-145 | 11/18/2015 14:22 |
| 13C-PCB 015 | 60 | 5-145 | 11/18/2015 14:22 |
| 13C-PCB 019 | 38 | 5-145 | 11/18/2015 14:22 |
| 13C-PCB 037 | 85 | 5-145 | 11/18/2015 14:22 |
| 13C-PCB 054 | 55 | 5-145 | 11/18/2015 14:22 |
| 13C-PCB 077 | 76 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 081 | 80 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 104 | 57 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 105 | 62 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 114 | 61 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 118 | 65 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 123 | 67 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 126 | 69 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 155 | 65 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 156/157 | 67 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 167 | 85 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 169 | 50 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 188 | 100 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 189 | 75 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 202 | 117 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 205 | 54 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 206 | 45 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 208 | 54 | 10-145 | 11/18/2015 14:22 |
| 13C-PCB 209 | 37 | 10-145 | 11/18/2015 14:22 |

*(Cont.)*

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# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-002** | **1511071-002A** | **Water** | **11/02/2015 09:52** | **GC36** | **113093** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|

Analyst(s): MG

*(Cont.)*

CDPH ELAP 1644 ♦ NELAP 4033ORELAP

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http://www.mccampbell.com / E-mail: main@mccampbell.com

# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-003** | **1511071-003A** | **Water** | **11/02/2015 09:56** | **GC36** | **113093** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB 008 | | ND | | 4.0 | 50 | 1 | | | | 11/18/2015 15:28 |
| PCB 018/030 | | **59** | | 3.2 | 50 | 1 | 1.04 | 0.92 | | 11/18/2015 15:28 |
| PCB 020/028 | | **110** | | 3.7 | 50 | 1 | 1.03 | 0.85 | | 11/18/2015 15:28 |
| PCB 031 | | **90** | | 2.2 | 50 | 1 | 1.08 | 0.82 | | 11/18/2015 15:28 |
| PCB 033 | | ND | | 2.4 | 50 | 1 | | | | 11/18/2015 15:28 |
| PCB 044/047/065 | | **120** | | 9.9 | 100 | 1 | 0.81 | 1.01 | | 11/18/2015 15:28 |
| PCB 049/069 | | **55** | J | 4.4 | 100 | 1 | 0.74 | 0.96 | | 11/18/2015 15:28 |
| PCB 052 | | **150** | | 3.2 | 50 | 1 | 0.77 | 1 | | 11/18/2015 15:28 |
| PCB 056 | | **57** | | 3.3 | 50 | 1 | 0.78 | 0.92 | | 11/18/2015 15:28 |
| PCB 060 | | **29** | J | 3.3 | 50 | 1 | 0.73 | 0.94 | | 11/18/2015 15:28 |
| PCB 066 | | **110** | | 2.5 | 50 | 1 | 0.77 | 0.87 | | 11/18/2015 15:28 |
| PCB 070/074/076 | | **220** | | 8.2 | 200 | 1 | 0.75 | 0.84 | | 11/18/2015 15:28 |
| PCB 086/097/109/119 | | **100** | J | 5.7 | 200 | 1 | 1.51 | 0.94 | | 11/18/2015 15:28 |
| PCB 087/125 | | ND | | 5.7 | 200 | 1 | | | | 11/18/2015 15:28 |
| PCB 090/101/113 | | **400** | | 5.4 | 200 | 1 | 1.57 | 1 | | 11/18/2015 15:28 |
| PCB 095 | | **280** | | 2.4 | 200 | 1 | 1.58 | 1.19 | | 11/18/2015 15:28 |
| PCB 099 | | **140** | | 2.5 | 100 | 1 | 1.58 | 1.05 | | 11/18/2015 15:28 |
| PCB 105 | 0.00003 | **180** | | 2.6 | 50 | 1 | 1.51 | 1 | 0.0054 | 11/18/2015 15:28 |
| PCB 110/115 | | **520** | | 4.5 | 100 | 1 | 1.63 | 1 | | 11/18/2015 15:28 |
| PCB 118 | 0.00003 | **400** | | 2.6 | 100 | 1 | 1.51 | 1 | 0.012 | 11/18/2015 15:28 |
| PCB 128/166 | | **130** | | 3.3 | 100 | 1 | 1.27 | 1.05 | | 11/18/2015 15:28 |
| PCB 129/138/163 | | **920** | | 5.7 | 200 | 1 | 1.24 | 1 | | 11/18/2015 15:28 |
| PCB 132 | | **230** | | 2.5 | 50 | 1 | 1.23 | 1.01 | | 11/18/2015 15:28 |
| PCB 135/151 | | **240** | | 3.9 | 100 | 1 | 1.28 | 1.02 | | 11/18/2015 15:28 |
| PCB 141 | | **160** | | 2.4 | 50 | 1 | 1.24 | 0.96 | | 11/18/2015 15:28 |
| PCB 147/149 | | **560** | | 2.8 | 100 | 1 | 1.31 | 0.97 | | 11/18/2015 15:28 |
| PCB 153/168 | | **640** | | 4.3 | 100 | 1 | 1.26 | 0.96 | | 11/18/2015 15:28 |
| PCB 156/157 | 0.00003 | **100** | | 4.9 | 100 | 1 | 1.21 | 1 | 0.003 | 11/18/2015 15:28 |
| PCB 158 | | **100** | | 1.9 | 50 | 1 | 1.18 | 1.02 | | 11/18/2015 15:28 |
| PCB 170 | | **290** | | 1.5 | 50 | 1 | 1.03 | 0.99 | | 11/18/2015 15:28 |
| PCB 174 | | **390** | | 3.4 | 50 | 1 | 1.03 | 0.97 | | 11/18/2015 15:28 |
| PCB 177 | | **230** | | 1.7 | 50 | 1 | 1.03 | 0.99 | | 11/18/2015 15:28 |
| PCB 180/193 | | **700** | | 4.1 | 100 | 1 | 1.04 | 0.97 | | 11/18/2015 15:28 |
| PCB 183/185 | | **250** | | 3.5 | 100 | 1 | 1.05 | 0.96 | | 11/18/2015 15:28 |
| PCB 187 | | **380** | | 2.1 | 50 | 1 | 1.05 | 1.06 | | 11/18/2015 15:28 |

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# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-003** | **1511071-003A** | **Water** | **11/02/2015 09:56** | **GC36** | **113093** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB 194 | | **100** | | 1.6 | 50 | 1 | 0.91 | 1 | | 11/18/2015 15:28 |
| PCB 195 | | **42** | J | 1.8 | 50 | 1 | 0.89 | 0.97 | | 11/18/2015 15:28 |
| PCB 201 | | **21** | J | 1.9 | 50 | 1 | 0.83 | 1.04 | | 11/18/2015 15:28 |
| PCB 203 | | **71** | | 1.7 | 50 | 1 | 0.83 | 0.96 | | 11/18/2015 15:28 |
| | | | | | | | | Total TEQ: | 0.0204 | |

| Isotope Dilution | REC (%) | Limits | Date Analyzed |
|---|---|---|---|
| 13C-PCB 028 | 97 | 5-145 | 11/18/2015 15:28 |
| 13C-PCB 111 | 70 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 178 | 68 | 10-145 | 11/18/2015 15:28 |
| Surrogate | | | |
| 13C-PCB 001 | 13 | 5-145 | 11/18/2015 15:28 |
| 13C-PCB 003 | 21 | 5-145 | 11/18/2015 15:28 |
| 13C-PCB 004 | 20 | 5-145 | 11/18/2015 15:28 |
| 13C-PCB 015 | 31 | 5-145 | 11/18/2015 15:28 |
| 13C-PCB 019 | 20 | 5-145 | 11/18/2015 15:28 |
| 13C-PCB 037 | 45 | 5-145 | 11/18/2015 15:28 |
| 13C-PCB 054 | 26 | 5-145 | 11/18/2015 15:28 |
| 13C-PCB 077 | 44 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 081 | 44 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 104 | 26 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 105 | 34 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 114 | 34 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 118 | 35 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 123 | 36 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 126 | 37 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 155 | 31 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 156/157 | 35 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 167 | 42 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 169 | 28 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 188 | 40 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 189 | 37 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 202 | 46 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 205 | 27 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 206 | 22 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 208 | 25 | 10-145 | 11/18/2015 15:28 |
| 13C-PCB 209 | 20 | 10-145 | 11/18/2015 15:28 |

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http://www.mccampbell.com / E-mail: main@mccampbell.com

# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-003** | **1511071-003A** | **Water** | **11/02/2015 09:56** | **GC36** | **113093** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|

Analyst(s): MG

*(Cont.)*

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# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-004** | **1511071-004A** | **Water** | **11/02/2015 10:10** | **GC36** | **113093** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB 008 | | ND | | 4.1 | 50 | 1 | | | | 11/18/2015 16:32 |
| PCB 018/030 | | ND | | 3.2 | 50 | 1 | | | | 11/18/2015 16:32 |
| PCB 020/028 | | ND | | 3.8 | 50 | 1 | | | | 11/18/2015 16:32 |
| PCB 031 | | **3.9** | J | 2.2 | 50 | 1 | 1.14 | 0.83 | | 11/18/2015 16:32 |
| PCB 033 | | ND | | 2.4 | 50 | 1 | | | | 11/18/2015 16:32 |
| PCB 044/047/065 | | ND | | 10 | 100 | 1 | | | | 11/18/2015 16:32 |
| PCB 049/069 | | ND | | 4.5 | 100 | 1 | | | | 11/18/2015 16:32 |
| PCB 052 | | **3.9** | J | 3.2 | 50 | 1 | 0.74 | 1 | | 11/18/2015 16:32 |
| PCB 056 | | ND | | 3.3 | 50 | 1 | | | | 11/18/2015 16:32 |
| PCB 060 | | ND | | 3.3 | 50 | 1 | | | | 11/18/2015 16:32 |
| PCB 066 | | ND | | 2.5 | 50 | 1 | | | | 11/18/2015 16:32 |
| PCB 070/074/076 | | ND | | 8.3 | 200 | 1 | | | | 11/18/2015 16:32 |
| PCB 086/097/109/119 | | ND | | 5.7 | 200 | 1 | | | | 11/18/2015 16:32 |
| PCB 087/125 | | ND | | 5.8 | 200 | 1 | | | | 11/18/2015 16:32 |
| PCB 090/101/113 | | **7.0** | J | 5.4 | 200 | 1 | 1.46 | 1 | | 11/18/2015 16:32 |
| PCB 095 | | **4.5** | J | 2.4 | 200 | 1 | 1.33 | 1.19 | | 11/18/2015 16:32 |
| PCB 099 | | ND | | 2.5 | 100 | 1 | | | | 11/18/2015 16:32 |
| PCB 105 | 0.00003 | **3.5** | JM | 2.6 | 50 | 1 | 2.71 | 1 | 0.000105 | 11/18/2015 16:32 |
| PCB 110/115 | | **9.3** | J | 4.6 | 100 | 1 | 1.42 | 1 | | 11/18/2015 16:32 |
| PCB 118 | 0.00003 | **7.4** | J | 2.6 | 100 | 1 | 1.44 | 1 | 0.000222 | 11/18/2015 16:32 |
| PCB 128/166 | | ND | | 3.3 | 100 | 1 | | | | 11/18/2015 16:32 |
| PCB 129/138/163 | | **17** | J | 5.8 | 200 | 1 | 1.1 | 1 | | 11/18/2015 16:32 |
| PCB 132 | | **3.9** | J | 2.5 | 50 | 1 | 1.2 | 1.02 | | 11/18/2015 16:32 |
| PCB 135/151 | | ND | | 4.0 | 100 | 1 | | | | 11/18/2015 16:32 |
| PCB 141 | | **3.5** | J | 2.4 | 50 | 1 | 1.09 | 0.96 | | 11/18/2015 16:32 |
| PCB 147/149 | | **8.7** | J | 2.8 | 100 | 1 | 1.34 | 0.97 | | 11/18/2015 16:32 |
| PCB 153/168 | | **11** | J | 4.4 | 100 | 1 | 1.1 | 0.96 | | 11/18/2015 16:32 |
| PCB 156/157 | | ND | | 4.9 | 100 | 1 | | | | 11/18/2015 16:32 |
| PCB 158 | | ND | | 1.9 | 50 | 1 | | | | 11/18/2015 16:32 |
| PCB 170 | | **6.0** | JM | 1.5 | 50 | 1 | 1.4 | 0.99 | | 11/18/2015 16:32 |
| PCB 174 | | **7.0** | J | 3.5 | 50 | 1 | 1.08 | 0.97 | | 11/18/2015 16:32 |
| PCB 177 | | **2.7** | JM | 1.7 | 50 | 1 | 0.28 | 0.99 | | 11/18/2015 16:32 |
| PCB 180/193 | | **14** | J | 4.2 | 100 | 1 | 1.00 | 0.97 | | 11/18/2015 16:32 |
| PCB 183/185 | | ND | | 3.6 | 100 | 1 | | | | 11/18/2015 16:32 |
| PCB 187 | | **6.2** | J | 2.1 | 50 | 1 | 1.15 | 1.06 | | 11/18/2015 16:32 |

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# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-004** | **1511071-004A** | **Water** | **11/02/2015 10:10** | **GC36** | **113093** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB 194 | | **2.7** | JM | 1.6 | 50 | 1 | 1.07 | 1 | | 11/18/2015 16:32 |
| PCB 195 | | ND | | 1.8 | 50 | 1 | | | | 11/18/2015 16:32 |
| PCB 201 | | ND | | 1.9 | 50 | 1 | | | | 11/18/2015 16:32 |
| PCB 203 | | **2.1** | JM | 1.7 | 50 | 1 | 0.63 | 0.96 | | 11/18/2015 16:32 |
| | | | | | | | Total TEQ: | | 0.000327 | |

| Isotope Dilution | REC (%) | Limits | |
|---|---|---|---|
| 13C-PCB 028 | 81 | 5-145 | 11/18/2015 16:32 |
| 13C-PCB 111 | 70 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 178 | 59 | 10-145 | 11/18/2015 16:32 |
| Surrogate | | | |
| 13C-PCB 001 | 31 | 5-145 | 11/18/2015 16:32 |
| 13C-PCB 003 | 34 | 5-145 | 11/18/2015 16:32 |
| 13C-PCB 004 | 30 | 5-145 | 11/18/2015 16:32 |
| 13C-PCB 015 | 35 | 5-145 | 11/18/2015 16:32 |
| 13C-PCB 019 | 28 | 5-145 | 11/18/2015 16:32 |
| 13C-PCB 037 | 46 | 5-145 | 11/18/2015 16:32 |
| 13C-PCB 054 | 32 | 5-145 | 11/18/2015 16:32 |
| 13C-PCB 077 | 59 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 081 | 57 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 104 | 30 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 105 | 54 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 114 | 52 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 118 | 52 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 123 | 52 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 126 | 58 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 155 | 28 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 156/157 | 48 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 167 | 50 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 169 | 47 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 188 | 35 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 189 | 47 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 202 | 42 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 205 | 37 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 206 | 29 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 208 | 30 | 10-145 | 11/18/2015 16:32 |
| 13C-PCB 209 | 26 | 10-145 | 11/18/2015 16:32 |

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# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-004** | **1511071-004A** | **Water** | **11/02/2015 10:10** | **GC36** | **113093** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|

Analyst(s): MG

*(Cont.)*

CDPH ELAP 1644 ♦ NELAP 4033ORELAP

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# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-005** | **1511071-005A** | **Water** | **11/02/2015 10:28** | **GC36** | **113093** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB 008 | | ND | | 4.0 | 50 | 1 | | | | 11/18/2015 17:37 |
| PCB 018/030 | | **38** | J | 3.2 | 50 | 1 | 1.02 | 0.92 | | 11/18/2015 17:37 |
| PCB 020/028 | | **82** | | 3.7 | 50 | 1 | 0.99 | 0.85 | | 11/18/2015 17:37 |
| PCB 031 | | **66** | | 2.2 | 50 | 1 | 1.05 | 0.82 | | 11/18/2015 17:37 |
| PCB 033 | | ND | | 2.4 | 50 | 1 | | | | 11/18/2015 17:37 |
| PCB 044/047/065 | | **86** | J | 9.9 | 100 | 1 | 0.76 | 1.01 | | 11/18/2015 17:37 |
| PCB 049/069 | | **40** | J | 4.4 | 100 | 1 | 0.82 | 0.96 | | 11/18/2015 17:37 |
| PCB 052 | | **110** | | 3.2 | 50 | 1 | 0.8 | 1 | | 11/18/2015 17:37 |
| PCB 056 | | **47** | J | 3.3 | 50 | 1 | 0.76 | 0.93 | | 11/18/2015 17:37 |
| PCB 060 | | **23** | J | 3.3 | 50 | 1 | 0.73 | 0.94 | | 11/18/2015 17:37 |
| PCB 066 | | **88** | | 2.5 | 50 | 1 | 0.73 | 0.87 | | 11/18/2015 17:37 |
| PCB 070/074/076 | | **180** | J | 8.2 | 200 | 1 | 0.78 | 0.84 | | 11/18/2015 17:37 |
| PCB 086/097/109/119 | | **77** | J | 5.7 | 200 | 1 | 1.56 | 0.94 | | 11/18/2015 17:37 |
| PCB 087/125 | | ND | | 5.7 | 200 | 1 | | | | 11/18/2015 17:37 |
| PCB 090/101/113 | | **320** | | 5.4 | 200 | 1 | 1.61 | 1 | | 11/18/2015 17:37 |
| PCB 095 | | **220** | | 2.4 | 200 | 1 | 1.6 | 1.19 | | 11/18/2015 17:37 |
| PCB 099 | | **120** | | 2.5 | 100 | 1 | 1.66 | 1.05 | | 11/18/2015 17:37 |
| PCB 105 | 0.00003 | **150** | | 2.6 | 50 | 1 | 1.56 | 1 | 0.0045 | 11/18/2015 17:37 |
| PCB 110/115 | | **410** | | 4.5 | 100 | 1 | 1.61 | 1 | | 11/18/2015 17:37 |
| PCB 118 | 0.00003 | **320** | | 2.6 | 100 | 1 | 1.52 | 1 | 0.0096 | 11/18/2015 17:37 |
| PCB 128/166 | | **100** | | 3.3 | 100 | 1 | 1.29 | 1.05 | | 11/18/2015 17:37 |
| PCB 129/138/163 | | **740** | | 5.7 | 200 | 1 | 1.24 | 1 | | 11/18/2015 17:37 |
| PCB 132 | | **180** | | 2.5 | 50 | 1 | 1.28 | 1.01 | | 11/18/2015 17:37 |
| PCB 135/151 | | **190** | | 3.9 | 100 | 1 | 1.23 | 1.02 | | 11/18/2015 17:37 |
| PCB 141 | | **130** | | 2.4 | 50 | 1 | 1.24 | 0.96 | | 11/18/2015 17:37 |
| PCB 147/149 | | **450** | | 2.8 | 100 | 1 | 1.25 | 0.97 | | 11/18/2015 17:37 |
| PCB 153/168 | | **530** | | 4.3 | 100 | 1 | 1.22 | 0.96 | | 11/18/2015 17:37 |
| PCB 156/157 | 0.00003 | **86** | J | 4.9 | 100 | 1 | 1.28 | 1 | 0.00258 | 11/18/2015 17:37 |
| PCB 158 | | **76** | | 1.9 | 50 | 1 | 1.26 | 1.02 | | 11/18/2015 17:37 |
| PCB 170 | | **240** | | 1.5 | 50 | 1 | 1.03 | 0.99 | | 11/18/2015 17:37 |
| PCB 174 | | **330** | | 3.4 | 50 | 1 | 1.08 | 0.97 | | 11/18/2015 17:37 |
| PCB 177 | | **200** | | 1.7 | 50 | 1 | 1.1 | 0.99 | | 11/18/2015 17:37 |
| PCB 180/193 | | **600** | | 4.1 | 100 | 1 | 1.06 | 0.97 | | 11/18/2015 17:37 |
| PCB 183/185 | | **210** | | 3.5 | 100 | 1 | 1.04 | 0.97 | | 11/18/2015 17:37 |
| PCB 187 | | **330** | | 2.1 | 50 | 1 | 1.07 | 1.06 | | 11/18/2015 17:37 |

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http://www.mccampbell.com / E-mail: main@mccampbell.com

# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-005** | **1511071-005A** | **Water** | **11/02/2015 10:28** | **GC36** | **113093** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB 194 | | **89** | | 1.6 | 50 | 1 | 0.81 | 1 | | 11/18/2015 17:37 |
| PCB 195 | | **33** | J | 1.8 | 50 | 1 | 0.85 | 0.97 | | 11/18/2015 17:37 |
| PCB 201 | | **20** | J | 1.9 | 50 | 1 | 0.77 | 1.04 | | 11/18/2015 17:37 |
| PCB 203 | | **61** | | 1.7 | 50 | 1 | 0.88 | 0.96 | | 11/18/2015 17:37 |
| | | | | | | | | Total TEQ: | 0.0167 | |

| Isotope Dilution | REC (%) | Limits | Date Analyzed |
|---|---|---|---|
| 13C-PCB 028 | 93 | 5-145 | 11/18/2015 17:37 |
| 13C-PCB 111 | 66 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 178 | 68 | 10-145 | 11/18/2015 17:37 |
| Surrogate | | | |
| 13C-PCB 001 | 9 | 5-145 | 11/18/2015 17:37 |
| 13C-PCB 003 | 21 | 5-145 | 11/18/2015 17:37 |
| 13C-PCB 004 | 20 | 5-145 | 11/18/2015 17:37 |
| 13C-PCB 015 | 39 | 5-145 | 11/18/2015 17:37 |
| 13C-PCB 019 | 24 | 5-145 | 11/18/2015 17:37 |
| 13C-PCB 037 | 54 | 5-145 | 11/18/2015 17:37 |
| 13C-PCB 054 | 31 | 5-145 | 11/18/2015 17:37 |
| 13C-PCB 077 | 53 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 081 | 55 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 104 | 32 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 105 | 41 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 114 | 39 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 118 | 41 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 123 | 42 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 126 | 45 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 155 | 39 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 156/157 | 42 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 167 | 53 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 169 | 32 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 188 | 55 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 189 | 46 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 202 | 64 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 205 | 33 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 206 | 26 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 208 | 31 | 10-145 | 11/18/2015 17:37 |
| 13C-PCB 209 | 21 | 10-145 | 11/18/2015 17:37 |

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# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-005** | **1511071-005A** | **Water** | **11/02/2015 10:28** | **GC36** | **113093** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|

Analyst(s): MG

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# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-006** | **1511071-006A** | **Water** | **11/02/2015 10:56** | **GC36** | **113278** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB 008 | | ND | | 4.1 | 50 | 1 | | | | 11/22/2015 23:46 |
| PCB 018/030 | | **38** | JB | 3.2 | 50 | 1 | 1.16 | 0.92 | | 11/22/2015 23:46 |
| PCB 020/028 | | **72** | | 3.8 | 50 | 1 | 1.04 | 0.85 | | 11/22/2015 23:46 |
| PCB 031 | | **50** | JB | 2.2 | 50 | 1 | 1.01 | 0.83 | | 11/22/2015 23:46 |
| PCB 033 | | ND | | 2.4 | 50 | 1 | | | | 11/22/2015 23:46 |
| PCB 044/047/065 | | **70** | J | 9.9 | 100 | 1 | 0.83 | 1.01 | | 11/22/2015 23:46 |
| PCB 049/069 | | **31** | JM | 4.4 | 100 | 1 | 0.99 | 0.96 | | 11/22/2015 23:46 |
| PCB 052 | | **94** | | 3.2 | 50 | 1 | 0.85 | 1 | | 11/22/2015 23:46 |
| PCB 056 | | **43** | J | 3.3 | 50 | 1 | 0.80 | 0.92 | | 11/22/2015 23:46 |
| PCB 060 | | **18** | J | 3.3 | 50 | 1 | 0.85 | 0.94 | | 11/22/2015 23:46 |
| PCB 066 | | **56** | | 2.5 | 50 | 1 | 0.75 | 0.87 | | 11/22/2015 23:46 |
| PCB 070/074/076 | | **130** | J | 8.3 | 200 | 1 | 0.87 | 0.84 | | 11/22/2015 23:46 |
| PCB 086/097/109/119 | | **75** | J | 5.7 | 200 | 1 | 1.53 | 0.94 | | 11/22/2015 23:46 |
| PCB 087/125 | | ND | | 5.8 | 200 | 1 | | | | 11/22/2015 23:46 |
| PCB 090/101/113 | | **260** | | 5.4 | 200 | 1 | 1.66 | 1 | | 11/22/2015 23:46 |
| PCB 095 | | **240** | | 2.4 | 200 | 1 | 1.45 | 1.19 | | 11/22/2015 23:46 |
| PCB 099 | | **89** | J | 2.5 | 100 | 1 | 1.7 | 1.05 | | 11/22/2015 23:46 |
| PCB 105 | 0.00003 | **150** | | 2.6 | 50 | 1 | 1.75 | 1 | 0.0045 | 11/22/2015 23:46 |
| PCB 110/115 | | **480** | | 4.5 | 100 | 1 | 1.59 | 1 | | 11/22/2015 23:46 |
| PCB 118 | 0.00003 | **340** | | 2.6 | 100 | 1 | 1.59 | 1 | 0.0102 | 11/22/2015 23:46 |
| PCB 128/166 | | **130** | | 3.3 | 100 | 1 | 1.19 | 1.05 | | 11/22/2015 23:46 |
| PCB 129/138/163 | | **860** | | 5.8 | 200 | 1 | 1.25 | 1 | | 11/22/2015 23:46 |
| PCB 132 | | **300** | | 2.5 | 50 | 1 | 1.24 | 1.02 | | 11/22/2015 23:46 |
| PCB 135/151 | | **230** | | 4.0 | 100 | 1 | 1.37 | 1.02 | | 11/22/2015 23:46 |
| PCB 141 | | **160** | | 2.4 | 50 | 1 | 1.27 | 0.96 | | 11/22/2015 23:46 |
| PCB 147/149 | | **530** | | 2.8 | 100 | 1 | 1.31 | 0.97 | | 11/22/2015 23:46 |
| PCB 153/168 | | **480** | | 4.3 | 100 | 1 | 1.21 | 0.96 | | 11/22/2015 23:46 |
| PCB 156/157 | 0.00003 | **86** | J | 4.9 | 100 | 1 | 1.33 | 1 | 0.00258 | 11/22/2015 23:46 |
| PCB 158 | | **93** | | 1.9 | 50 | 1 | 1.19 | 1.02 | | 11/22/2015 23:46 |
| PCB 170 | | **320** | | 1.5 | 50 | 1 | 1.14 | 0.99 | | 11/22/2015 23:46 |
| PCB 174 | | **330** | | 3.5 | 50 | 1 | 1.07 | 0.97 | | 11/22/2015 23:46 |
| PCB 177 | | **200** | | 1.7 | 50 | 1 | 1.02 | 0.99 | | 11/22/2015 23:46 |
| PCB 180/193 | | **580** | | 4.2 | 100 | 1 | 1.06 | 0.97 | | 11/22/2015 23:46 |
| PCB 183/185 | | **180** | | 3.6 | 100 | 1 | 1.16 | 0.96 | | 11/22/2015 23:46 |
| PCB 187 | | **300** | | 2.1 | 50 | 1 | 1.13 | 1.06 | | 11/22/2015 23:46 |

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# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-006** | **1511071-006A** | **Water** | **11/02/2015 10:56** | **GC36** | **113278** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB 194 | | **120** | | 1.6 | 50 | 1 | 0.77 | 1 | | 11/22/2015 23:46 |
| PCB 195 | | **53** | | 1.8 | 50 | 1 | 0.9 | 0.97 | | 11/22/2015 23:46 |
| PCB 201 | | ND | | 1.9 | 50 | 1 | | | | 11/22/2015 23:46 |
| PCB 203 | | **75** | | 1.7 | 50 | 1 | 0.82 | 0.96 | | 11/22/2015 23:46 |
| | | | | | | | | Total TEQ: | 0.0173 | |

| Isotope Dilution | REC (%) | Limits | Date Analyzed |
|---|---|---|---|
| 13C-PCB 028 | 109 | 5-145 | 11/22/2015 23:46 |
| 13C-PCB 111 | 65 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 178 | 65 | 10-145 | 11/22/2015 23:46 |
| Surrogate | | | |
| 13C-PCB 001 | 63 | 5-145 | 11/22/2015 23:46 |
| 13C-PCB 003 | 80 | 5-145 | 11/22/2015 23:46 |
| 13C-PCB 004 | 73 | 5-145 | 11/22/2015 23:46 |
| 13C-PCB 015 | 90 | 5-145 | 11/22/2015 23:46 |
| 13C-PCB 019 | 82 | 5-145 | 11/22/2015 23:46 |
| 13C-PCB 037 | 99 | 5-145 | 11/22/2015 23:46 |
| 13C-PCB 054 | 81 | 5-145 | 11/22/2015 23:46 |
| 13C-PCB 077 | 101 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 081 | 87 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 104 | 67 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 105 | 106 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 114 | 84 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 118 | 85 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 123 | 77 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 126 | 101 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 155 | 46 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 156/157 | 84 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 167 | 72 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 169 | 85 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 188 | 64 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 189 | 95 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 202 | 70 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 205 | 75 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 206 | 47 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 208 | 45 | 10-145 | 11/22/2015 23:46 |
| 13C-PCB 209 | 26 | 10-145 | 11/22/2015 23:46 |

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# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-006** | **1511071-006A** | **Water** | **11/02/2015 10:56** | **GC36** | **113278** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|

Analyst(s): MG

*(Cont.)*

CDPH ELAP 1644 ♦ NELAP 4033ORELAP

Angela Rydelius, Lab Manager

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http://www.mccampbell.com / E-mail: main@mccampbell.com

# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-007** | **1511071-007A** | **Water** | **11/02/2015 11:00** | **GC36** | **113278** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB 008 | | ND | | 4.1 | 50 | 1 | | | | 11/22/2015 20:33 |
| PCB 018/030 | | ND | | 3.2 | 50 | 1 | | | | 11/22/2015 20:33 |
| PCB 020/028 | | **4.9** | JB | 3.8 | 50 | 1 | 0.95 | 0.85 | | 11/22/2015 20:33 |
| PCB 031 | | ND | | 2.3 | 50 | 1 | | | | 11/22/2015 20:33 |
| PCB 033 | | ND | | 2.5 | 50 | 1 | | | | 11/22/2015 20:33 |
| PCB 044/047/065 | | ND | | 10 | 100 | 1 | | | | 11/22/2015 20:33 |
| PCB 049/069 | | ND | | 4.5 | 100 | 1 | | | | 11/22/2015 20:33 |
| PCB 052 | | ND | | 3.2 | 50 | 1 | | | | 11/22/2015 20:33 |
| PCB 056 | | ND | | 3.3 | 50 | 1 | | | | 11/22/2015 20:33 |
| PCB 060 | | ND | | 3.3 | 50 | 1 | | | | 11/22/2015 20:33 |
| PCB 066 | | ND | | 2.6 | 50 | 1 | | | | 11/22/2015 20:33 |
| PCB 070/074/076 | | ND | | 8.5 | 200 | 1 | | | | 11/22/2015 20:33 |
| PCB 086/097/109/119 | | ND | | 5.8 | 200 | 1 | | | | 11/22/2015 20:33 |
| PCB 087/125 | | ND | | 5.9 | 200 | 1 | | | | 11/22/2015 20:33 |
| PCB 090/101/113 | | ND | | 5.5 | 200 | 1 | | | | 11/22/2015 20:33 |
| PCB 095 | | ND | | 2.5 | 200 | 1 | | | | 11/22/2015 20:33 |
| PCB 099 | | ND | | 2.6 | 100 | 1 | | | | 11/22/2015 20:33 |
| PCB 105 | | ND | | 2.7 | 50 | 1 | | | | 11/22/2015 20:33 |
| PCB 110/115 | | ND | | 4.6 | 100 | 1 | | | | 11/22/2015 20:33 |
| PCB 118 | 0.00003 | **3.3** | J | 2.7 | 100 | 1 | 1.40 | 1 | 0.000099 | 11/22/2015 20:33 |
| PCB 128/166 | | ND | | 3.3 | 100 | 1 | | | | 11/22/2015 20:33 |
| PCB 129/138/163 | | ND | | 5.9 | 200 | 1 | | | | 11/22/2015 20:33 |
| PCB 132 | | ND | | 2.6 | 50 | 1 | | | | 11/22/2015 20:33 |
| PCB 135/151 | | ND | | 4.0 | 100 | 1 | | | | 11/22/2015 20:33 |
| PCB 141 | | ND | | 2.5 | 50 | 1 | | | | 11/22/2015 20:33 |
| PCB 147/149 | | ND | | 2.9 | 100 | 1 | | | | 11/22/2015 20:33 |
| PCB 153/168 | | ND | | 4.4 | 100 | 1 | | | | 11/22/2015 20:33 |
| PCB 156/157 | | ND | | 5.0 | 100 | 1 | | | | 11/22/2015 20:33 |
| PCB 158 | | ND | | 2.0 | 50 | 1 | | | | 11/22/2015 20:33 |
| PCB 170 | | ND | | 1.6 | 50 | 1 | | | | 11/22/2015 20:33 |
| PCB 174 | | ND | | 3.5 | 50 | 1 | | | | 11/22/2015 20:33 |
| PCB 177 | | ND | | 1.8 | 50 | 1 | | | | 11/22/2015 20:33 |
| PCB 180/193 | | ND | | 4.2 | 100 | 1 | | | | 11/22/2015 20:33 |
| PCB 183/185 | | ND | | 3.6 | 100 | 1 | | | | 11/22/2015 20:33 |
| PCB 187 | | ND | | 2.2 | 50 | 1 | | | | 11/22/2015 20:33 |

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# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-007** | **1511071-007A** | **Water** | **11/02/2015 11:00** | **GC36** | **113278** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB 194 | | ND | | 1.7 | 50 | 1 | | | | 11/22/2015 20:33 |
| PCB 195 | | ND | | 1.9 | 50 | 1 | | | | 11/22/2015 20:33 |
| PCB 201 | | ND | | 2.0 | 50 | 1 | | | | 11/22/2015 20:33 |
| PCB 203 | | ND | | 1.8 | 50 | 1 | | | | 11/22/2015 20:33 |
| | | | | | | | Total TEQ: | | 0.0000990 | |

| Isotope Dilution | REC (%) | Limits | Date Analyzed |
|---|---|---|---|
| 13C-PCB 028 | 114 | 5-145 | 11/22/2015 20:33 |
| 13C-PCB 111 | 92 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 178 | 81 | 10-145 | 11/22/2015 20:33 |
| **Surrogate** | | | |
| 13C-PCB 001 | 70 | 5-145 | 11/22/2015 20:33 |
| 13C-PCB 003 | 72 | 5-145 | 11/22/2015 20:33 |
| 13C-PCB 004 | 59 | 5-145 | 11/22/2015 20:33 |
| 13C-PCB 015 | 83 | 5-145 | 11/22/2015 20:33 |
| 13C-PCB 019 | 62 | 5-145 | 11/22/2015 20:33 |
| 13C-PCB 037 | 102 | 5-145 | 11/22/2015 20:33 |
| 13C-PCB 054 | 62 | 5-145 | 11/22/2015 20:33 |
| 13C-PCB 077 | 112 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 081 | 108 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 104 | 56 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 105 | 91 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 114 | 89 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 118 | 90 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 123 | 92 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 126 | 95 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 155 | 67 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 156/157 | 89 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 167 | 91 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 169 | 98 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 188 | 52 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 189 | 84 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 202 | 56 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 205 | 73 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 206 | 60 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 208 | 54 | 10-145 | 11/22/2015 20:33 |
| 13C-PCB 209 | 55 | 10-145 | 11/22/2015 20:33 |

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http://www.mccampbell.com / E-mail: main@mccampbell.com

# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-007** | **1511071-007A** | **Water** | **11/02/2015 11:00** | **GC36** | **113278** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|

Analyst(s): MG

*(Cont.)*

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http://www.mccampbell.com / E-mail: main@mccampbell.com

# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-008** | **1511071-008A** | **Water** | **11/02/2015 11:31** | **GC36** | **113278** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB 008 | | ND | | 4.1 | 50 | 1 | | | | 11/22/2015 22:41 |
| PCB 018/030 | | **50** | JB | 3.2 | 50 | 1 | 1.09 | 0.92 | | 11/22/2015 22:41 |
| PCB 020/028 | | **130** | | 3.8 | 50 | 1 | 1.03 | 0.85 | | 11/22/2015 22:41 |
| PCB 031 | | **38** | JB | 2.2 | 50 | 1 | 1.03 | 0.82 | | 11/22/2015 22:41 |
| PCB 033 | | ND | | 2.4 | 50 | 1 | | | | 11/22/2015 22:41 |
| PCB 044/047/065 | | **110** | | 10 | 100 | 1 | 0.78 | 1.01 | | 11/22/2015 22:41 |
| PCB 049/069 | | **24** | J | 4.5 | 100 | 1 | 0.79 | 0.96 | | 11/22/2015 22:41 |
| PCB 052 | | **130** | | 3.2 | 50 | 1 | 0.76 | 1 | | 11/22/2015 22:41 |
| PCB 056 | | **33** | J | 3.3 | 50 | 1 | 0.82 | 0.92 | | 11/22/2015 22:41 |
| PCB 060 | | **16** | J | 3.3 | 50 | 1 | 0.76 | 0.94 | | 11/22/2015 22:41 |
| PCB 066 | | **57** | | 2.5 | 50 | 1 | 0.82 | 0.87 | | 11/22/2015 22:41 |
| PCB 070/074/076 | | **190** | J | 8.3 | 200 | 1 | 0.8 | 0.84 | | 11/22/2015 22:41 |
| PCB 086/097/109/119 | | **55** | J | 5.7 | 200 | 1 | 1.50 | 0.94 | | 11/22/2015 22:41 |
| PCB 087/125 | | ND | | 5.8 | 200 | 1 | | | | 11/22/2015 22:41 |
| PCB 090/101/113 | | **190** | J | 5.4 | 200 | 1 | 1.60 | 1 | | 11/22/2015 22:41 |
| PCB 095 | | **120** | J | 2.4 | 200 | 1 | 1.57 | 1.19 | | 11/22/2015 22:41 |
| PCB 099 | | **72** | J | 2.5 | 100 | 1 | 1.56 | 1.05 | | 11/22/2015 22:41 |
| PCB 105 | 0.00003 | **110** | | 2.6 | 50 | 1 | 1.55 | 1 | 0.0033 | 11/22/2015 22:41 |
| PCB 110/115 | | **350** | | 4.5 | 100 | 1 | 1.57 | 1 | | 11/22/2015 22:41 |
| PCB 118 | 0.00003 | **300** | | 2.6 | 100 | 1 | 1.56 | 1 | 0.009 | 11/22/2015 22:41 |
| PCB 128/166 | | **74** | J | 3.3 | 100 | 1 | 1.18 | 1.05 | | 11/22/2015 22:41 |
| PCB 129/138/163 | | **580** | | 5.8 | 200 | 1 | 1.23 | 1 | | 11/22/2015 22:41 |
| PCB 132 | | **130** | | 2.5 | 50 | 1 | 1.22 | 1.01 | | 11/22/2015 22:41 |
| PCB 135/151 | | **140** | | 4.0 | 100 | 1 | 1.26 | 1.02 | | 11/22/2015 22:41 |
| PCB 141 | | **93** | | 2.4 | 50 | 1 | 1.25 | 0.96 | | 11/22/2015 22:41 |
| PCB 147/149 | | **360** | | 2.8 | 100 | 1 | 1.26 | 0.97 | | 11/22/2015 22:41 |
| PCB 153/168 | | **430** | | 4.4 | 100 | 1 | 1.24 | 0.96 | | 11/22/2015 22:41 |
| PCB 156/157 | 0.00003 | **61** | J | 4.9 | 100 | 1 | 1.26 | 1 | 0.00183 | 11/22/2015 22:41 |
| PCB 158 | | **60** | | 1.9 | 50 | 1 | 1.21 | 1.02 | | 11/22/2015 22:41 |
| PCB 170 | | **180** | | 1.5 | 50 | 1 | 1.05 | 0.99 | | 11/22/2015 22:41 |
| PCB 174 | | **220** | | 3.5 | 50 | 1 | 1.04 | 0.97 | | 11/22/2015 22:41 |
| PCB 177 | | **130** | | 1.7 | 50 | 1 | 1.03 | 0.99 | | 11/22/2015 22:41 |
| PCB 180/193 | | **450** | | 4.2 | 100 | 1 | 1.05 | 0.97 | | 11/22/2015 22:41 |
| PCB 183/185 | | **140** | | 3.6 | 100 | 1 | 1.04 | 0.97 | | 11/22/2015 22:41 |
| PCB 187 | | **220** | | 2.1 | 50 | 1 | 1.07 | 1.06 | | 11/22/2015 22:41 |

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# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-008** | **1511071-008A** | **Water** | **11/02/2015 11:31** | **GC36** | **113278** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB 194 | | **65** | | 1.6 | 50 | 1 | 0.89 | 1 | | 11/22/2015 22:41 |
| PCB 195 | | **28** | J | 1.8 | 50 | 1 | 0.87 | 0.97 | | 11/22/2015 22:41 |
| PCB 201 | | **12** | J | 1.9 | 50 | 1 | 0.86 | 1.04 | | 11/22/2015 22:41 |
| PCB 203 | | **44** | J | 1.7 | 50 | 1 | 0.93 | 0.96 | | 11/22/2015 22:41 |
| | | | | | | | Total TEQ: | | 0.0141 | |

| Isotope Dilution | REC (%) | Limits | |
|---|---|---|---|
| 13C-PCB 028 | 113 | 5-145 | 11/22/2015 22:41 |
| 13C-PCB 111 | 93 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 178 | 80 | 10-145 | 11/22/2015 22:41 |
| Surrogate | | | |
| 13C-PCB 001 | 51 | 5-145 | 11/22/2015 22:41 |
| 13C-PCB 003 | 61 | 5-145 | 11/22/2015 22:41 |
| 13C-PCB 004 | 49 | 5-145 | 11/22/2015 22:41 |
| 13C-PCB 015 | 74 | 5-145 | 11/22/2015 22:41 |
| 13C-PCB 019 | 51 | 5-145 | 11/22/2015 22:41 |
| 13C-PCB 037 | 93 | 5-145 | 11/22/2015 22:41 |
| 13C-PCB 054 | 52 | 5-145 | 11/22/2015 22:41 |
| 13C-PCB 077 | 96 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 081 | 97 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 104 | 55 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 105 | 83 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 114 | 81 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 118 | 82 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 123 | 84 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 126 | 88 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 155 | 60 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 156/157 | 79 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 167 | 88 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 169 | 64 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 188 | 89 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 189 | 81 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 202 | 98 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 205 | 59 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 206 | 48 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 208 | 58 | 10-145 | 11/22/2015 22:41 |
| 13C-PCB 209 | 40 | 10-145 | 11/22/2015 22:41 |

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# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-008** | **1511071-008A** | **Water** | **11/02/2015 11:31** | **GC36** | **113278** |

| Analytes | TEF WHO '05 | Result | Qualifiers | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|---|

Analyst(s): MG

(Cont.)

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http://www.mccampbell.com / E-mail: main@mccampbell.com

# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-009** | **1511071-009A** | **Water** | **11/02/2015 11:24** | **GC36** | **113278** |

| Analytes | TEF WHO '05 | Result | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|
| PCB 008 | | ND | 4.3 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 018/030 | | ND | 3.4 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 020/028 | | ND | 4.0 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 031 | | ND | 2.4 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 033 | | ND | 2.6 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 044/047/065 | | ND | 11 | 100 | 1 | | | | 11/22/2015 21:37 |
| PCB 049/069 | | ND | 4.7 | 100 | 1 | | | | 11/22/2015 21:37 |
| PCB 052 | | ND | 3.4 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 056 | | ND | 3.5 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 060 | | ND | 3.5 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 066 | | ND | 2.7 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 070/074/076 | | ND | 8.8 | 200 | 1 | | | | 11/22/2015 21:37 |
| PCB 086/097/109/119 | | ND | 6.1 | 200 | 1 | | | | 11/22/2015 21:37 |
| PCB 087/125 | | ND | 6.2 | 200 | 1 | | | | 11/22/2015 21:37 |
| PCB 090/101/113 | | ND | 5.8 | 200 | 1 | | | | 11/22/2015 21:37 |
| PCB 095 | | ND | 2.6 | 200 | 1 | | | | 11/22/2015 21:37 |
| PCB 099 | | ND | 2.7 | 100 | 1 | | | | 11/22/2015 21:37 |
| PCB 105 | | ND | 2.8 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 110/115 | | ND | 4.8 | 100 | 1 | | | | 11/22/2015 21:37 |
| PCB 118 | | ND | 2.8 | 100 | 1 | | | | 11/22/2015 21:37 |
| PCB 128/166 | | ND | 3.5 | 100 | 1 | | | | 11/22/2015 21:37 |
| PCB 129/138/163 | | ND | 6.2 | 200 | 1 | | | | 11/22/2015 21:37 |
| PCB 132 | | ND | 2.7 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 135/151 | | ND | 4.2 | 100 | 1 | | | | 11/22/2015 21:37 |
| PCB 141 | | ND | 2.6 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 147/149 | | ND | 3.0 | 100 | 1 | | | | 11/22/2015 21:37 |
| PCB 153/168 | | ND | 4.6 | 100 | 1 | | | | 11/22/2015 21:37 |
| PCB 156/157 | | ND | 5.2 | 100 | 1 | | | | 11/22/2015 21:37 |
| PCB 158 | | ND | 2.1 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 170 | | ND | 1.6 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 174 | | ND | 3.7 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 177 | | ND | 1.8 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 180/193 | | ND | 4.4 | 100 | 1 | | | | 11/22/2015 21:37 |
| PCB 183/185 | | ND | 3.8 | 100 | 1 | | | | 11/22/2015 21:37 |
| PCB 187 | | ND | 2.3 | 50 | 1 | | | | 11/22/2015 21:37 |

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# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-009** | **1511071-009A** | **Water** | **11/02/2015 11:24** | **GC36** | **113278** |

| Analytes | TEF WHO '05 | Result | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|
| PCB 194 | | ND | 1.7 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 195 | | ND | 2.0 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 201 | | ND | 2.1 | 50 | 1 | | | | 11/22/2015 21:37 |
| PCB 203 | | ND | 1.8 | 50 | 1 | | | | 11/22/2015 21:37 |

Total TEQ: 0

| Isotope Dilution | REC (%) | Limits | Date Analyzed |
|---|---|---|---|
| 13C-PCB 028 | 114 | 5-145 | 11/22/2015 21:37 |
| 13C-PCB 111 | 91 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 178 | 80 | 10-145 | 11/22/2015 21:37 |
| **Surrogate** | | | |
| 13C-PCB 001 | 75 | 5-145 | 11/22/2015 21:37 |
| 13C-PCB 003 | 77 | 5-145 | 11/22/2015 21:37 |
| 13C-PCB 004 | 62 | 5-145 | 11/22/2015 21:37 |
| 13C-PCB 015 | 88 | 5-145 | 11/22/2015 21:37 |
| 13C-PCB 019 | 64 | 5-145 | 11/22/2015 21:37 |
| 13C-PCB 037 | 106 | 5-145 | 11/22/2015 21:37 |
| 13C-PCB 054 | 61 | 5-145 | 11/22/2015 21:37 |
| 13C-PCB 077 | 117 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 081 | 115 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 104 | 58 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 105 | 97 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 114 | 94 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 118 | 94 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 123 | 96 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 126 | 102 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 155 | 69 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 156/157 | 96 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 167 | 98 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 169 | 109 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 188 | 51 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 189 | 90 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 202 | 55 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 205 | 76 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 206 | 63 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 208 | 54 | 10-145 | 11/22/2015 21:37 |
| 13C-PCB 209 | 56 | 10-145 | 11/22/2015 21:37 |

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http://www.mccampbell.com / E-mail: main@mccampbell.com

# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1668C |
| **Date Prepared:** | 11/18/15-11/23/15 | **Analytical Method:** | E1668C |
| **Project:** | North Richmond Pump Station | **Unit:** | pg/L |

## 40 PCB Congeners

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-009** | **1511071-009A** | **Water** | **11/02/2015 11:24** | **GC36** | **113278** |

| Analytes | TEF WHO '05 | Result | MDL | ML | DF | Ion Ratio | RRT | TEQ | Date Analyzed |
|---|---|---|---|---|---|---|---|---|---|

Analyst(s): MG

CDPH ELAP 1644 ♦ NELAP 4033ORELAP

Angela Rydelius, Lab Manager

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http://www.mccampbell.com / E-mail: main@mccampbell.com

# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1631E |
| **Date Prepared:** | 11/9/15 | **Analytical Method:** | E1631E |
| **Project:** | North Richmond Pump Station | **Unit:** | ng/L |

## Mercury by CVAF

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| NRPSIS-001 | 1511071-001B | Water | 11/02/2015 09:37 | PSA2 | 112506 |

| Analytes | Result | RL | DF | Date Analyzed |
|---|---|---|---|---|
| Mercury | **37** | 2.5 | 5 | 11/10/2015 11:57 |

Analyst(s): BBO

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| NRPSIS-002 | 1511071-002B | Water | 11/02/2015 09:52 | PSA2 | 112506 |

| Analytes | Result | RL | DF | Date Analyzed |
|---|---|---|---|---|
| Mercury | **36** | 2.5 | 5 | 11/10/2015 12:22 |

Analyst(s): BBO

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| NRPSIS-003 | 1511071-003B | Water | 11/02/2015 09:56 | PSA2 | 112506 |

| Analytes | Result | RL | DF | Date Analyzed |
|---|---|---|---|---|
| Mercury | **42** | 2.5 | 5 | 11/10/2015 12:27 |

Analyst(s): BBO

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| NRPSIS-004 | 1511071-004B | Water | 11/02/2015 10:10 | PSA2 | 112506 |

| Analytes | Result | RL | DF | Date Analyzed |
|---|---|---|---|---|
| Mercury | ND | 0.50 | 1 | 11/10/2015 11:42 |

Analyst(s): BBO

*(Cont.)*



Angela Rydelius, Lab Manager

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# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1631E |
| **Date Prepared:** | 11/9/15 | **Analytical Method:** | E1631E |
| **Project:** | North Richmond Pump Station | **Unit:** | ng/L |

## Mercury by CVAF

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-005** | **1511071-005B** | **Water** | **11/02/2015 10:28** | **PSA2** | **112506** |

| Analytes | Result | RL | DF | Date Analyzed |
|---|---|---|---|---|
| Mercury | **37** | 2.5 | 5 | 11/10/2015 12:47 |

Analyst(s): BBO

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-006** | **1511071-006B** | **Water** | **11/02/2015 10:56** | **PSA2** | **112506** |

| Analytes | Result | RL | DF | Date Analyzed |
|---|---|---|---|---|
| Mercury | **31** | 2.5 | 5 | 11/10/2015 12:32 |

Analyst(s): BBO

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-007** | **1511071-007B** | **Water** | **11/02/2015 11:00** | **PSA2** | **112506** |

| Analytes | Result | RL | DF | Date Analyzed |
|---|---|---|---|---|
| Mercury | ND | 0.50 | 1 | 11/10/2015 11:47 |

Analyst(s): BBO

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-008** | **1511071-008B** | **Water** | **11/02/2015 11:31** | **PSA2** | **112506** |

| Analytes | Result | RL | DF | Date Analyzed |
|---|---|---|---|---|
| Mercury | **32** | 2.5 | 5 | 11/10/2015 12:36 |

Analyst(s): BBO

*(Cont.)*

CDPH ELAP 1644 ♦ NELAP 4033ORELAP

Angela Rydelius, Lab Manager

McCampbell Analytical, Inc.
"When Quality Counts"
1534 Willow Pass Road, Pittsburg, CA 94565-1701
Toll Free Telephone: (877) 252-9262 / Fax: (925) 252-9269
http://www.mccampbell.com / E-mail: main@mccampbell.com

# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | E1631E |
| **Date Prepared:** | 11/9/15 | **Analytical Method:** | E1631E |
| **Project:** | North Richmond Pump Station | **Unit:** | ng/L |

## Mercury by CVAF

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-009** | **1511071-009B** | **Water** | **11/02/2015 11:24** | **PSA2** | **112506** |

| Analytes | Result | RL | DF | Date Analyzed |
|---|---|---|---|---|
| Mercury | ND | 0.50 | 1 | 11/10/2015 11:52 |

Analyst(s): BBO

1534 Willow Pass Road, Pittsburg, CA 94565-1701
Toll Free Telephone: (877) 252-9262 / Fax: (925) 252-9269
http://www.mccampbell.com / E-mail: main@mccampbell.com

# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | ASTM D3977-B |
| **Date Prepared:** | 11/6/15 | **Analytical Method:** | ASTM D3977-B |
| **Project:** | North Richmond Pump Station | **Unit:** | mg/L |

## Suspended Sediment Concentration (SSC) in Water

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-001** | **1511071-001D** | **Water** | **11/02/2015 09:37** | **WetChem** | **112590** |

| Analytes | Result | RL | DF | Date Analyzed |
|---|---|---|---|---|
| Suspended Sediment Concentration | **53.9** | 1.00 | 1 | 11/06/2015 15:15 |

Analyst(s): AL

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-002** | **1511071-002D** | **Water** | **11/02/2015 09:52** | **WetChem** | **112590** |

| Analytes | Result | RL | DF | Date Analyzed |
|---|---|---|---|---|
| Suspended Sediment Concentration | **53.5** | 10.0 | 1 | 11/06/2015 15:20 |

Analyst(s): AL

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-003** | **1511071-003D** | **Water** | **11/02/2015 09:56** | **WetChem** | **112590** |

| Analytes | Result | RL | DF | Date Analyzed |
|---|---|---|---|---|
| Suspended Sediment Concentration | **52.8** | 1.00 | 1 | 11/06/2015 15:25 |

Analyst(s): AL

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-005** | **1511071-005D** | **Water** | **11/02/2015 10:28** | **WetChem** | **112590** |

| Analytes | Result | RL | DF | Date Analyzed |
|---|---|---|---|---|
| Suspended Sediment Concentration | **49.5** | 1.00 | 1 | 11/06/2015 15:30 |

Analyst(s): AL

*(Cont.)*

McCampbell Analytical, Inc.
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Toll Free Telephone: (877) 252-9262 / Fax: (925) 252-9269
http://www.mccampbell.com / E-mail: main@mccampbell.com

# Analytical Report

| | | | |
|---|---|---|---|
| **Client:** | AMEC | **WorkOrder:** | 1511071 |
| **Date Received:** | 11/2/15 20:38 | **Extraction Method:** | ASTM D3977-B |
| **Date Prepared:** | 11/6/15 | **Analytical Method:** | ASTM D3977-B |
| **Project:** | North Richmond Pump Station | **Unit:** | mg/L |

## Suspended Sediment Concentration (SSC) in Water

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-006** | **1511071-006D** | **Water** | **11/02/2015 10:56** | **WetChem** | **112590** |

| Analytes | Result | RL | DF | Date Analyzed |
|---|---|---|---|---|
| Suspended Sediment Concentration | **49.3** | 1.00 | 1 | 11/06/2015 15:35 |

Analyst(s): AL

| Client ID | Lab ID | Matrix | Date Collected | Instrument | Batch ID |
|---|---|---|---|---|---|
| **NRPSIS-008** | **1511071-008D** | **Water** | **11/02/2015 11:31** | **WetChem** | **112590** |

| Analytes | Result | RL | DF | Date Analyzed |
|---|---|---|---|---|
| Suspended Sediment Concentration | **50.4** | 1.00 | 1 | 11/06/2015 15:40 |

Analyst(s): AL

**CLIENT:** AMEC
**Work Order:** 1511071
**Project:** North Richmond Pump Station

# ANALYTICAL QC SUMMARY REPORT

**BatchID:** **113093**

SampleID **MB-113093** TestCode: **1668_PCB40_W** Units: **pg/L** Prep Date: **11/18/2015**
Batch ID: **113093** TestNo: **E1668C** Run ID: **GC36_151123A** Analysis Date: **11/18/2015**

| Analyte | Result | MDL | ML | SPKValue | SPKRefVal | %REC | Limits | RPDRefVal | %RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PCB 001 | ND | 9.9 | 20 | | | | - | | | | |
| PCB 003 | ND | 7.1 | 50 | | | | - | | | | |
| PCB 004 | ND | 2.3 | 50 | | | | - | | | | |
| PCB 008 | ND | 4.2 | 50 | | | | - | | | | |
| PCB 015 | ND | 1.9 | 20 | | | | - | | | | |
| PCB 018/030 | ND | 3.3 | 50 | | | | - | | | | |
| PCB 019 | ND | 2.1 | 20 | | | | - | | | | |
| PCB 020/028 | ND | 3.9 | 50 | | | | - | | | | |
| PCB 031 | ND | 2.3 | 50 | | | | - | | | | |
| PCB 033 | ND | 2.5 | 50 | | | | - | | | | |
| PCB 037 | 2.20 | 1.8 | 20 | | | | - | | | | JM |
| PCB 044/047/065 | ND | 10 | 100 | | | | - | | | | |
| PCB 049/069 | ND | 4.6 | 100 | | | | - | | | | |
| PCB 052 | ND | 3.3 | 50 | | | | - | | | | |
| PCB 054 | ND | 2.6 | 50 | | | | - | | | | |
| PCB 056 | ND | 3.4 | 50 | | | | - | | | | |
| PCB 060 | ND | 3.4 | 50 | | | | - | | | | |
| PCB 066 | ND | 2.6 | 50 | | | | - | | | | |
| PCB 070/074/076 | ND | 8.6 | 200 | | | | - | | | | |
| PCB 077 | ND | 2.6 | 50 | | | | - | | | | |
| PCB 081 | ND | 2.2 | 50 | | | | - | | | | |
| PCB 086/097/109/119 | ND | 5.9 | 200 | | | | - | | | | |
| PCB 087/125 | ND | 6.0 | 200 | | | | - | | | | |
| PCB 090/101/113 | ND | 5.6 | 200 | | | | - | | | | |
| PCB 095 | ND | 2.5 | 200 | | | | - | | | | |
| PCB 099 | ND | 2.6 | 100 | | | | - | | | | |
| PCB 104 | ND | 2.7 | 50 | | | | - | | | | |
| PCB 105 | ND | 2.7 | 50 | | | | - | | | | |
| PCB 106 | ND | 5.3 | 50 | | | | - | | | | |
| PCB 110/115 | ND | 4.7 | 100 | | | | - | | | | |
| PCB 114 | ND | 3.0 | 50 | | | | - | | | | |
| PCB 118 | ND | 2.7 | 100 | | | | - | | | | |
| PCB 123 | ND | 3.4 | 50 | | | | - | | | | |
| PCB 126 | ND | 5.5 | 50 | | | | - | | | | |
| PCB 128/166 | ND | 3.4 | 100 | | | | - | | | | |
| PCB 129/138/163 | ND | 6.0 | 200 | | | | - | | | | |
| PCB 132 | ND | 2.6 | 50 | | | | - | | | | |
| PCB 135/151 | ND | 4.1 | 100 | | | | - | | | | |
| PCB 141 | ND | 2.5 | 50 | | | | - | | | | |
| PCB 147/149 | ND | 2.9 | 100 | | | | - | | | | |
| PCB 153/168 | ND | 4.5 | 100 | | | | - | | | | |
| PCB 155 | ND | 1.9 | 50 | | | | - | | | | |
| PCB 156/157 | ND | 5.1 | 100 | | | | - | | | | |
| PCB 158 | ND | 2.0 | 50 | | | | - | | | | |
| PCB 167 | ND | 3.7 | 50 | | | | - | | | | |
| PCB 169 | ND | 2.8 | 50 | | | | - | | | | |

**CLIENT:** AMEC
**Work Order:** 1511071
**Project:** North Richmond Pump Station

# ANALYTICAL QC SUMMARY REPORT

**BatchID: 113093**

SampleID **MB-113093** TestCode: **1668_PCB40_W** Units: **pg/L** Prep Date: **11/18/2015**
Batch ID: **113093** TestNo: **E1668C** Run ID: **GC36_151123A** Analysis Date: **11/18/2015**

| Analyte | Result | MDL | ML | SPKValue | SPKRefVal | %REC | Limits | RPDRefVal | %RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PCB 170 | ND | 1.6 | 50 | | | | - | | | | |
| PCB 174 | ND | 3.6 | 50 | | | | - | | | | |
| PCB 177 | ND | 1.8 | 50 | | | | - | | | | |
| PCB 180/193 | ND | 4.3 | 100 | | | | - | | | | |
| PCB 183/185 | ND | 3.7 | 100 | | | | - | | | | |
| PCB 187 | ND | 2.2 | 50 | | | | - | | | | |
| PCB 188 | ND | 2.0 | 50 | | | | - | | | | |
| PCB 189 | ND | 4.4 | 50 | | | | - | | | | |
| PCB 194 | ND | 1.7 | 50 | | | | - | | | | |
| PCB 195 | ND | 1.9 | 50 | | | | - | | | | |
| PCB 201 | ND | 2.0 | 50 | | | | - | | | | |
| PCB 202 | ND | 4.0 | 100 | | | | - | | | | |
| PCB 203 | ND | 1.8 | 50 | | | | - | | | | |
| PCB 205 | ND | 5.1 | 50 | | | | - | | | | |
| PCB 206 | ND | 3.9 | 50 | | | | - | | | | |
| PCB 208 | ND | 4.8 | 50 | | | | - | | | | |
| PCB 209 | ND | 3.7 | 50 | | | | - | | | | |
| ***Isotope Dilution*** | | | | | | | | | | | |
| 13C-PCB 028 | 1830 | | | 2000 | | 91 | 5 - 145 | | | | |
| 13C-PCB 111 | 1570 | | | 2000 | | 78 | 10 - 145 | | | | |
| 13C-PCB 178 | 1540 | | | 2000 | | 77 | 10 - 145 | | | | |
| ***Surrogate*** | | | | | | | | | | | |
| 13C-PCB 001 | 882 | | | 2000 | | 44 | 5 - 145 | | | | |
| 13C-PCB 003 | 860 | | | 2000 | | 43 | 5 - 145 | | | | |
| 13C-PCB 004 | 858 | | | 2000 | | 43 | 5 - 145 | | | | |
| 13C-PCB 015 | 956 | | | 2000 | | 48 | 5 - 145 | | | | |
| 13C-PCB 019 | 860 | | | 2000 | | 43 | 5 - 145 | | | | |
| 13C-PCB 037 | 1250 | | | 2000 | | 62 | 5 - 145 | | | | |
| 13C-PCB 052 | 2070 | | | 2000 | | 103 | 5 - 145 | | | | |
| 13C-PCB 054 | 956 | | | 2000 | | 48 | 5 - 145 | | | | |
| 13C-PCB 077 | 1400 | | | 2000 | | 70 | 10 - 145 | | | | |
| 13C-PCB 081 | 1400 | | | 2000 | | 70 | 10 - 145 | | | | |
| 13C-PCB 104 | 1080 | | | 2000 | | 54 | 10 - 145 | | | | |
| 13C-PCB 105 | 1410 | | | 2000 | | 70 | 10 - 145 | | | | |
| 13C-PCB 114 | 1400 | | | 2000 | | 70 | 10 - 145 | | | | |
| 13C-PCB 118 | 1400 | | | 2000 | | 70 | 10 - 145 | | | | |
| 13C-PCB 123 | 1410 | | | 2000 | | 71 | 10 - 145 | | | | |
| 13C-PCB 126 | 1390 | | | 2000 | | 69 | 10 - 145 | | | | |
| 13C-PCB 155 | 1300 | | | 2000 | | 65 | 10 - 145 | | | | |
| 13C-PCB 156/157 | 2950 | | | 4000 | | 74 | 10 - 145 | | | | |
| 13C-PCB 167 | 1540 | | | 2000 | | 77 | 10 - 145 | | | | |
| 13C-PCB 169 | 1640 | | | 2000 | | 82 | 10 - 145 | | | | |
| 13C-PCB 188 | 949 | | | 2000 | | 47 | 10 - 145 | | | | |
| 13C-PCB 189 | 1470 | | | 2000 | | 74 | 10 - 145 | | | | |
| 13C-PCB 194 | 2290 | | | 2000 | | 115 | 10 - 145 | | | | |
| 13C-PCB 202 | 951 | | | 2000 | | 48 | 10 - 145 | | | | |
| 13C-PCB 205 | 1300 | | | 2000 | | 65 | 10 - 145 | | | | |

**CLIENT:** AMEC
**Work Order:** 1511071
**Project:** North Richmond Pump Station

# ANALYTICAL QC SUMMARY REPORT

**BatchID: 113093**

| SampleID **MB-113093** | TestCode: **1668_PCB40_W** | Units: **pg/L** | Prep Date: **11/18/2015** |
|---|---|---|---|
| Batch ID: **113093** | TestNo: **E1668C** | Run ID: **GC36_151123A** | Analysis Date: **11/18/2015** |

| Analyte | Result | MDL | ML | SPKValue | SPKRefVal | %REC | Limits | RPDRefVal | %RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 13C-PCB 206 | 1020 | | | 2000 | | 51 | 10 - 145 | | | | |
| 13C-PCB 208 | 925 | | | 2000 | | 46 | 10 - 145 | | | | |
| 13C-PCB 209 | 1020 | | | 2000 | | 51 | 10 - 145 | | | | |

CDPH ELAP 1644 ♦ NELAP 4033ORELAP

Angela Rydelius, Lab Manager

**CLIENT:** AMEC
**Work Order:** 1511071
**Project:** North Richmond Pump Station

# ANALYTICAL QC SUMMARY REPORT

**BatchID: 113093**

| SampleID **LCS-113093** | TestCode: **1668_PCB40_W** | Units: **pg/L** | Prep Date: **11/18/2015** |
|---|---|---|---|
| Batch ID: **113093** | TestNo: **E1668C** | Run ID: **GC36_151123B** | Analysis Date: **11/18/2015** |

| Analyte | Result | MDL | ML | SPKValue | SPKRefVal | %REC | Limits | RPDRefVal | %RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PCB 001 | 1050 | 9.9 | 20 | 1000 | 0 | 105 | 60 - 135 | | | | |
| PCB 003 | 1040 | 7.1 | 50 | 1000 | 0 | 104 | 60 - 135 | | | | |
| PCB 004 | 1010 | 2.3 | 50 | 1000 | 0 | 101 | 60 - 135 | | | | |
| PCB 015 | 975 | 1.9 | 20 | 1000 | 0 | 98 | 60 - 135 | | | | |
| PCB 019 | 1000 | 2.1 | 20 | 1000 | 0 | 100 | 60 - 135 | | | | |
| PCB 037 | 1030 | 1.8 | 20 | 1000 | 0 | 103 | 60 - 135 | | | | |
| PCB 054 | 1020 | 2.6 | 50 | 1000 | 0 | 102 | 60 - 135 | | | | |
| PCB 077 | 1030 | 2.6 | 50 | 1000 | 0 | 103 | 60 - 135 | | | | |
| PCB 081 | 1030 | 2.2 | 50 | 1000 | 0 | 103 | 60 - 135 | | | | |
| PCB 104 | 1030 | 2.7 | 50 | 1000 | 0 | 103 | 60 - 135 | | | | |
| PCB 105 | 1000 | 2.7 | 50 | 1000 | 0 | 100 | 60 - 135 | | | | |
| PCB 114 | 992 | 3.0 | 50 | 1000 | 0 | 99 | 60 - 135 | | | | |
| PCB 118 | 1030 | 2.7 | 100 | 1000 | 0 | 103 | 60 - 135 | | | | |
| PCB 123 | 968 | 3.4 | 50 | 1000 | 0 | 97 | 60 - 135 | | | | |
| PCB 126 | 995 | 5.5 | 50 | 1000 | 0 | 100 | 60 - 135 | | | | |
| PCB 155 | 1010 | 1.9 | 50 | 1000 | 0 | 101 | 60 - 135 | | | | |
| PCB 156/157 | 2040 | 5.1 | 100 | 2000 | 0 | 102 | 60 - 135 | | | | |
| PCB 167 | 963 | 3.7 | 50 | 1000 | 0 | 96 | 60 - 135 | | | | |
| PCB 169 | 993 | 2.8 | 50 | 1000 | 0 | 99 | 60 - 135 | | | | |
| PCB 188 | 984 | 2.0 | 50 | 1000 | 0 | 98 | 60 - 135 | | | | |
| PCB 189 | 1000 | 4.4 | 50 | 1000 | 0 | 100 | 60 - 135 | | | | |
| PCB 202 | 995 | 4.0 | 100 | 1000 | 0 | 100 | 60 - 135 | | | | |
| PCB 205 | 1050 | 5.1 | 50 | 1000 | 0 | 105 | 60 - 135 | | | | |
| PCB 206 | 981 | 3.9 | 50 | 1000 | 0 | 98 | 60 - 135 | | | | |
| PCB 208 | 1030 | 4.8 | 50 | 1000 | 0 | 103 | 60 - 135 | | | | |
| PCB 209 | 1020 | 3.7 | 50 | 1000 | 0 | 103 | 60 - 135 | | | | |
| ***Isotope Dilution*** | | | | | | | | | | | |
| 13C-PCB 028 | 1920 | | | 2000 | | 96 | 15 - 145 | | | | |
| 13C-PCB 111 | 1630 | | | 2000 | | 81 | 40 - 145 | | | | |
| 13C-PCB 178 | 1660 | | | 2000 | | 83 | 40 - 145 | | | | |
| ***Surrogate*** | | | | | | | | | | | |
| 13C-PCB 001 | 1860 | | | 2000 | | 93 | 15 - 145 | | | | |
| 13C-PCB 003 | 1680 | | | 2000 | | 84 | 15 - 145 | | | | |
| 13C-PCB 004 | 1650 | | | 2000 | | 82 | 15 - 145 | | | | |
| 13C-PCB 015 | 1630 | | | 2000 | | 81 | 15 - 145 | | | | |
| 13C-PCB 019 | 1600 | | | 2000 | | 80 | 15 - 145 | | | | |
| 13C-PCB 037 | 1660 | | | 2000 | | 83 | 15 - 145 | | | | |
| 13C-PCB 054 | 1610 | | | 2000 | | 81 | 15 - 145 | | | | |
| 13C-PCB 077 | 1640 | | | 2000 | | 82 | 40 - 145 | | | | |
| 13C-PCB 081 | 1710 | | | 2000 | | 86 | 40 - 145 | | | | |
| 13C-PCB 104 | 1730 | | | 2000 | | 87 | 40 - 145 | | | | |
| 13C-PCB 105 | 1740 | | | 2000 | | 87 | 40 - 145 | | | | |
| 13C-PCB 114 | 1740 | | | 2000 | | 87 | 40 - 145 | | | | |
| 13C-PCB 118 | 1760 | | | 2000 | | 88 | 40 - 145 | | | | |
| 13C-PCB 123 | 1790 | | | 2000 | | 90 | 40 - 145 | | | | |
| 13C-PCB 126 | 1540 | | | 2000 | | 77 | 40 - 145 | | | | |
| 13C-PCB 155 | 1980 | | | 2000 | | 99 | 40 - 145 | | | | |

**CLIENT:** AMEC
**Work Order:** 1511071
**Project:** North Richmond Pump Station

# ANALYTICAL QC SUMMARY REPORT

**BatchID: 113093**

| SampleID **LCS-113093** | TestCode: **1668_PCB40_W** | Units: **pg/L** | Prep Date: **11/18/2015** |
|---|---|---|---|
| Batch ID: **113093** | TestNo: **E1668C** | Run ID: **GC36_151123B** | Analysis Date: **11/18/2015** |

| Analyte | Result | MDL | ML | SPKValue | SPKRefVal | %REC | Limits | RPDRefVal | %RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 13C-PCB 156/157 | 3580 | | | 4000 | | 90 | 40 - 145 | | | | |
| 13C-PCB 167 | 1870 | | | 2000 | | 94 | 40 - 145 | | | | |
| 13C-PCB 169 | 1640 | | | 2000 | | 82 | 40 - 145 | | | | |
| 13C-PCB 188 | 1740 | | | 2000 | | 87 | 40 - 145 | | | | |
| 13C-PCB 189 | 1840 | | | 2000 | | 92 | 40 - 145 | | | | |
| 13C-PCB 202 | 1600 | | | 2000 | | 80 | 40 - 145 | | | | |
| 13C-PCB 205 | 1640 | | | 2000 | | 82 | 40 - 145 | | | | |
| 13C-PCB 206 | 1450 | | | 2000 | | 73 | 40 - 145 | | | | |
| 13C-PCB 208 | 1340 | | | 2000 | | 67 | 40 - 145 | | | | |
| 13C-PCB 209 | 1460 | | | 2000 | | 73 | 40 - 145 | | | | |

**CLIENT:** AMEC
**Work Order:** 1511071
**Project:** North Richmond Pump Station

# ANALYTICAL QC SUMMARY REPORT

**BatchID: 113278**

| SampleID **MB-113278** | TestCode: **1668_PCB40_W** | Units: **pg/L** | Prep Date: **11/23/2015** |
|---|---|---|---|
| Batch ID: **113278** | TestNo: **E1668C** | Run ID: **GC36_151123C** | Analysis Date: **11/22/2015** |

| Analyte | Result | MDL | ML | SPKValue | SPKRefVal | %REC | Limits | RPDRefVal | %RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PCB 001 | ND | 9.9 | 20 | | | | - | | | | |
| PCB 003 | ND | 7.1 | 50 | | | | - | | | | |
| PCB 004 | ND | 2.3 | 50 | | | | - | | | | |
| PCB 008 | ND | 4.2 | 50 | | | | - | | | | |
| PCB 015 | ND | 1.9 | 20 | | | | - | | | | |
| PCB 018/030 | 3.60 | 3.3 | 50 | | | | - | | | | J |
| PCB 019 | ND | 2.1 | 20 | | | | - | | | | |
| PCB 020/028 | 6.20 | 3.9 | 50 | | | | - | | | | J |
| PCB 031 | 3.80 | 2.3 | 50 | | | | - | | | | JM |
| PCB 033 | ND | 2.5 | 50 | | | | - | | | | |
| PCB 037 | ND | 1.8 | 20 | | | | - | | | | |
| PCB 044/047/065 | ND | 10 | 100 | | | | - | | | | |
| PCB 049/069 | ND | 4.6 | 100 | | | | - | | | | |
| PCB 052 | ND | 3.3 | 50 | | | | - | | | | |
| PCB 054 | ND | 2.6 | 50 | | | | - | | | | |
| PCB 056 | ND | 3.4 | 50 | | | | - | | | | |
| PCB 060 | ND | 3.4 | 50 | | | | - | | | | |
| PCB 066 | ND | 2.6 | 50 | | | | - | | | | |
| PCB 070/074/076 | ND | 8.6 | 200 | | | | - | | | | |
| PCB 077 | ND | 2.6 | 50 | | | | - | | | | |
| PCB 081 | ND | 2.2 | 50 | | | | - | | | | |
| PCB 086/097/109/119 | ND | 5.9 | 200 | | | | - | | | | |
| PCB 087/125 | ND | 6.0 | 200 | | | | - | | | | |
| PCB 090/101/113 | ND | 5.6 | 200 | | | | - | | | | |
| PCB 095 | ND | 2.5 | 200 | | | | - | | | | |
| PCB 099 | ND | 2.6 | 100 | | | | - | | | | |
| PCB 104 | ND | 2.7 | 50 | | | | - | | | | |
| PCB 105 | ND | 2.7 | 50 | | | | - | | | | |
| PCB 106 | ND | 5.3 | 50 | | | | - | | | | |
| PCB 110/115 | ND | 4.7 | 100 | | | | - | | | | |
| PCB 114 | ND | 3.0 | 50 | | | | - | | | | |
| PCB 118 | ND | 2.7 | 100 | | | | - | | | | |
| PCB 123 | ND | 3.4 | 50 | | | | - | | | | |
| PCB 126 | ND | 5.5 | 50 | | | | - | | | | |
| PCB 128/166 | ND | 3.4 | 100 | | | | - | | | | |
| PCB 129/138/163 | ND | 6.0 | 200 | | | | - | | | | |
| PCB 132 | ND | 2.6 | 50 | | | | - | | | | |
| PCB 135/151 | ND | 4.1 | 100 | | | | - | | | | |
| PCB 141 | ND | 2.5 | 50 | | | | - | | | | |
| PCB 147/149 | ND | 2.9 | 100 | | | | - | | | | |
| PCB 153/168 | ND | 4.5 | 100 | | | | - | | | | |
| PCB 155 | ND | 1.9 | 50 | | | | - | | | | |
| PCB 156/157 | ND | 5.1 | 100 | | | | - | | | | |
| PCB 158 | ND | 2.0 | 50 | | | | - | | | | |
| PCB 167 | ND | 3.7 | 50 | | | | - | | | | |
| PCB 169 | ND | 2.8 | 50 | | | | - | | | | |
| PCB 170 | ND | 1.6 | 50 | | | | - | | | | |

**CLIENT:** AMEC
**Work Order:** 1511071
**Project:** North Richmond Pump Station

# ANALYTICAL QC SUMMARY REPORT

**BatchID: 113278**

| SampleID **MB-113278** | TestCode: **1668_PCB40_W** | Units: **pg/L** | Prep Date: **11/23/2015** |
|---|---|---|---|
| Batch ID: **113278** | TestNo: **E1668C** | Run ID: **GC36_151123C** | Analysis Date: **11/22/2015** |

| Analyte | Result | MDL | ML | SPKValue | SPKRefVal | %REC | Limits | RPDRefVal | %RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PCB 174 | ND | 3.6 | 50 | | | | - | | | | |
| PCB 177 | ND | 1.8 | 50 | | | | - | | | | |
| PCB 180/193 | ND | 4.3 | 100 | | | | - | | | | |
| PCB 183/185 | ND | 3.7 | 100 | | | | - | | | | |
| PCB 187 | ND | 2.2 | 50 | | | | - | | | | |
| PCB 188 | ND | 2.0 | 50 | | | | - | | | | |
| PCB 189 | ND | 4.4 | 50 | | | | - | | | | |
| PCB 194 | ND | 1.7 | 50 | | | | - | | | | |
| PCB 195 | ND | 1.9 | 50 | | | | - | | | | |
| PCB 201 | ND | 2.0 | 50 | | | | - | | | | |
| PCB 202 | ND | 4.0 | 100 | | | | - | | | | |
| PCB 203 | ND | 1.8 | 50 | | | | - | | | | |
| PCB 205 | ND | 5.1 | 50 | | | | - | | | | |
| PCB 206 | ND | 3.9 | 50 | | | | - | | | | |
| PCB 208 | ND | 4.8 | 50 | | | | - | | | | |
| PCB 209 | ND | 3.7 | 50 | | | | - | | | | |
| ***Isotope Dilution*** | | | | | | | | | | | |
| 13C-PCB 028 | 2140 | | | 2000 | | 107 | 5 - 145 | | | | |
| 13C-PCB 111 | 1760 | | | 2000 | | 88 | 10 - 145 | | | | |
| 13C-PCB 178 | 1570 | | | 2000 | | 79 | 10 - 145 | | | | |
| ***Surrogate*** | | | | | | | | | | | |
| 13C-PCB 001 | 1100 | | | 2000 | | 55 | 5 - 145 | | | | |
| 13C-PCB 003 | 1150 | | | 2000 | | 58 | 5 - 145 | | | | |
| 13C-PCB 004 | 956 | | | 2000 | | 48 | 5 - 145 | | | | |
| 13C-PCB 015 | 1450 | | | 2000 | | 73 | 5 - 145 | | | | |
| 13C-PCB 019 | 1080 | | | 2000 | | 54 | 5 - 145 | | | | |
| 13C-PCB 037 | 1840 | | | 2000 | | 92 | 5 - 145 | | | | |
| 13C-PCB 052 | 1820 | | | 2000 | | 91 | 5 - 145 | | | | |
| 13C-PCB 054 | 1060 | | | 2000 | | 53 | 5 - 145 | | | | |
| 13C-PCB 077 | 2140 | | | 2000 | | 107 | 10 - 145 | | | | |
| 13C-PCB 081 | 2090 | | | 2000 | | 105 | 10 - 145 | | | | |
| 13C-PCB 104 | 1060 | | | 2000 | | 53 | 10 - 145 | | | | |
| 13C-PCB 105 | 1800 | | | 2000 | | 90 | 10 - 145 | | | | |
| 13C-PCB 114 | 1740 | | | 2000 | | 87 | 10 - 145 | | | | |
| 13C-PCB 118 | 1780 | | | 2000 | | 89 | 10 - 145 | | | | |
| 13C-PCB 123 | 1780 | | | 2000 | | 89 | 10 - 145 | | | | |
| 13C-PCB 126 | 1820 | | | 2000 | | 91 | 10 - 145 | | | | |
| 13C-PCB 155 | 1340 | | | 2000 | | 67 | 10 - 145 | | | | |
| 13C-PCB 156/157 | 3580 | | | 4000 | | 89 | 10 - 145 | | | | |
| 13C-PCB 167 | 1830 | | | 2000 | | 91 | 10 - 145 | | | | |
| 13C-PCB 169 | 1940 | | | 2000 | | 97 | 10 - 145 | | | | |
| 13C-PCB 188 | 1070 | | | 2000 | | 53 | 10 - 145 | | | | |
| 13C-PCB 189 | 1680 | | | 2000 | | 84 | 10 - 145 | | | | |
| 13C-PCB 194 | 2200 | | | 2000 | | 110 | 10 - 145 | | | | |
| 13C-PCB 202 | 1160 | | | 2000 | | 58 | 10 - 145 | | | | |
| 13C-PCB 205 | 1470 | | | 2000 | | 73 | 10 - 145 | | | | |
| 13C-PCB 206 | 1270 | | | 2000 | | 64 | 10 - 145 | | | | |

**CLIENT:** AMEC
**Work Order:** 1511071
**Project:** North Richmond Pump Station

# ANALYTICAL QC SUMMARY REPORT

**BatchID: 113278**

| SampleID **MB-113278** | TestCode: **1668_PCB40_W** | Units: **pg/L** | Prep Date: **11/23/2015** |
|---|---|---|---|
| Batch ID: **113278** | TestNo: **E1668C** | Run ID: **GC36_151123C** | Analysis Date: **11/22/2015** |

| Analyte | Result | MDL | ML | SPKValue | SPKRefVal | %REC | Limits | RPDRefVal | %RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 13C-PCB 208 | 1080 | | | 2000 | | 54 | 10 - 145 | | | | |
| 13C-PCB 209 | 1140 | | | 2000 | | 57 | 10 - 145 | | | | |

**CLIENT:** AMEC
**Work Order:** 1511071
**Project:** North Richmond Pump Station

# ANALYTICAL QC SUMMARY REPORT

**BatchID: 113278**

SampleID **LCS-113278** TestCode: **1668_PCB40_W** Units: **pg/L** Prep Date: **11/23/2015**
Batch ID: **113278** TestNo: **E1668C** Run ID: **GC36_151123D** Analysis Date: **11/22/2015**

| Analyte | Result | MDL | ML | SPKValue | SPKRefVal | %REC | Limits | RPDRefVal | %RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PCB 001 | 1080 | 9.9 | 20 | 1000 | 0 | 107 | 60 - 135 | | | | |
| PCB 003 | 1060 | 7.1 | 50 | 1000 | 0 | 106 | 60 - 135 | | | | |
| PCB 004 | 1030 | 2.3 | 50 | 1000 | 0 | 103 | 60 - 135 | | | | |
| PCB 015 | 1040 | 1.9 | 20 | 1000 | 0 | 104 | 60 - 135 | | | | |
| PCB 019 | 1040 | 2.1 | 20 | 1000 | 0 | 104 | 60 - 135 | | | | |
| PCB 037 | 1050 | 1.8 | 20 | 1000 | 0 | 105 | 60 - 135 | | | | |
| PCB 054 | 1050 | 2.6 | 50 | 1000 | 0 | 105 | 60 - 135 | | | | |
| PCB 077 | 1010 | 2.6 | 50 | 1000 | 0 | 101 | 60 - 135 | | | | |
| PCB 081 | 1040 | 2.2 | 50 | 1000 | 0 | 104 | 60 - 135 | | | | |
| PCB 104 | 1040 | 2.7 | 50 | 1000 | 0 | 104 | 60 - 135 | | | | |
| PCB 105 | 1010 | 2.7 | 50 | 1000 | 0 | 101 | 60 - 135 | | | | |
| PCB 114 | 1000 | 3.0 | 50 | 1000 | 0 | 100 | 60 - 135 | | | | |
| PCB 118 | 1030 | 2.7 | 100 | 1000 | 0 | 103 | 60 - 135 | | | | |
| PCB 123 | 992 | 3.4 | 50 | 1000 | 0 | 99 | 60 - 135 | | | | |
| PCB 126 | 995 | 5.5 | 50 | 1000 | 0 | 100 | 60 - 135 | | | | |
| PCB 155 | 1020 | 1.9 | 50 | 1000 | 0 | 103 | 60 - 135 | | | | |
| PCB 156/157 | 2000 | 5.1 | 100 | 2000 | 0 | 100 | 60 - 135 | | | | |
| PCB 167 | 967 | 3.7 | 50 | 1000 | 0 | 97 | 60 - 135 | | | | |
| PCB 169 | 965 | 2.8 | 50 | 1000 | 0 | 97 | 60 - 135 | | | | |
| PCB 188 | 1030 | 2.0 | 50 | 1000 | 0 | 103 | 60 - 135 | | | | |
| PCB 189 | 1000 | 4.4 | 50 | 1000 | 0 | 100 | 60 - 135 | | | | |
| PCB 202 | 1020 | 4.0 | 100 | 1000 | 0 | 101 | 60 - 135 | | | | |
| PCB 205 | 1020 | 5.1 | 50 | 1000 | 0 | 102 | 60 - 135 | | | | |
| PCB 206 | 993 | 3.9 | 50 | 1000 | 0 | 99 | 60 - 135 | | | | |
| PCB 208 | 1000 | 4.8 | 50 | 1000 | 0 | 100 | 60 - 135 | | | | |
| PCB 209 | 1020 | 3.7 | 50 | 1000 | 0 | 102 | 60 - 135 | | | | |
| ***Isotope Dilution*** | | | | | | | | | | | |
| 13C-PCB 028 | 2020 | | | 2000 | | 101 | 15 - 145 | | | | |
| 13C-PCB 111 | 1460 | | | 2000 | | 73 | 40 - 145 | | | | |
| 13C-PCB 178 | 1370 | | | 2000 | | 69 | 40 - 145 | | | | |
| ***Surrogate*** | | | | | | | | | | | |
| 13C-PCB 001 | 972 | | | 2000 | | 49 | 15 - 145 | | | | |
| 13C-PCB 003 | 1030 | | | 2000 | | 51 | 15 - 145 | | | | |
| 13C-PCB 004 | 874 | | | 2000 | | 44 | 15 - 145 | | | | |
| 13C-PCB 015 | 1170 | | | 2000 | | 59 | 15 - 145 | | | | |
| 13C-PCB 019 | 894 | | | 2000 | | 45 | 15 - 145 | | | | |
| 13C-PCB 037 | 1400 | | | 2000 | | 70 | 15 - 145 | | | | |
| 13C-PCB 054 | 903 | | | 2000 | | 45 | 15 - 145 | | | | |
| 13C-PCB 077 | 1390 | | | 2000 | | 69 | 40 - 145 | | | | |
| 13C-PCB 081 | 1380 | | | 2000 | | 69 | 40 - 145 | | | | |
| 13C-PCB 104 | 880 | | | 2000 | | 44 | 40 - 145 | | | | |
| 13C-PCB 105 | 1100 | | | 2000 | | 55 | 40 - 145 | | | | |
| 13C-PCB 114 | 1110 | | | 2000 | | 55 | 40 - 145 | | | | |
| 13C-PCB 118 | 1140 | | | 2000 | | 57 | 40 - 145 | | | | |
| 13C-PCB 123 | 1150 | | | 2000 | | 58 | 40 - 145 | | | | |
| 13C-PCB 126 | 1060 | | | 2000 | | 53 | 40 - 145 | | | | |
| 13C-PCB 155 | 1380 | | | 2000 | | 69 | 40 - 145 | | | | |



Angela Rydelius, Lab Manager

**CLIENT:** AMEC
**Work Order:** 1511071
**Project:** North Richmond Pump Station

# ANALYTICAL QC SUMMARY REPORT

**BatchID: 113278**

| SampleID **LCS-113278** | TestCode: **1668_PCB40_W** | Units: **pg/L** | Prep Date: **11/23/2015** |
|---|---|---|---|
| Batch ID: **113278** | TestNo: **E1668C** | Run ID: **GC36_151123D** | Analysis Date: **11/22/2015** |

| Analyte | Result | MDL | ML | SPKValue | SPKRefVal | %REC | Limits | RPDRefVal | %RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 13C-PCB 156/157 | 2230 | | | 4000 | | 56 | 40 - 145 | | | | |
| 13C-PCB 167 | 1160 | | | 2000 | | 58 | 40 - 145 | | | | |
| 13C-PCB 169 | 1160 | | | 2000 | | 58 | 40 - 145 | | | | |
| 13C-PCB 188 | 963 | | | 2000 | | 48 | 40 - 145 | | | | |
| 13C-PCB 189 | 1210 | | | 2000 | | 60 | 40 - 145 | | | | |
| 13C-PCB 202 | 773 | | | 2000 | | 39 | 40 - 145 | | | | S |
| 13C-PCB 205 | 1100 | | | 2000 | | 55 | 40 - 145 | | | | |
| 13C-PCB 206 | 964 | | | 2000 | | 48 | 40 - 145 | | | | |
| 13C-PCB 208 | 759 | | | 2000 | | 38 | 40 - 145 | | | | S |
| 13C-PCB 209 | 914 | | | 2000 | | 46 | 40 - 145 | | | | |

# Quality Control Report

**Client:** AMEC

**Date Prepared:** 11/9/15

**Date Analyzed:** 11/10/15

**Instrument:** PSA2

**Matrix:** Water

**Project:** North Richmond Pump Station

**WorkOrder:** 1511071

**BatchID:** 112506

**Extraction Method:** E1631E

**Analytical Method:** E1631E

**Unit:** ng/L

**Sample ID:** MB/LCS-112506
1511071-001BMS/MSD

## QC Summary Report for Mercury by CVAF

| Analyte | MB Result | LCS Result | RL | SPK Val | MB SS %REC | LCS %REC | LCS Limits |
|---|---|---|---|---|---|---|---|
| Mercury | ND | 2.45 | 0.50 | 2.5 | - | 98 | 80-120 |

| Analyte | MS Result | MSD Result | SPK Val | SPKRef Val | MS %REC | MSD %REC | MS/MSD Limits | RPD | RPD Limit |
|---|---|---|---|---|---|---|---|---|---|
| Mercury | 132 | 138 | 100 | 36.65 | 95 | 101 | 80-120 | 4.45 | 20 |

McCampbell Analytical, Inc.

1534 Willow Pass Rd
Pittsburg, CA 94565-1701
(925) 252-9262

# CHAIN-OF-CUSTODY RECORD



**WorkOrder: 1511071** **ClientCode: AMEC**

☐ WaterTrax ☐ WriteOn ☐ EDF ☐ Excel ☐ EQuIS ☑ Email ☐ HardCopy ☐ ThirdParty ☐ J-flag

**Report to:**
Emily Sportsman
AMEC
2101 Webster Street, 12th Floor
Oakland, CA 94612
(510) 663-4232 FAX: 510-663-4141

Email: emily.sportsman@amec.com
cc/3rd Party: khalil.abusaba@amec.com;
PO:
ProjectNo: North Richmond Pump Station

**Bill to:**
Accounts Payable
AMEC
2101 Webster Street, 12th Floor
Oakland, CA 94612

**Requested TATs:** **15 days; 5 days;**

***Date Received:*** **11/02/2015**
***Date Printed:*** **11/05/2015**

| Lab ID | Client ID | Matrix | Collection Date | Hold | Requested Tests (See legend below) 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1511071-001 | NRPSIS-001 | Water | 11/2/2015 9:37 | ☐ | A | B | C | D | | | | | | | | |
| 1511071-002 | NRPSIS-002 | Water | 11/2/2015 9:52 | ☐ | A | B | C | D | | | | | | | | |
| 1511071-003 | NRPSIS-003 | Water | 11/2/2015 9:56 | ☐ | A | B | C | D | | | | | | | | |
| 1511071-004 | NRPSIS-004 | Water | 11/2/2015 10:10 | ☐ | A | B | C | | | | | | | | | |
| 1511071-005 | NRPSIS-005 | Water | 11/2/2015 10:28 | ☐ | A | B | C | D | | | | | | | | |
| 1511071-006 | NRPSIS-006 | Water | 11/2/2015 10:56 | ☐ | A | B | C | D | | | | | | | | |
| 1511071-007 | NRPSIS-007 | Water | 11/2/2015 11:00 | ☐ | A | B | C | | | | | | | | | |
| 1511071-008 | NRPSIS-008 | Water | 11/2/2015 11:31 | ☐ | A | B | C | D | | | | | | | | |
| 1511071-009 | NRPSIS-009 | Water | 11/2/2015 11:24 | ☐ | A | B | C | | | | | | | | | |

**Test Legend:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | 1668_PCB40_W | 2 | HGPSA1_W | 3 | MethylMercury_W | 4 | SSC_W |
| 5 | | 6 | | 7 | | 8 | |
| 9 | | 10 | | 11 | | 12 | |

**Prepared by: Maria Venegas**

**Comments:**

NOTE: Soil samples are discarded 60 days after results are reported unless other arrangements are made (Water samples are 30 days).
Hazardous samples will be returned to client or disposed of at client expense.

McCampbell Analytical, Inc.
*"When Quality Counts"*

1534 Willow Pass Road, Pittsburg, CA 94565-1701
Toll Free Telephone: (877) 252-9262 / Fax: (925) 252-9269
http://www.mccampbell.com / E-mail: main@mccampbell.com

# WORK ORDER SUMMARY

**Client Name:** AMEC **QC Level:** **Work Order:** 1511071
**Project:** North Richmond Pump Station **Client Contact:** Emily Sportsman **Date Received:** 11/2/2015
**Comments:** **Contact's Email:** emily.sportsman@amec.com

☐ WaterTrax ☐ WriteOn ☐ EDF ☐ Excel ☐ Fax ☑ Email ☐ HardCopy ☐ ThirdParty ☐ J-flag

| Lab ID | Client ID | Matrix | Test Name | Containers /Composites | Bottle & Preservative | De-chlorinated | Collection Date & Time | TAT | Sediment Content | Hold | SubOut |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1511071-001A | NRPSIS-001 | Water | E1668C (40 PCB Congeners) | 2 | 1LA | ☐ | 11/2/2015 9:37 | 15 days | Present | ☐ | |
| 1511071-001B | NRPSIS-001 | Water | E1631E (Mercury by CVAF) | 1 | 500mL CG, Pre-Cl w/ HCl | ☐ | 11/2/2015 9:37 | 5 days | Present | ☐ | |
| 1511071-001C | NRPSIS-001 | Water | EM1630 (Methyl Mercury) | 1 | 500mL HDPE, Pre-Cl | ☐ | 11/2/2015 9:37 | 5 days | Present | ☐ | SubOut |
| 1511071-001D | NRPSIS-001 | Water | ASTM D3977-B (SSC) | 1 | 1L HDPE, unprsv. | ☐ | 11/2/2015 9:37 | 5 days | Present | ☐ | |
| 1511071-002A | NRPSIS-002 | Water | E1668C (40 PCB Congeners) | 2 | 1LA | ☐ | 11/2/2015 9:52 | 15 days | Present | ☐ | |
| 1511071-002B | NRPSIS-002 | Water | E1631E (Mercury by CVAF) | 1 | 500mL CG, Pre-Cl w/ HCl | ☐ | 11/2/2015 9:52 | 5 days | Present | ☐ | |
| 1511071-002C | NRPSIS-002 | Water | EM1630 (Methyl Mercury) | 1 | 500mL HDPE, Pre-Cl | ☐ | 11/2/2015 9:52 | 5 days | Present | ☐ | SubOut |
| 1511071-002D | NRPSIS-002 | Water | ASTM D3977-B (SSC) | 1 | 1L HDPE, unprsv. | ☐ | 11/2/2015 9:52 | 5 days | Present | ☐ | |
| 1511071-003A | NRPSIS-003 | Water | E1668C (40 PCB Congeners) | 2 | 1LA | ☐ | 11/2/2015 9:56 | 15 days | Present | ☐ | |
| 1511071-003B | NRPSIS-003 | Water | E1631E (Mercury by CVAF) | 1 | 500mL CG, Pre-Cl w/ HCl | ☐ | 11/2/2015 9:56 | 5 days | Present | ☐ | |
| 1511071-003C | NRPSIS-003 | Water | EM1630 (Methyl Mercury) | 1 | 500mL HDPE, Pre-Cl | ☐ | 11/2/2015 9:56 | 5 days | Present | ☐ | SubOut |
| 1511071-003D | NRPSIS-003 | Water | ASTM D3977-B (SSC) | 1 | 1L HDPE, unprsv. | ☐ | 11/2/2015 9:56 | 5 days | Present | ☐ | |
| 1511071-004A | NRPSIS-004 | Water | E1668C (40 PCB Congeners) | 2 | 1LA | ☐ | 11/2/2015 10:10 | 15 days | None | ☐ | |
| 1511071-004B | NRPSIS-004 | Water | E1631E (Mercury by CVAF) | 1 | 500mL CG, Pre-Cl w/ HCl | ☐ | 11/2/2015 10:10 | 5 days | None | ☐ | |
| 1511071-004C | NRPSIS-004 | Water | EM1630 (Methyl Mercury) | 1 | 500mL HDPE, Pre-Cl | ☐ | 11/2/2015 10:10 | 5 days | None | ☐ | SubOut |
| 1511071-005A | NRPSIS-005 | Water | E1668C (40 PCB Congeners) | 2 | 1LA | ☐ | 11/2/2015 10:28 | 15 days | Present | ☐ | |

**NOTES: - STLC and TCLP extractions require 2 days to complete; therefore, all TATs begin after the extraction is completed (i.e., One-day TAT yields results in 3 days from sample submission).**

**- MAI assumes that all material present in the provided sampling container is considered part of the sample - MAI does not exclude any material from the sample prior to sample preparation unless requested in writing by the client.**

McCampbell Analytical, Inc.
"When Quality Counts"

1534 Willow Pass Road, Pittsburg, CA 94565-1701
Toll Free Telephone: (877) 252-9262 / Fax: (925) 252-9269
http://www.mccampbell.com / E-mail: main@mccampbell.com

# WORK ORDER SUMMARY

**Client Name:** AMEC **QC Level:** **Work Order:** 1511071

**Project:** North Richmond Pump Station **Client Contact:** Emily Sportsman **Date Received:** 11/2/2015

**Comments:** **Contact's Email:** emily.sportsman@amec.com

☐ WaterTrax ☐ WriteOn ☐ EDF ☐ Excel ☐ Fax ☑ Email ☐ HardCopy ☐ ThirdParty ☐ J-flag

| Lab ID | Client ID | Matrix | Test Name | Containers /Composites | Bottle & Preservative | De-chlorinated | Collection Date & Time | TAT | Sediment Content | Hold | SubOut |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1511071-005B | NRPSIS-005 | Water | E1631E (Mercury by CVAF) | 1 | 500mL CG, Pre-Cl w/ HCl | ☐ | 11/2/2015 10:28 | 5 days | Present | ☐ | |
| 1511071-005C | NRPSIS-005 | Water | EM1630 (Methyl Mercury) | 1 | 500mL HDPE, Pre-Cl | ☐ | 11/2/2015 10:28 | 5 days | Present | ☐ | SubOut |
| 1511071-005D | NRPSIS-005 | Water | ASTM D3977-B (SSC) | 1 | 1L HDPE, unprsv. | ☐ | 11/2/2015 10:28 | 5 days | Present | ☐ | |
| 1511071-006A | NRPSIS-006 | Water | E1668C (40 PCB Congeners) | 2 | 1LA | ☐ | 11/2/2015 10:56 | 15 days | Present | ☐ | |
| 1511071-006B | NRPSIS-006 | Water | E1631E (Mercury by CVAF) | 1 | 500mL CG, Pre-Cl w/ HCl | ☐ | 11/2/2015 10:56 | 5 days | Present | ☐ | |
| 1511071-006C | NRPSIS-006 | Water | EM1630 (Methyl Mercury) | 1 | 500mL HDPE, Pre-Cl | ☐ | 11/2/2015 10:56 | 5 days | Present | ☐ | SubOut |
| 1511071-006D | NRPSIS-006 | Water | ASTM D3977-B (SSC) | 1 | 1L HDPE, unprsv. | ☐ | 11/2/2015 10:56 | 5 days | Present | ☐ | |
| 1511071-007A | NRPSIS-007 | Water | E1668C (40 PCB Congeners) | 2 | 1LA | ☐ | 11/2/2015 11:00 | 15 days | None | ☐ | |
| 1511071-007B | NRPSIS-007 | Water | E1631E (Mercury by CVAF) | 1 | 500mL CG, Pre-Cl w/ HCl | ☐ | 11/2/2015 11:00 | 5 days | None | ☐ | |
| 1511071-007C | NRPSIS-007 | Water | EM1630 (Methyl Mercury) | 1 | 500mL HDPE, Pre-Cl | ☐ | 11/2/2015 11:00 | 5 days | None | ☐ | SubOut |
| 1511071-008A | NRPSIS-008 | Water | E1668C (40 PCB Congeners) | 2 | 1LA | ☐ | 11/2/2015 11:31 | 15 days | | ☐ | |
| 1511071-008B | NRPSIS-008 | Water | E1631E (Mercury by CVAF) | 1 | 500mL CG, Pre-Cl w/ HCl | ☐ | 11/2/2015 11:31 | 5 days | | ☐ | |
| 1511071-008C | NRPSIS-008 | Water | EM1630 (Methyl Mercury) | 1 | 500mL HDPE, Pre-Cl | ☐ | 11/2/2015 11:31 | 5 days | | ☐ | SubOut |
| 1511071-008D | NRPSIS-008 | Water | ASTM D3977-B (SSC) | 1 | 1L HDPE, unprsv. | ☐ | 11/2/2015 11:31 | 5 days | | ☐ | |
| 1511071-009A | NRPSIS-009 | Water | E1668C (40 PCB Congeners) | 2 | 1LA | ☐ | 11/2/2015 11:24 | 15 days | None | ☐ | |
| 1511071-009B | NRPSIS-009 | Water | E1631E (Mercury by CVAF) | 1 | 500mL CG, Pre-Cl w/ HCl | ☐ | 11/2/2015 11:24 | 5 days | None | ☐ | |

**NOTES:** **- STLC and TCLP extractions require 2 days to complete; therefore, all TATs begin after the extraction is completed (i.e., One-day TAT yields results in 3 days from sample submission).**

**- MAI assumes that all material present in the provided sampling container is considered part of the sample - MAI does not exclude any material from the sample prior to sample preparation unless requested in writing by the client.**

McCampbell Analytical, Inc.
*"When Quality Counts"*

1534 Willow Pass Road, Pittsburg, CA 94565-1701
Toll Free Telephone: (877) 252-9262 / Fax: (925) 252-9269
http://www.mccampbell.com / E-mail: main@mccampbell.com

# WORK ORDER SUMMARY

**Client Name:** AMEC
**QC Level:**
**Work Order:** 1511071
**Project:** North Richmond Pump Station
**Client Contact:** Emily Sportsman
**Date Received:** 11/2/2015
**Comments:**
**Contact's Email:** emily.sportsman@amec.com

☐ WaterTrax ☐ WriteOn ☐ EDF ☐ Excel ☐ Fax ☑ Email ☐ HardCopy ☐ ThirdParty ☐ J-flag

| Lab ID | Client ID | Matrix | Test Name | Containers /Composites | Bottle & Preservative | De-chlorinated | Collection Date & Time | TAT | Sediment Content | Hold | SubOut |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1511071-009C | NRPSIS-009 | Water | EM1630 (Methyl Mercury) | 1 | 500mL HDPE, Pre-Cl | ☐ | 11/2/2015 11:24 | 5 days | None | ☐ | SubOut |

**NOTES: - STLC and TCLP extractions require 2 days to complete; therefore, all TATs begin after the extraction is completed (i.e., One-day TAT yields results in 3 days from sample submission).**

**- MAI assumes that all material present in the provided sampling container is considered part of the sample - MAI does not exclude any material from the sample prior to sample preparation unless requested in writing by the client.**

1511071

**CHAIN-OF-CUSTODY RECORD** 17697

| | | | |
|---|---|---|---|
| PROJECT NAME: North Richmond Pump Station | | DATE: 2Nov | PAGE 1 OF 1 |
| PROJECT NUMBER: | LABORATORY NAME: McCampbell | CLIENT INFORMATION: | REPORTING REQUIREMENTS: See email |
| RESULTS TO: see comments | LABORATORY ADDRESS: 1534 Willow Pass Rd Pittsburg, CA 94565 | | |
| TURNAROUND TIME: standart | | | |
| SAMPLE SHIPMENT METHOD: Courier | LABORATORY CONTACT: Rosa Venegas | | GEOTRACKER REQUIRED YES NO |
| | LABORATORY PHONE NUMBER: 925-252-9262 | | SITE SPECIFIC GLOBAL ID NO. |

SAMPLERS (SIGNATURE): E. Sportsman, K. Abusaba

| | DATE | TIME | SAMPLE NUMBER | SSC | PCB | Total Hg | Methyl Hg | CONTAINER TYPE AND SIZE | Soil (S), Water (W), Vapor (V), or Other (O) | Filtered | Preservative Type | Cooled | MS/MSD | No. of Containers | ADDITIONAL COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| + | 2Nov | 9:37 | NRPS15-001 | ✓ | ✓ | ✓ | ✓ | | W | N | | Y | | | |
| + | ↓ | 9:52 | 002 | ✓ | ✓ | ✓ | ✓ | | ↓ | ↓ | | ↓ | | | |
| + | ↓ | 9:56 | 003 | ✓ | ✓ | ✓ | ✓ | | ↓ | ↓ | | ↓ | | | |
| ✓ | ↓ | 10:10 | 004 | | ✓ | ✓ | ✓ | | ↓ | ↓ | | ↓ | | | |
| + | ↓ | 10:28 | 005 | ✓ | ✓ | ✓ | ✓ | | ↓ | ↓ | | ↓ | | | |
| + | ↓ | 10:56 | 006 | ✓ | ✓ | ✓ | ✓ | | ↓ | ↓ | | ↓ | | | |
| ✓ | ↓ | 11:00 | 007 | | ✓ | ✓ | ✓ | | ↓ | ↓ | | ↓ | | | |
| + | ↓ | 11:31 | 008 | ✓ | ✓ | ✓ | ✓ | | ↓ | ↓ | | ↓ | | | |
| ✓ | ↓ | 11:24 | 009 | | ✓ | ✓ | ✓ | | ↓ | ↓ | | ↓ | | | |
| | | | | 6 | 18 | 9 | 9 = 42 bottles | | | | | | | | |

| RELINQUISHED BY: | DATE | TIME | RECEIVED BY: | DATE | TIME |
|---|---|---|---|---|---|
| SIGNATURE: [signature] PRINTED NAME: E. Sportsman COMPANY: AFW | 2Nov | 2:34 | SIGNATURE: [signature] PRINTED NAME: Julio Venegas COMPANY: McCampbell | 11/2 | 1750 |
| SIGNATURE: [signature] PRINTED NAME: Julio Venegas COMPANY: McCampbell | 11/2/15 | 16:00 | SIGNATURE: PRINTED NAME: COMPANY: | | |
| SIGNATURE: [signature] PRINTED NAME: COMPANY: | | | SIGNATURE: [signature] PRINTED NAME: Jena Alfaro COMPANY: MAI | | |

TOTAL NUMBER OF CONTAINERS: 42

SAMPLING COMMENTS: 3 coolers
1L plastic SSC, 2x 1L Amber PCB
1x 500mL THg 1x 500mL Methyl Hg

Results to: Khalil.Abusaba@amecfw.com
emily.sportsman@amecfw.com

ICE/t° 4.7
GOOD CONDITION ___ APPROPRIATE
HEAD SPACE ABSENT ___ CONTAINERS ___
DECHLORINATED IN LAB ___ PRESERVED IN LAB ___
PRESERVATION VOAS | O & G | METALS | OTHER

amec

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http://www.mccampbell.com / E-mail: main@mccampbell.com

# Sample Receipt Checklist

| | | | |
|---|---|---|---|
| Client Name: | **AMEC** | Date and Time Received: | **11/2/2015 8:38:58 PM** |
| Project Name: | **North Richmond Pump Station** | LogIn Reviewed by: | Maria Venegas |
| WorkOrder №: | **1511071** Matrix: Water | Carrier: | Courier |

## Chain of Custody (COC) Information

| | Yes | No | NA |
|---|---|---|---|
| Chain of custody present? | ☑ | ☐ | |
| Chain of custody signed when relinquished and received? | ☑ | ☐ | |
| Chain of custody agrees with sample labels? | ☑ | ☐ | |
| Sample IDs noted by Client on COC? | ☑ | ☐ | |
| Date and Time of collection noted by Client on COC? | ☑ | ☐ | |
| Sampler's name noted on COC? | ☑ | ☐ | |

## Sample Receipt Information

| | Yes | No | NA |
|---|---|---|---|
| Custody seals intact on shipping container/cooler? | ☐ | ☐ | ☑ |
| Shipping container/cooler in good condition? | ☑ | ☐ | |
| Samples in proper containers/bottles? | ☑ | ☐ | |
| Sample containers intact? | ☑ | ☐ | |
| Sufficient sample volume for indicated test? | ☑ | ☐ | |

## Sample Preservation and Hold Time (HT) Information

| | Yes | No | NA |
|---|---|---|---|
| All samples received within holding time? | ☑ | ☐ | |
| Sample/Temp Blank temperature | Temp: 4.7°C | | ☐ |
| Water - VOA vials have zero headspace / no bubbles? | ☐ | ☐ | ☑ |
| Sample labels checked for correct preservation? | ☑ | ☐ | |
| pH acceptable upon receipt (Metal: <2; 522: <4; 218.7: >8)? | ☐ | ☐ | ☑ |
| Samples Received on Ice? | ☑ | ☐ | |

(Ice Type: WET ICE )

UCMR3 Samples:

| | Yes | No | NA |
|---|---|---|---|
| Total Chlorine tested and acceptable upon receipt for EPA 522? | ☐ | ☐ | ☑ |
| Free Chlorine tested and acceptable upon receipt for EPA 218.7, 300.1, 537, 539? | ☐ | ☐ | ☑ |

** NOTE: If the "No" box is checked, see comments below.*

Comments:

amec foster wheeler

# APPENDIX B

Field Notes

2 Nov

North Richmond Pump Station
Stormwater diversion

9:10 on site. [illegible] - has permission to divert.
Diversion in place

9:26 turned pump on @ ~ 9am
flow is 'choppy' due to debris, leaves, etc getting into line

pump @ ~ 212 gpm
based on flow meter

Samples will be
NRPS-15-001
NRPS15-001

| | | |
|---|---|---|
| SSC | | 1 L plastic |
| methyl-Hg | | 500 mL plastic w/ acid |
| THg | | 1 L glass pre-preserved |
| PCB | 2 x | 1 L amber |

"Rite in the Rain"

9:37 start collecting
NRPS 15-001

9:52 NRPS 15-002
~~dup 001~~

9:56
NRPS15-003 field dup

10:10 NRPS15-004 field blank
w/DI
not for SSC (PCBs Hg only)

10:28 NRPS-005

10:56 NRPS-006

11:00 NRPS-007 field blank
no SSC
PCB & Hg only



11:31 NRPS-008

11:24 NRPS-009 field blank
no SSC
Hg & PCB only

large pumps did NOT turn on during diversion.

small pump 'kept up'

finished sampling ~11:30

# Appendix 9

Mt. Diablo Mercury Mine Clean-up Status Report

Contra Costa County
Public Works
Department

Julia R. Bueren, Director
Deputy Directors
R. Mitch Avalon
Brian M. Balbas
Stephen Kowalewski
Stephen Silveira

# Memo

September 15, 2015

**TO:** Mercury Mine Clean-Up Team

**FROM:** Mike Carlson, Flood Control Division Manager

**SUBJECT:** Status Report on Mount Diablo Mercury Mine Clean-Up

The last status report of September 17, 2012 discussed the status and progress of the Army Corps of Engineers' Technical Planning Process to clean up the mercury mine through their Remediation of Abandoned Mine Sites (RAMS) program. Attached is a memo that outlines the latest developments in this project.

RMA:lz
G:\Admin\Mitch\Mercury Mines\Status Report 9-14-15.docx

c: Julie Bueren, Public Works Department
Bailey Grewal, City of Brentwood
Kevin Rohani, City of Oakley
Ben Wallace, Resource Conservation District
Lisa Anich, Resource Conservation District
Todd Wang, CH2M HILL
Melanie Barber, Versar
Steve Morioka, Hazardous Materials
Steve Kowalewski, Public Works
Paul Detjens, Flood Control District
Tom Dalziel, Clean Water Program
Lucile Paquette, Clean Water Program
Cece Sellgren, Watershed Program
Linda Wilcox, County Counsel
Lara Delaney, County Administrator's Office
Theresa Speiker, County Administrator's Office
Michael Kent, Health Services
Jack Wessman, Property Owner
Bob Nisbet, East Bay Regional Park District
Marty Hartzell, Central Valley Regional Water Quality Control Board
Amy Ha, Central Valley Regional Water Quality Control Board
Tim Vendlinski, Environmental Protection Agency
Jerelean Johnson, Environmental Protection Agency
Larry Bradfish, Environmental Protection Agency
Sara Puckett, Consultant
Kelly Davidson, Mt. View Sanitary District
Seth Adams, Save Mt. Diablo
Laura Whitney, Army Corps of Engineers
Diane Burgis, Friends of Marsh Creek Watershed
Paul Schlesinger, Alcalde & Fay

Julia R. Bueren, Director
Deputy Directors
Brian M. Balbas
Stephen Kowalewski
Stephen Silveira
Joe Yee

# Memo

September 14, 2015

**TO:** Mike Carlson, Division Manager

**FROM:** Mitch Avalon, Consultant

**SUBJECT:** Status of the Mount Diablo Mercury Mine

On December 4, 2012 the Board of Supervisors accepted a comprehensive status report on the cleanup efforts of the Mount Diablo Mercury Mine. The status report included a history of the project, project objectives, and an outline of our strategy at that time. The report concluded the list of key milestones with the September 21, 2012 completion of the Data Collection Plan. Completion of this plan depleted the original congressional appropriation of $517,000. Additional planning work was needed to perform the data collection, assess the impacts of the mine drainage and develop a project scope. It is estimated that another appropriation of $483,000 will be needed to complete the planning work. The following is an update of the Board of Supervisors status report, which is attached for easy reference.

## Recent Events

On April 16, 2013, the Executive Officer of the Central Valley Regional Water Quality Control Board (Regional Board) issued a Cleanup and Abatement Order to several responsible parties to clean up the mine site. Responsible parties are entities that have legal responsibility to clean up the mine site under the federal Comprehensive Environmental Response, Compensation, and Liability Act. The two key responsible parties were Sunoco and Kennametal. These two responsible parties subsequently requested the Regional Board reconsider issuance of the Cleanup and Abatement Order (CAO). The Regional Board agreed to reconsider the CAO on August 8, 2013, and it was subsequently scheduled for the Regional Board meeting of March 27, 2014. On March 12, 2014 the Board of Supervisors sent a letter to the Regional Board requesting they not modify the CAO but rather to fully pursue the CAO and require the responsible parties to clean up the mine site. The reconsideration was continued and finally heard by the Regional Board at their October 10, 2014 meeting where they upheld the Executive Officer's Cleanup and Abatement Order. Of all the responsible parties listed in the final Quarter, Sunoco was the only mining company, as Kennametal had been released for lack of evidence. In November 2014, Sunoco appealed the Regional Board's decision to the State Water Resources Control Board.

On October 20, 2011, the Central Valley Regional Water Quality Control Board approved a Total Maximum Daily Load (TMDL) allocation to control methylmercury and total mercury in the watershed and amended the Water Quality Control Plan for the Sacramento-San Joaquin River Delta. Marsh Creek drains into the Delta and is subject to this TMDL requirement. The Response Plan for the TMDL recognizes the Mount Diablo Mercury Mine as a point source of mercury contamination and its cleanup now takes on an additional degree of importance. We participate in (help fund) the Delta Mercury Exposure Reduction Program, through the County Clean Water Program, which works to reduce exposure to mercury among people who eat fish from the Delta. We are also currently developing a Methylmercury Control Study to meet our TMDL requirements and taking water quality sampling for mercury below the Marsh Creek Reservoir. The Regional Board is currently working on a TMDL for both Marsh Creek and Dunn Creek. The information we are gathering should help with the Corps planning work.

The Mount Diablo Mercury Mine project has enjoyed strong support in Congress for many years. The Water Resources Development Act of 2007, authorizing projects and programs for the Army Corps of Engineers (Corps), extended and increased funding for the RAMS program, and at our request included language in the accompanying Statement of Managers that "In carrying out this section, the Secretary shall give priority to the Mount Diablo Mercury Mine Cleanup project in Contra Costa County, California."

On May 15, 2013, the Board of Supervisors sent a letter to Senator Feinstein requesting support for a $1 million appropriation to fund the Remediation of Abandoned Mine Sites (RAMS) program and, without any reference that might constitute an earmark, also expressed our hope the Corps would program $483,000 towards the Mount Diablo Mercury Mine. A similar letter was sent to our Congressional Representatives on May 21, 2013. Congress approved a Consolidated Appropriations Act which included $1 million for the RAMS program. In July 2014, the County's congressional delegation sent a letter to Jo-Ellen Darcy, Assistant Secretary of the Corps, urging the Corps to program $483,000 for the mine project. As a result, $483,000 is currently in the project account at the Sacramento Corps District.

In 2013 Congress was debating passage of a Water Resources Development Act. On June 28, 2013, at our request, Congressman Mike Thompson sent a letter to the House Committee on Transportation and Infrastructure requesting an expansion of authority for the Corps to construct mine cleanup projects under the RAMS program. Currently, the Corps only has authority to conduct planning and design work and cannot construct a cleanup project. This expansion of Corps authority would reduce liability exposure for the County, but unfortunately was not included in the adopted legislation. We will continue to propose expanding Corps authority whenever Congress introduces a new

Water Resources Development Act, and continue to support appropriations each year to fund the RAMS program.

A letter agreement for the mine project dated June 10, 2009, was developed and signed by the program manager for the RAMS program and the project manager for the Flood Control District outlining the cost-share activities performed by the County. Subsequently, the national and local economies suffered heavily as we went through what is now referred to as the Great Recession. County staff were let go and budgets slashed. The County was not able to perform the anticipated work outlined in the 2009 cost-share letter. In early 2014, there was a leadership change in the RAMS program and there was a general review of current projects and past practices. In light of this review, the Corps eventually determined that the existing letter agreement would not be adequate. Toward the end of 2014 the Flood Control District was informed by the Corps project manager that a formal cost-share agreement, or Project Partnership Agreement, would be required before any further work on the project could be performed. Since then, the Corps has been refining RAMS processes to be compliant with RAMS Authority. This involves searching for the closest model agreement that could be modified to accommodate the Mercury Mine project, which is on private property. Twice monthly coordination meetings were set up to facilitate moving the project forward. The Corps is currently preparing a draft agreement which should be in our hands within the next two months.

## Current Issues

In developing the agreement with the Corps, the following are some of the issues that have been discussed and we will need to consider:

- **Design Services Agreement.** The Corps has determined the most appropriate model agreement is their Section 219 Model Agreement for Design Assistance. However, we haven't completed the planning work and the sequence and project development is to complete the planning and define the project. Once the project is adequately defined then it can be designed. We need to complete the Technical Project Planning work the Corps started in 2008 before the project can be defined and designed, so the agreement needs to include a section on planning. At this time, we have no objection to the Corps developing an agreement with both planning and design services, but we don't want to commit to design services now when we do not know what the project is. The agreement should be written with a decision point upon completion of the planning work and project definition. At that time, with a clear understanding of the project objectives and description, the Corps and the County can decide whether or not to move forward with project design.

- **Cost-Share.** The Local Match required for our project in the RAMS program is 50%.

- **In-Kind Work.** We would like the ability to contribute in-kind work that would be integral to and supportive of the project, such as project management costs and other work like water quality testing, as part of our local match requirement, rather than having to contribute all cash. The advantage to the County is getting credit for work that benefits the project and will be done and paid for anyway. Any cash contribution would be on top of expenditures that are already occurring in the watershed. Close coordination with the Corps to determine what types of activities would be acceptable in-kind credit will be on-going.

- **Costs Forward.** At this time, we are working with the Corps to determine project costs. From our perspective, there are two approaches in determining the cost-share amount. One is to calculate the cost-share from today forward and receive in-kind credit for work done from today forward. The other is to calculate the cost-share from the beginning of the project and receive credit for past work performed. With the second approach, we need to know exactly how much the Corps has spent, because we would have to match that cost. There was a $517,000 appropriation that has been expended and that may be the total past cost. Presently, we are in the process of gathering our costs since 2009 so we can determine the best approach forward.

- **Corps Cost.** A 50% cost-share by the County will be required to complete the planning work (and possible design efforts). Before signing an agreement, we will need to know the estimated cost for that work. It is assumed the cost to complete the planning phase will be around $483,000, as that was the budget request to Congress before the local match requirement. With a 50% cost-share formula, the estimated County contribution would be $241,500. Design costs cannot be estimated until the project is defined, and those costs will be one element in the decision whether or not to go beyond the planning phase and into the design phase.

- **Liability.** Maintaining a low exposure to liability has been a primary driver of the County's policy and strategy with this project. County Counsel has indicated in the past that planning work is a low risk activity. The further you move along the project development continuum of planning, design, permitting, and construction, the more risk is assumed. Up until now we have not had a direct financial participation in the planning process, which has resulted in low risk. Providing direct financial participation may increase risk levels, but may also be acceptable for the planning phase. Moving into the design phase and the attendant risk will require a deeper understanding of the project, which is yet to be defined. For example, we may be interested in designing a project at the reservoir, which we own, but may not be interested in the design of a project on private property upstream or downstream of the reservoir, as we do not have control of nor responsibility for that property.

- **Mine Cleanup.** The mine represents an ongoing point source of Mercury in the watershed and must be cleaned up. At this time, it is still unknown if the identified responsible parties will be required to remediate the entire mine site or a portion of the site. The outcome of the State Water Resources Control Board enforcement action will be a key determinant of what our project will be.

- **Marsh Creek Reservoir.** In our correspondence to the Regional Board and others on the enforcement action, we have requested the responsible parties also contribute to mitigating impacts downstream of the mine site, including the Marsh Creek Reservoir. However, it appears the enforcement action is focusing solely on cleaning up the mine site and it will be considered a victory if that is achieved. We should plan on not receiving any significant assistance from the responsible parties for the Marsh Creek Reservoir project.

RMA:lz
G:\Admin\Mitch\Mercury Mines\Status 9-14-15.docx

To: Board of Supervisors
From: Julia R. Bueren, Public Works
Date: December 4, 2012

Contra
Costa
County

Subject: Accept Status Report on the Clean-up of the Mount Diablo Mercury Mine

**RECOMMENDATION(S):**
ACCEPT the following status report on the clean-up of the Mount Diablo Mercury Mine and Direct staff to continue to seek funds to complete the planning and design phase of the project.

**FISCAL IMPACT:**
No Fiscal Impact.

**BACKGROUND:**
Introduction

The Mount Diablo Mercury Mine is a large, abandoned mercury mine located on the northeast side of Mount Diablo in the headwaters of the Marsh Creek watershed. Since the early 1990's the Flood Control District has been interested in assisting in the clean-up of the abandoned mine, which is located on private property next to Mt. Diablo State Park. The mine was operational, on and off, from 1849 to 1971. The property was purchased by the current owner in 1974, who inherited the remediation challenges associated with the abandoned mine. The current owner has been cited by the Regional Water Quality Control Board to clean up the mine site, even though he did not create the problem, did not operate the mine, and doesn't have the resources to do the work.

The mining area

☑ APPROVE ☐ OTHER

☑ RECOMMENDATION OF CNTY ADMINISTRATOR ☐ RECOMMENDATION OF BOARD COMMITTEE

Action of Board On: **12/04/2012** ☑ APPROVED AS RECOMMENDED ☐ OTHER

Clerks Notes:

VOTE OF SUPERVISORS

AYES 5 NOES ____

ABSENT ____ ABSTAIN ____

RECUSE ____

I hereby certify that this is a true and correct copy of an action taken and entered on the minutes of the Board of Supervisors on the date shown.

ATTESTED: December 4, 2012

David J. Twa, County Administrator and Clerk of the Board of Supervisors

By: June McHuen, Deputy

Contact: Mitch Avalon, 925-313-2203

cc: David Twa, Julie Bueren, Mitch Avalon, Mike Carlson, Paul Detjens, Cece Sellgren consists of a huge underground system of mine tunnels that collect rainwater which percolates out through cracks in the surrounding rock, showing up as seeps in the surface and bringing contaminants with it. The mining area also has remnants of an open pit mine and many piles of mine tailings. Rainwater falling on the piles of mine tailings drain down into two ponds and then overflow into Marsh Creek. This rainwater draining through the piles of tailings carries contaminates with it down through the watershed.

There are several reasons why it is in the interest of the Flood Control District and the County to clean-up the Mount Diablo Mercury Mine.

• Public Health - Mercury washed into Marsh Creek and downstream into the San Francisco Bay-Delta Estuary system poses a health risk. Fish in the Marsh Creek Reservoir have been tested and exceed health standards for mercury.

• Water Quality – the County's Non-Point Discharge Elimination System Permit (NPDES) requires the County, and now the Flood Control District, to improve water quality in the Marsh Creek watershed.

• Pollutant Specific Requirements – The Environmental Protection Agency (EPA) and the State Water Resources Control Board have a program to focus on eliminating concentrations of specific pollutants. This program is the Total Maximum Daily Load (TMDL) program and limits specific concentrations of various pollutants discharging into receiving water bodies. The Regional Water Quality Control Board is currently working on a methyl-mercury TMDL for the Delta, which would ultimately include discharges from Marsh Creek into the Delta system.

• Downstream Property Owner - The Flood Control District owns the Marsh Creek Reservoir and several miles of Marsh Creek channel downstream of the Mount Diablo Mercury Mine. As a result, mercury has settled in various locations along Flood Control District owned property, most notably in the Marsh Creek Reservoir.

The Regional Board has identified the entire length of Marsh Creek from the mine site to the Sacramento-San Joaquin Delta as an impaired water body for mercury and heavy metals under Section 303(d) of the Clean Water Act. One of the key issues of concern in the Marsh Creek watershed is the presence of mercury and its toxic impact on fish and the people who consume them. In 1995, Public Works commissioned a comprehensive assessment of mercury contamination throughout the Marsh Creek watershed. The report established that about 90% of the mercury in the creek originated at the abandoned mine.

The Flood Control District is interested in helping cleanup the Mount Diablo Mercury Mine but liability concerns are the principal roadblock to the District's full participation to date. The liability that the District would incur is primarily associated with the Clean Water Act and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The EPA's Good Samaritan Initiative, and its companion Good Samaritan Agreement, is an attempt to address the liability concerns tied to CERCLA and the Clean Water Act through an administrative process. In the past Congress has also reviewed legislation intended to more fully address these same concerns.

Entering into a Good Samaritan Agreement would allow the Flood Control District to voluntarily improve the abandoned mine site with EPA oversight and reasonable requirements with some liability protection. This agreement will provide protection against a lawsuit by the federal government and by past mining companies who worked the mine. The agreement will not protect the District against third-party lawsuits allowed by the Clean Water Act. As a result, if we participate in cleaning up the mine site, we will expose ourselves to lawsuits by downstream property owners and environmental organizations. EPA and the Regional Water Board are working on Total Maximum Daily Load requirements for methyl-mercury in the Delta. Establishing these numeric limits will make it easier for environmental groups and others to file a lawsuit against a local agency that has cleaned up a mine site that, despite the best planning and construction practices available, will probably still have a residual discharge.

If the Flood Control District participates in the planning process for a clean-up project, as we have been doing with the Army Corps of Engineers to date, our exposure is extremely small. However, if we participate in a construction project that results in changes to the mine and there are post-construction discharges, then our liability exposure goes way up. Financial participation in a construction project means we are a project participant. As a result, we have requested Congress do two things to limit our liability. First, we have requested authorization for the Corps to construct the clean-up project. If the Corps constructs the project, then the federal government is the lead agency and assumes liability. Secondly, we have requested the Corps fund 100% of the project without a local cost share. If the Corps constructed the project under normal Corps rules, we would be obligated to contribute a local cost share, which would increase our liability exposure. Alternatively, other funding sources could be used for the local cost share.

There is also liability exposure at the state level. California Water Code, Section 13397, provides some protection against liability for local government agencies that clean-up an abandoned mine. It does not, however, provide protection against all potential liability, such as third party lawsuits, from individual property owners or environmental groups.

Project Development Overview

In June 2006, Sustainable Conservation, a non-profit organization that specializes in facilitating intergovernmental agency work to achieve environmental good, received a grant from CalFed for $50,000 to assist in the clean-up of the Mount Diablo Mercury Mine. Sustainable Conservation assisted the Flood Control District for several years in working with the EPA and the Water Board and others to promote a limiting liability agreement to clean-up the mercury mine.

On May 15, 2006, EPA Region IX held a press conference at the Mount Diablo Mercury Mine on the need for and benefits of their proposed Good Samaritan legislation, which would assist non-responsible third parties (Good Samaritans) in cleaning up abandoned mines. For some time the Flood Control District had discussed potential ways of resolving clean up liability issues through EPA's existing administrative authority, the Good Samaritan Initiative. The Good Samaritan legislation would provide EPA additional options to address liability associated with abandoned mine clean up by Good Samaritan agencies.

In early June 2006, EPA requested Contra Costa County testify before the Senate Environment and Public Works Committee hearing on the proposed legislation. On June 14, 2006, Supervisor John Gioia testified on behalf of the County, describing the Mount Diablo Mercury Mine and the Flood Control District's desire to clean it up but not being able to do so because of liability issues. On June 20, 2006, the Board of Supervisors took a position of support for both federal legislative and administrative efforts to eliminate liability exposure for local government agencies in remediating abandoned mines.

At the Senate hearing, Senator Boxer expressed interest in our project. Over the next several weeks we fine-tuned an 8-step proposal to clean up the mine site and prepared an overview and briefing paper on the proposal. Subsequent discussions with Senator Boxer's office along with Congresswoman Tauscher and Congressman Miller's offices resulted in our understanding of the following:

- EPA has existing authority to provide immunity under superfund law (CERCLA). This immunity, we found out later, was not 100% complete immunity.

- EPA can use superfund statutes to cover mines that are not designated as superfund sites, so Mount Diablo Mercury Mine could qualify, but there is a stigma associated with superfund sites.

- No other federal permits are needed if the clean-up is under the superfund statutes.

- If the clean-up project improves property value, we need to ensure there is no gift of public funds by creating a conservation easement over the mine area, splitting the mine site out as a separate parcel or taking some other action.

- An agreement should include a "no re-opener" clause that would disallow any future mining operations.

- The term "removal action" appears to be more appropriate for our proposal than "remediation". The term remediation means 100% clean up, whereas removal action can be less than 100% clean up.

• The Army Corps of Engineers has a program for mine clean up and some potential funding.

During this same time period, the Army Corps of Engineers mine clean-up program, Remediation of Abandoned Mine Sites (RAMS), was included in the Senate version of the Water Resources Development Act (WRDA). The Senate provision included an extension of the RAMS program and $45 million in funding. On September 19, 2006, the Board of Supervisor's took a position of support for the Senate version of WRDA in the hope that some funding would be available for the Mount Diablo Mercury Mine.

The following are some key points about the RAMS program:

• Cost share requirement is fifty-fifty, although the local match can be reduced if the clean-up is a demonstration project. In subsequent discussions with the Corps, nobody has been able to figure a way to classify our project as a demonstration project.

• Must ensure there is no Potentially Responsible Party before federal funds can be spent on the project. A Potentially Responsible Party or Responsible Party is a prior owner of the mine that conducted mining activities and is liable for clean-up under CERCLA.

• RAMS funding is limited to planning and design costs, but can fund construction if it is a demonstration project.

• RAMS funding has historically been appropriated through congressional add-ons/earmarks.

• RAMS projects are usually done in partnership with EPA.

In 2006 we submitted an appropriations request for RAMS funding in the amount of $1 million. This funding would cover the costs outlined in our September 2006 proposed eight-step "demonstration" project to clean up the mine. In 2007 Congress subsequently approved WRDA and an appropriation of $517,000 for the Mount Diablo Mercury Mine.

In June 2007, EPA completed a model agreement that would limit liability to Good Samaritan agencies like the Flood Control District. The agreement was an Administrative Order on Consent. EPA released the model Administrative Order on Consent along with a model "Comfort Letter" for small projects, and guiding principles that outlined the application of these model agreements.

Over the course of several months we met with EPA and others to review the model agreement for applicability to the Mount Diablo Mercury Mine and the associated impacts on Contra Costa County. Comments were submitted and various possibilities were discussed as we tried to form-fit the model agreement into a real-life project. During this time, the Army Corps stressed their preference for a watershed based approach to the mercury clean-up. Rather than focusing strictly on the mine, we should look at the entire watershed as part of the initial planning process. Another key point of discussion was the search for a potential responsible party. No federal grant funds can be expended on a project until the federal agencies are satisfied that there are no potential responsible parties. The Corps agreed to conduct the historical and chain of ownership research on the mine that would be necessary for the ultimate potential responsible party search which would be conducted by EPA. The Corps began this effort in late 2007.

Discussions with EPA on their model Good Samaritan Agreement were then placed on hold for two reasons; (1) EPA cannot commit to a project until all the responsible parties have been identified and an enforcement project clarified, (2) EPA was uncertain if a Good Samaritan Agreement could be implemented in conjunction with a RAMS project.

On October 29, 2007, we met with the Central Valley Regional Water Quality Control Board and others. We discussed the background of the Mount Diablo Mercury Mine project and our long-time desire for the mine to be cleaned up. The Regional Board indicated that a stormwater permit would be required during construction, and that a waste discharge permit would be required after construction if there is discharge from the mine site. We have come to understand the site will most assuredly have a post-construction discharge, which greatly complicates the liability issue. We stressed the need to limit liability for the Flood Control District as part of the project if we are actively involved in the clean-up.

In early 2008 the Corps went through a process to hire a consultant to manage the planning process for the mine clean-up. The Corps uses its standard process for gathering community input called a Technical Project Planning process, which is similar to a community-based planning process or stakeholder driven process. This planning process identifies project goals and objectives, probable remedies and a conceptual design. The first public meeting was held on June 19, 2008. In the fall of 2008 the planning process was held up until the Flood Control District could verify its 50% cost share. In the summer of 2009, the Corps agreed on the Flood Control District's participation and local cost share for the project and the planning process resumed.

The following project objective for the Flood Control District has remained the same from the beginning.

"Enable a clean-up of the Mount Diablo Mercury Mine that will reduce mercury discharges to the maximum extent practicable with limited liability exposure to the District."

The Corps' planning process, which includes a host of stakeholders, resulted in the following project objective. This community based objective is broader than the Flood Control District's objective.

"Protect public health and the environment by cleaning up the Mount Diablo mine site and addressing the downstream effects on Marsh Creek and the Marsh Creek reservoir".

In 2008 EPA, now armed with the Corps historical mining information and chain of title for the mercury mine, began their search for a potential responsible party. In the fall of 2008, EPA identified Sunoco Incorporated as a potential responsible party and several months later became concerned that the spillway at the pond below the mine tailings could give way during the winter rains. In December 2008 EPA ordered Sunoco to conduct emergency repairs to the dam. This work was completed before the end of the year.

In early 2009, EPA formally named Sunoco a responsible party through a Unilateral Administrative Order. EPA subsequently turned over follow up activities with Sunoco to the Central Valley Regional Water Quality Control Board. Sunoco contends they did not mine the entire site. In June 2009, the Regional Board issued a Revised Order to Sunoco requiring them to submit technical reports on what areas of the site they mined, the volume of materials mined, and other potential responsible parties. The requested technical reports will be used by the Regional Board to determine if other potential responsible parties exist, determine what further site investigation efforts are needed to identify the extent of impacts from the mine on the surrounding environment, and identify potential remedial actions.

The Regional Board has continued to pursue Sunoco as a responsible party and is trying to identify other potential responsible parties and/or responsible parties. It is unknown at this time how many responsible parties will end up being identified and how long it will take to complete that process. Once that is complete, negotiations will commence on the extent of their responsibility for the cost for a total clean-up project. Given the initial results, however, it is possible the responsible party or parties will not be responsible for 100% of the total clean-up of the mine site.

The Corps continued along with the planning process. In November 2010, the Corps released a report entitled "Initial Data Gaps Assessment for Mount Diablo Mercury Mine". This report identified all of the known information on the mine site from prior reports and testing, identified what information is needed for a complete site characterization and project design, and identified what data gaps are needed to provide that information. At this point a significant amount of the original appropriation for this project had been expended. In 2009, the County began requesting an appropriation of $483,000 to complete the planning process.

In February 2012, the Regional Board accepted a site characterization report submitted by Sunoco for the mercury mine. The report characterized the causes of mercury releases associated with mining wastes at the mine and provided the data necessary to design a remedial action plan for the site. Also in February 2012, the agency stakeholders met to provide an update on the project. The Regional Board verified the site characterization report prepared by Sunoco covered the entire mercury mine and not just the portion that Sunoco mined when they owned the site. It was also agreed the Corps' planning process would focus more on the downstream impacts of mercury, especially in the Marsh Creek Reservoir, since the Regional Board had accepted the site characterization report from Sunoco.

In June 2012, the Regional Board accepted a preliminary site remediation work plan submitted by Sunoco for remediation of the mercury mine. The work plan provides an evaluation of water quality, a health risk assessment, scope of work for the removal of the mine waste, management of water discharge and a long-term maintenance and monitoring program. The work plan outlines the remedial action approach and recognizes that more detailed planning and design would have to occur at a later date. This would happen with the Regional Board's next step in their enforcement action, which will be an order to clean-up the mercury mine.

On August 23, 2012, a public meeting was held to discuss the status of activities to date and to receive comments on a draft data collection plan prepared by the Corps Technical Team. The data collection plan was completed on September 21, 2012. The project is now on hold until funding is in place for the data sampling, which will take at least one year. After the data sampling is completed, evaluation of the data will ensue and a risk assessment will be developed and then remedial actions considered. The original appropriation by Congress in 2007 of $517,000 has been depleted and further work will have to wait until additional funding is secured.

On a separate funding effort, the Flood Control District submitted the remediation of the mercury mine as a project to the Coalition to Support Delta Projects in May of 2012. This Coalition has requested project proponents to submit projects that would benefit Delta water quality, water flows and Delta habitat. It is uncertain how this process will proceed, whether funding will be awarded or when that might occur.

Moving Forward

The mercury mine project has been a perennial item on the Board's legislative platform for the past several years, both as an appropriation and authorization request. The Board has also written letters to Congress from time to time to urge support for the project. The project also enjoys broad support from the surrounding communities, environmental groups and local creek groups.

While our project objective has remained the same over the years, our strategy to achieve it has not. Below are elements of our current strategy, which may need to be changed in the future depending on how things turn out and evolve in this ongoing project.

• Flood Control District Role. Progressing through the Corps planning process, the Flood Control District role has evolved. The Flood Control District has always been interested in cleaning up the mercury mine and enabling a project to achieve that goal. Through the planning process the District has taken on more of a role to clean up mercury downstream of the mine, in the District's Marsh Creek Reservoir. Most of the mercury that flows downstream from the mine site is captured at the reservoir. The District has plans in the future to enlarge the reservoir and at that time can address the accumulation of mercury in the sediment at the bottom of the reservoir. We need to ensure that the Corps planning process provides us the information needed to develop remediation measures for the reservoir, and the Regional Board enforcement action provides as much resources towards the reservoir as possible.

• Responsible Party Funding. The Regional Board needs to complete their enforcement action against the responsible party(s). This will result in a determination of remedial actions to be taken to clean-up the mercury and how much each party will contribute. The Flood Control District may have to assume responsibility for cleaning up the reservoir, which we understand could be accomplished through some sort of a cap of the sediment and could be accommodated as part of a storage enlargement project. The next phase of the planning process will provide the information we need to make the decision whether this approach will be achievable for us or not from a constructability and liability perspective. Depending on how things turn out, we may be able to get some funding from the responsible party(s) to help fund the reservoir remediation measures.

• Continue the Planning Process. We need to work with the Corps to complete the planning process so we have all the information necessary to design a clean-up project that will be acceptable to the community and regulatory agencies.

• Continue Legislative Requests. We need to work with our legislative representatives each year to request federal funding for the Corps' RAMS program to move this project forward. We also need to pursue our request to expand the Corps' authority to allow construction of the clean-up project and reduce the local cost share. This would be accomplished through the Water Resources Development Act.

• Stewardship. The Flood Control District's historic position is to not take ownership of the cleaned up mercury mine site. From the District's perspective, the property owner currently owns the mercury mine and has the ultimate responsibility. If the District is successful in enabling a clean-up project then the property owner should continue to assume ownership as he would be in a much better position than owning the mine in its current condition.

CONSEQUENCE OF NEGATIVE ACTION:

This report and the recommended actions to keep the project moving forward would not be accepted.

CHILDREN'S IMPACT STATEMENT:

Not applicable.