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

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

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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). An initial draft report was submitted to BASMAA in February 2016 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. Minor additional changes have been made to this version of the report in response to SPLWG and TRC review comments.

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, Chris Sommers, Kelly Moran (TDC Environmental), Barbara Mahler (USGS), Dan Cain (USGS) and Richard Looker provided helpful written reviews of this report.

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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, 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 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 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),

[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).

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),
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 high leverage watersheds, source areas, and source properties that are more polluted and located upstream from sensitive Bay margin areas. 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

[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

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 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

[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.

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 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 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.

[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.

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)
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] ranged between 2% and 78% and averaged 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 yet the resulting concentrations were surprisingly low, and therefore warranted re-sampling. 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). Although a matrix of site characteristics for sampling strategic larger watersheds was also developed (Table 2), none of these could be sampled during WY 2015 because climatic conditions for rainfall and flow were not met.

[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).

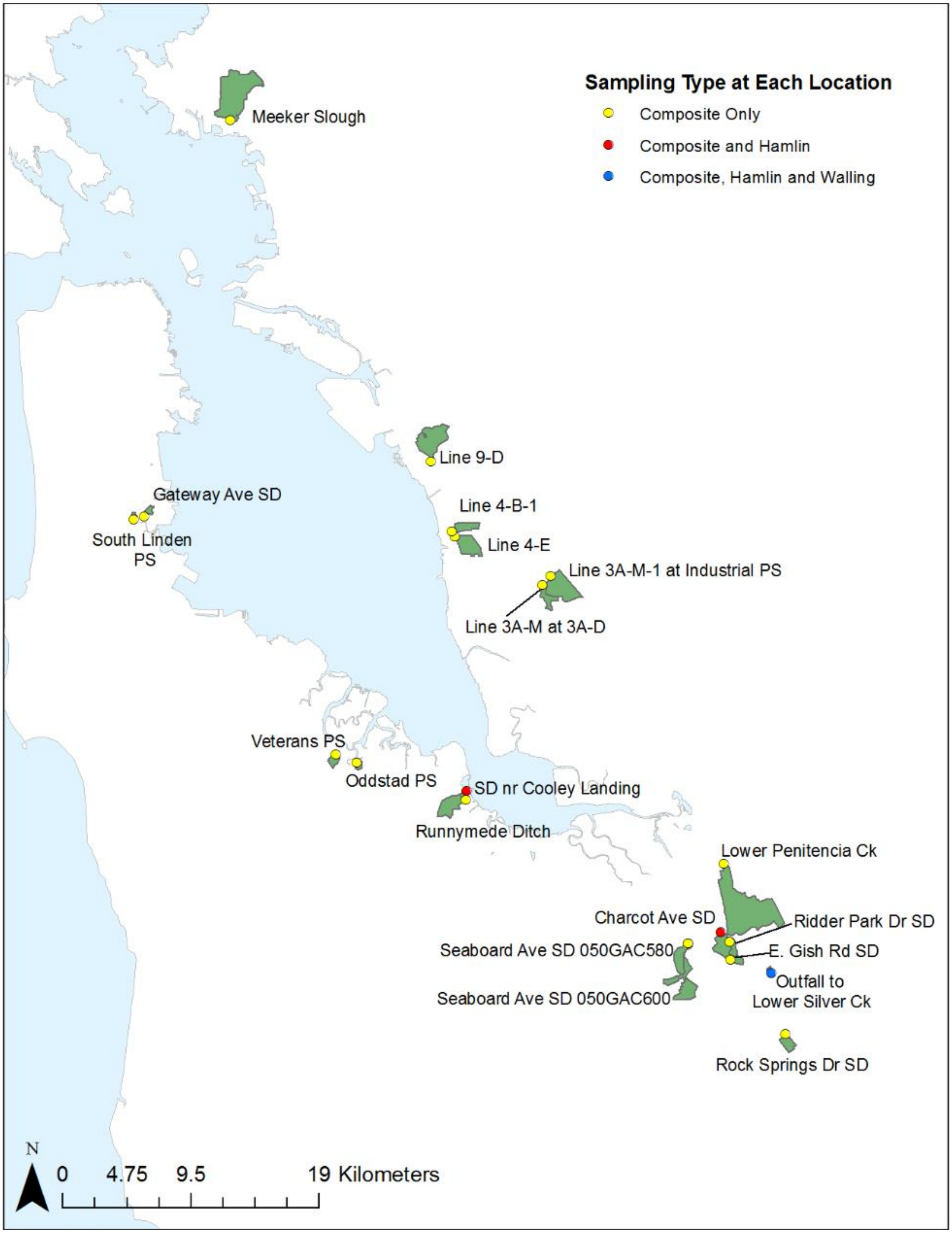

Figure 1. Sampling locations (marked by the dots), watershed boundaries (shown in green) and sampler type (color of the dots).

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 km)**	**Impervious surface (%)**	**Industrial (%)**	**Sampling objective**	**Commentary**	**Proposed sampling triggers**	**Gauge number**	**Area at USGS gauge (sq km)**
Alameda Creek at EBRPD Bridge at Quarry Lakes	913	8.5	2.3	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	906
Dry Creek at Arizona Street (Purposely downstream from historic industrial influences)	25.3	3.5	0.3	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	24.3
San Francisquito Creek at University Avenue (as far down as possible to capture urban influence upstream from tide)	81.8	11.9	0.5	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. Sample pair with Matadero Ck.	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	61.1
Matadero Creek at Waverly Street (purposely downstream from the railroad)	25.3	22.4	3.7	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	18.8
Colma Creek at West Orange Avenue (location strategically downstream from historic industrial influence but still upstream from tide)	27.5	38	0.8	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 are 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	27.5

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.

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 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 long as the minimum volume was reached, was usually adjusted depending upon how rainfall 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 sampling procedures

The Hamlin and Walling tube remote suspended sediment samplers were deployed approximately mid-channel/ storm drain. The Hamlin sampler sat flush, or nearly 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 bottom of the sampler (see Figure 2b). The Walling tube could not be deployed in storm drains due to its size and

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[9] Note, this was relaxed due to a lack of larger storms. Ideally, mobilization would only proceed with a 0.5" forecast.

[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, antecedent dry-weather is 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 more off the bed may be necessary but was not the case in WY 2015.

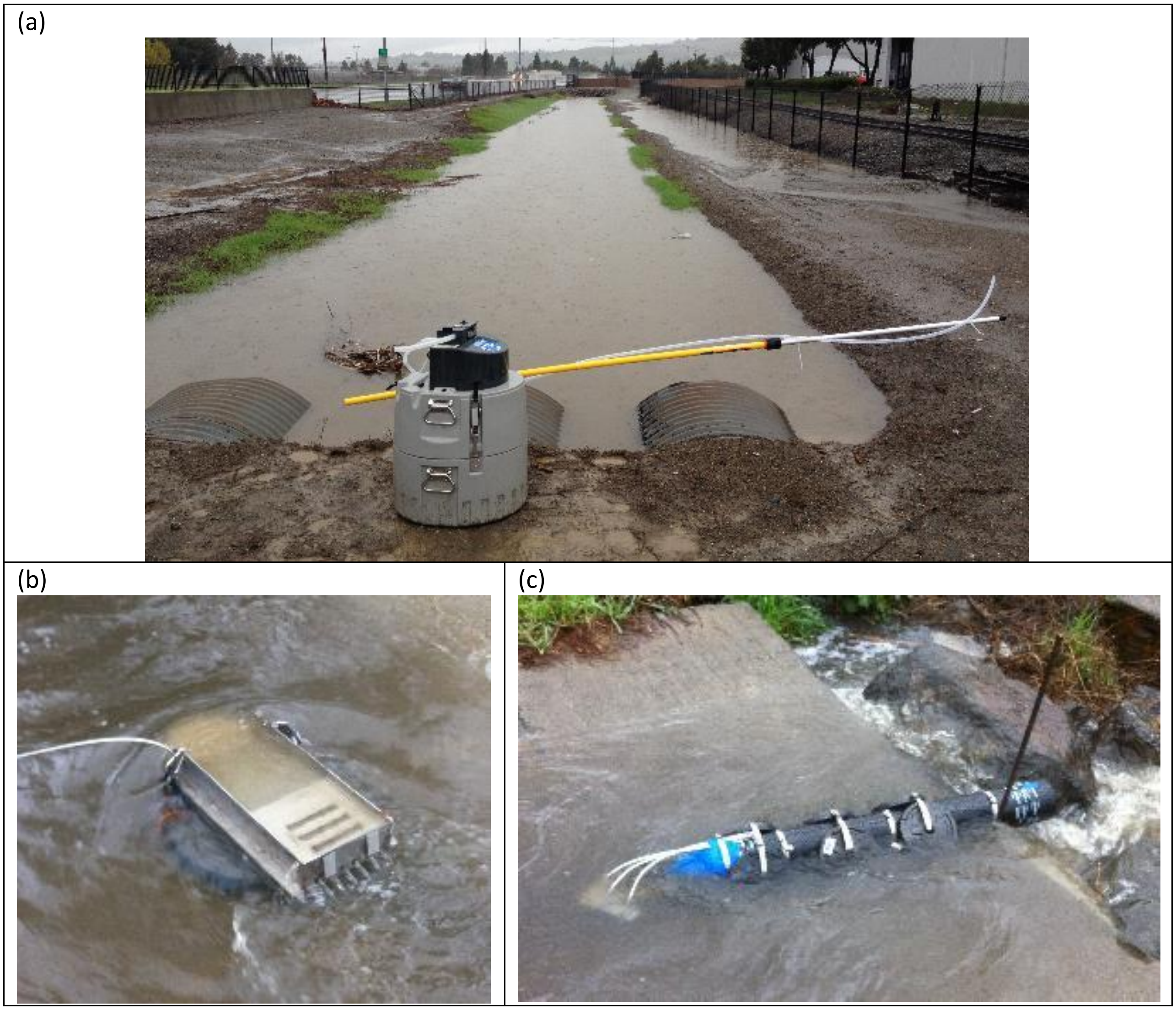

Figure 2. Sampling equipment used in the field. (a) Painters pole, Teflon tubing and an ISCO used as a slave pump; alternatively a Teflon bottle is attached to the end of a painters pole (DH84) and used for sample water collection as opposed to using an ISCO as a pump (b) Hamlin suspended sediment sampler;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

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

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.

The suspended sediment 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 sediment 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 sediment 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 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. While this is not greatly below average, most of this rainfall (11.7 in) fell in a single month (December), resulting in a rainfall year of one wet month and otherwise mostly dry conditions. 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): $$PR\left(\frac{ng}{mg}\right) = \frac{PCB\left(\frac{ng}{L}\right)}{SSC\left(\frac{mg}{L}\right)}$$

These ratios were 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 as measures of central tendency of a dataset. In the Bay Area, the average or median of water concentrations at a site has 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 has 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. Therefore, the most comparable manipulation of previously collected discrete sample data was to sum all of the water concentration samples and divide by the sum of all the suspended sediment concentrations for each 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 report 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.

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

[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.

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 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 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 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.

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 (pg/L)	PCBs Rank	PCBs (ng/g)	PCBs Rank	Total Hg (ng/L)	Total Hg Rank	Total Hg (µg/g)	Total Hg Rank	As (µg/L)	Cd (µg/L)	Cu (µg/L)	Pb (µg/L)	Zn (µg/L)
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

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 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 Pump Station-North (1,050 ng/g) (52% old industrial), Pulgas 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 similar to the upper range of those observed during the WY 2011 sampling campaign (Pulgas 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]

[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 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.

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 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 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.

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.

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

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~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 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

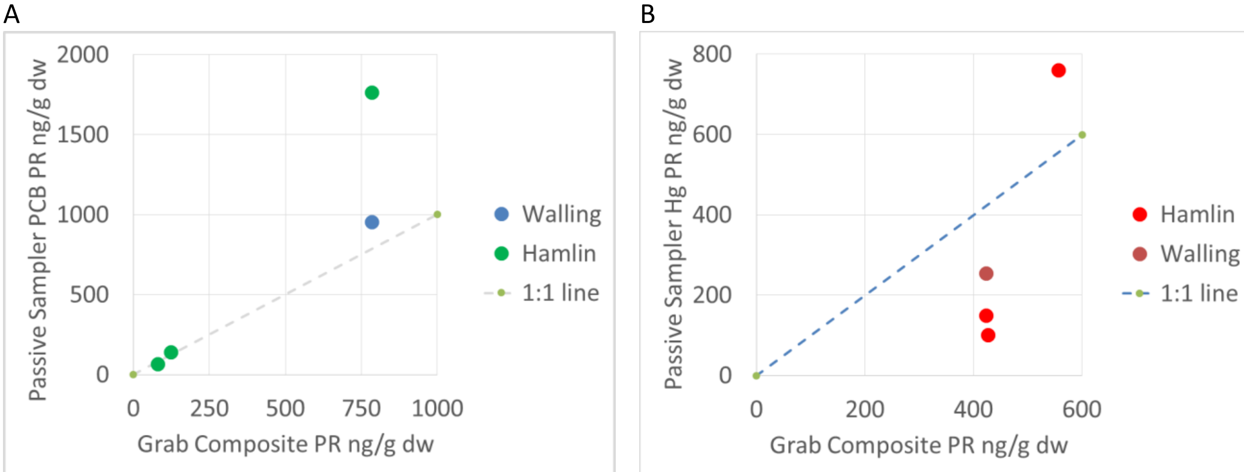

Figure 4. Particle Ratio (PR) comparisons between remote (sediment) versus composite (water) samples for A) PCBs and B) total mercury.

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 a relative ranking or prioritization tool; 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 are the pros and cons of all sampling methods 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 as 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 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).

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 Pump Station-South	San Mateo	2011-2014	0.584	87%	54%	8222	1	447984	1	0.35	23	19	39
Santa Fe Channel	Contra Costa	2011	3.26	69%	3%	1295	2	197923	2	0.57	13	86	7
Pulgas Pump Station-North	San Mateo	2011	0.552	84%	52%	893	3	60320	4	0.40	21	24	36
Outfall to Lower Silver Creek	Santa Clara	2015	0.171	79%	78%	783	4	44643	7	0.42	20	24	37
Ettie Street Pump Station	Alameda	2011	4.03	75%	22%	759	5	58951	5	0.69	9	55	19
Ridder Park Dr Storm Drain	Santa Clara	2015	0.497	72%	57%	488	6	55503	6	0.33	26	37	30
El Cerrito Bioretention Influent	Contra Costa	2011	0.00408	74%	0%	442	NR[a]	37690	NR[a]	0.19	NR[a]	16	NR[a]
Sunnyvale East Channel	Santa Clara	2011	14.5	59%	4%	343	7	96572	3	0.20	34	50	22
Line-3A-M at 3A-D	Alameda	2015	0.881	73%	12%	337	8	24791	11	1.17	4	86	8
North Richmond Pump Station	Contra Costa	2011-2014	1.96	62%	18%	241	9	13226	19	0.81	8	47	23
Seabord Ave Storm Drain SC-050GAC580	Santa Clara	2015	1.35	81%	68%	236	10	19915	14	0.55	15	47	24
Line4-E	Alameda	2015	2.00	81%	27%	219	11	37350	8	0.35	24	59	14
Glen Echo Creek	Alameda	2011	5.45	39%	0%	191	12	31078	9	0.21	33	73	12
Seabord Ave Storm Drain SC-050GAC600	Santa Clara	2015	2.80	62%	18%	186	13	13472	18	0.53	16	38	28
South Linden Pump Station	San Mateo	2015	0.137	83%	22%	182	14	7814	30	0.68	10	29	35
Line 9-D	Alameda	2015	3.59	78%	46%	153	15	10451	22	0.24	29	17	41

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	16	8560	28	1.27	3	76	11
Rock Springs Dr Storm Drain	Santa Clara	2015	0.829	80%	10%	128	17	5252	33	0.93	6	38	29
Charcot Ave Storm Drain	Santa Clara	2015	1.84	79%	24%	123	18	14927	16	0.56	14	67	13
Veterans Pump Station	San Mateo	2015	0.522	67%	7%	121	19	3520	37	0.47	17	14	42
Gateway Ave Storm Drain	San Mateo	2015	0.356	69%	52%	117	20	5244	34	0.44	18	20	38
Guadalupe River at Hwy 101	Santa Clara	2003-2006, 2010, 2012-2014	233	39%	3%	115	21	23736	12	3.60	2	603	1
Runnymede Ditch	San Mateo	2015	2.05	53%	2%	108	22	28549	10	0.19	35	52	21
E. Gish Rd Storm Drain	Santa Clara	2015	0.447	84%	70%	99	23	14365	17	0.59	11	85	9
Line 3A-M-1 at Industrial Pump Station	Alameda	2015	3.44	78%	26%	96	24	8923	24	0.34	25	31	33
Zone 4 Line A	Alameda	2007-2010	4.17	68%	12%	82	25	18442	15	0.17	37	30	34
Storm Drain near Cooley Landing	San Mateo	2015	0.108	73%	39%	79	26	6473	31	0.43	19	35	31
San Leandro Creek	Alameda	2011-2014	8.94	38%	0%	66	27	8614	27	0.86	7	117	5
Oddstad Pump Station	San Mateo	2015	0.280	74%	11%	62	28	9204	23	0.37	22	55	18
Line 4-B-1	Alameda	2015	0.963	85%	28%	57	29	8674	26	0.28	28	43	26
Fremont Osgood Road Bioretention Influent	Alameda	2012, 2013	0.000804	76%	0%	45	NR[a]	2906	NR[a]	0.12	NR[a]	10	NR[a]
Gellert Park Daly City Library Bioretention Influent	San Mateo	2009	0.0153	40%	0%	36	NR[a]	725	NR[a]	1.01	NR[a]	22	NR[a]
Lower Coyote Creek	Santa Clara	2005	327	22%	1%	30	30	4576	35	0.24	30	34	32

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
Calabazas Creek	Santa Clara	2011	50.1	44%	3%	29	31	11493	21	0.15	40	59	15
San Lorenzo Creek	Alameda	2011	125	13%	0%	25	32	12870	20	0.18	36	41	27
Stevens Creek	Santa Clara	2011	26.0	38%	1%	23	33	8160	29	0.22	32	77	10
Guadalupe River at Foxworthy Road/ Almaden Expressway	Santa Clara	2010	107	22%	0%	19	34	3120	38	4.09	1	529	2
Lower Penitencia Creek	Santa Clara	2011, 2015	11.5	65%	2%	16	35	1588	40	0.16	39	17	40
Borel Creek	San Mateo	2011	3.23	31%	0%	15	36	6129	32	0.16	38	58	17
San Tomas Creek	Santa Clara	2011	108	33%	0%	14	37	2825	39	0.28	27	59	16
Zone 5 Line M	Alameda	2011	8.05	34%	5%	13	38	21120	13	0.57	12	505	3
Belmont Creek	San Mateo	2011	7.22	27%	0%	13	39	3599	36	0.22	31	53	20
Walnut Creek	Contra Costa	2011	232	15%	0%	7	40	8830	25	0.07	42	94	6
Lower Marsh Creek	Contra Costa	2011-2014	83.6	10%	0%	3	41	1445	41	0.11	41	44	25
San Pedro Storm Drain	Santa Clara	2006	1.27	72%	16%	No data				1.12	5	160	4

[a]NR = site not included in ranking. These are very small catchments with unique sampling designs for evaluation of green infrastructure.

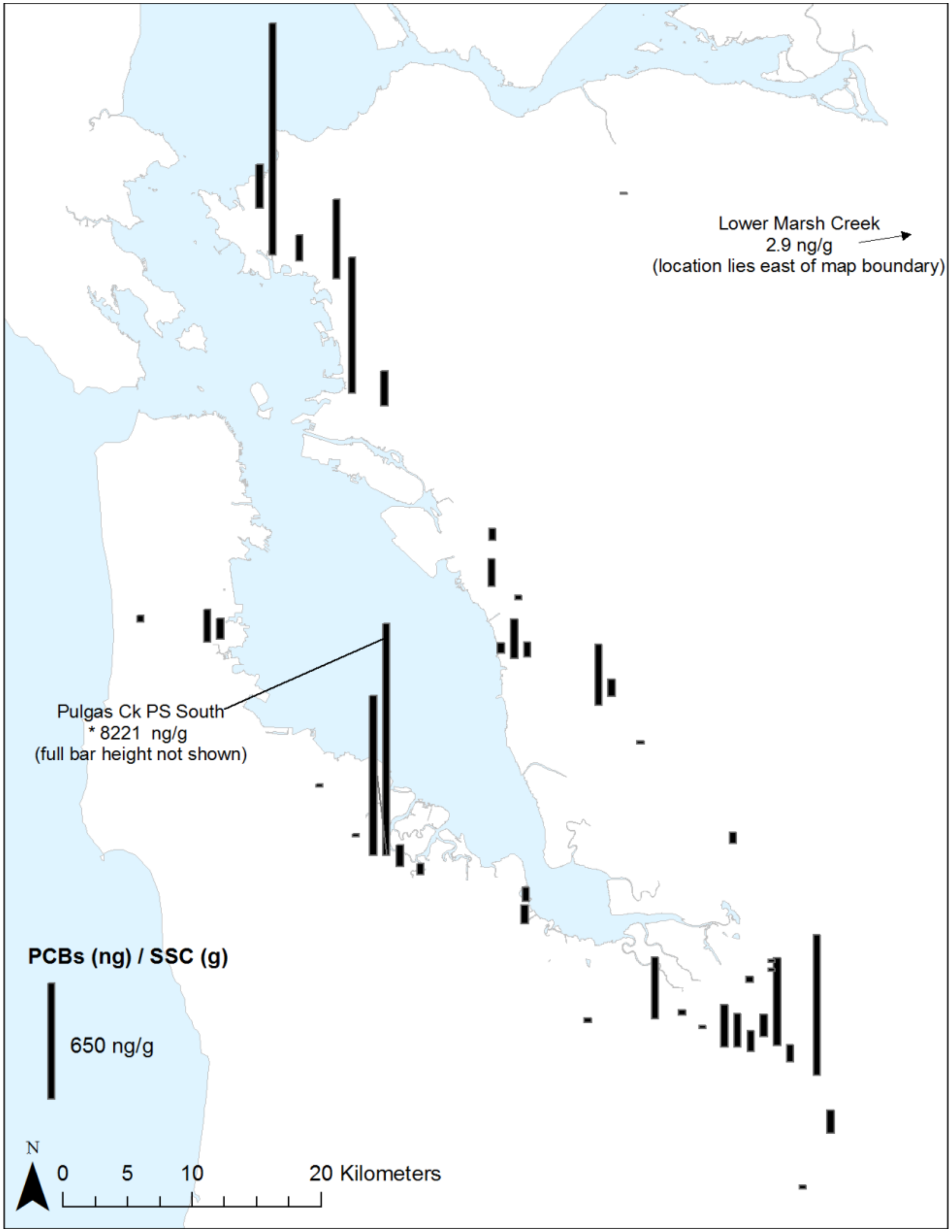

Figure 5. Regional distribution of particle ratios of polychlorinated biphenyl (PCB) in stormwater samples collected to date.

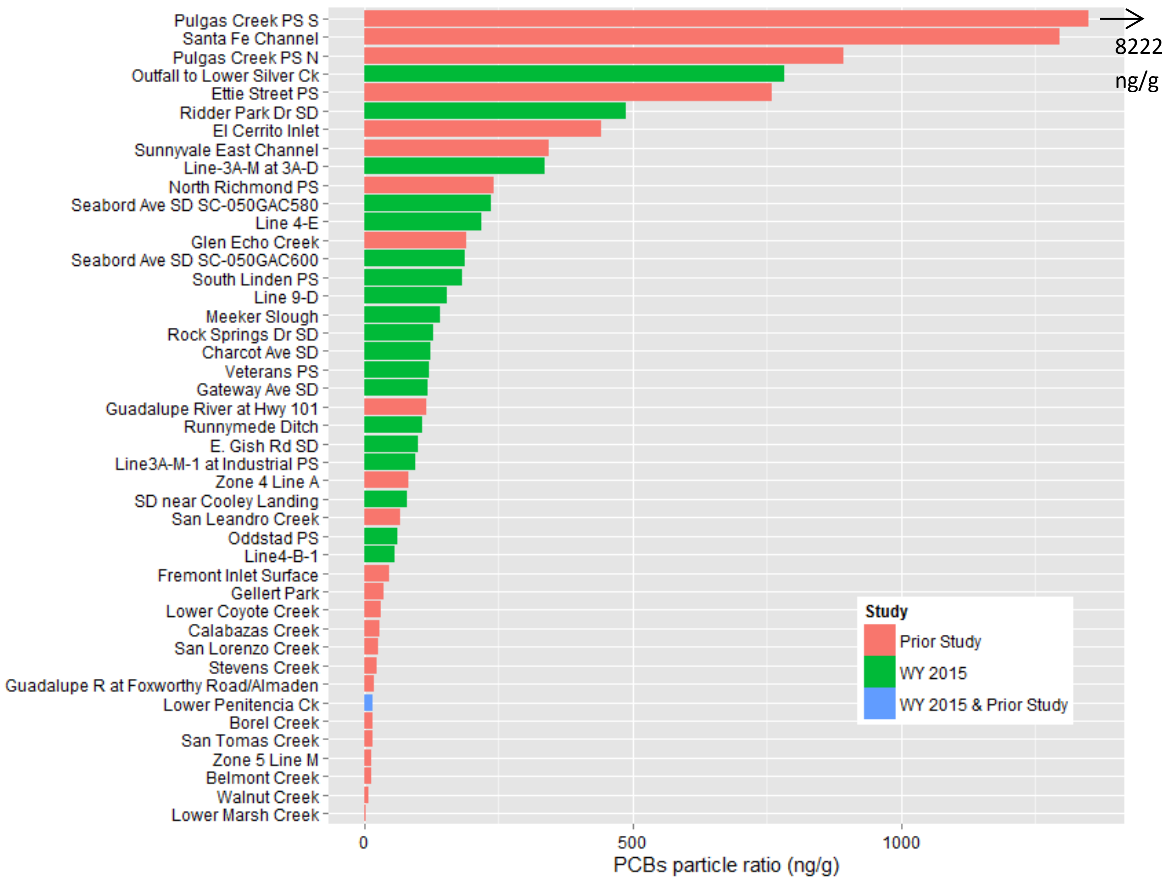

Figure 6. All watershed sampling locations measured to date ranked using PCB particle ratios. Note Pulgas Pump Station-South is beyond the extent of this graph at 8,222 ng/g.

To a large degree, sites that rank high for PCB water concentrations also rank high for particle ratios (Figure 7). This is another affirmation of our conceptual model that atmospheric deposition and 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 Pump Station-South, Santa Fe Channel, Sunnyvale East Channel, Pulgas 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 Pump Station-South, Santa Fe Channel, Pulgas 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 and particle ratios but three of the sites with elevated water concentrations dropped to lower rank for particle ratios 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

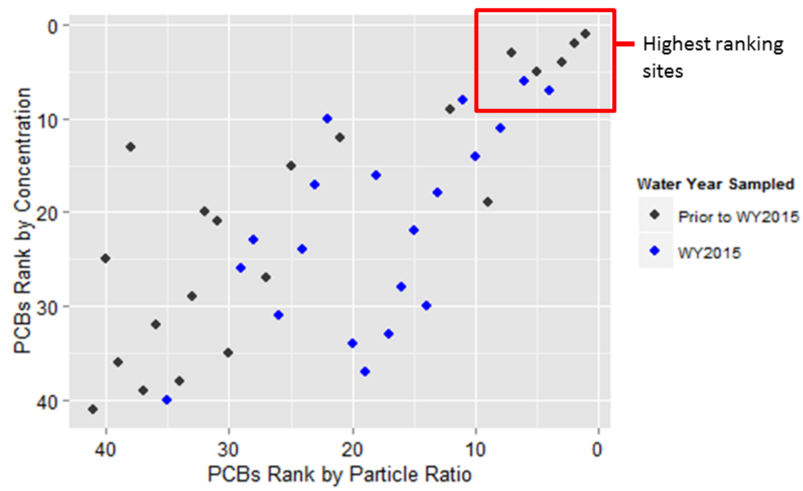

Figure 7. Correlation between site ranking for PCBs based on particle ratios versus water concentrations. 1 = highest rank; 41 = lowest rank.

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 larger and less pervious watersheds. On the other hand, a high ranking for water concentrations and high ranking for particle ratio can indicate that sediment is not the dominant vector for transport and that PCB emulsions are possibly in transport, which is more typical of smaller and more impervious watersheds with sources. 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. These hints can 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 8; Figure 9). 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 4.2 $\mu g/m^2/y$ (Tsai and Hoenicke, 2001) and 4.4 $\mu g/m^2/y$ (Steding and Flegal, 2002) with Tsai and Hoenicke reporting a total (wet + dry) deposition rate of 18-21 $\mu g/m^2/y$. 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 10 most polluted sites (ranked in order from high to lower) would include the Guadalupe River mainstem, Guadalupe River at Foxworthy Road, Zone 5 Line M, San Pedro Storm Drain, San Leandro Creek, Walnut Creek, Santa Fe Channel (the only watershed also ranked in the top 10 for PCB water concentrations (Figure 10)), Line-3A-M at 3A-D, E. Gish Rd SD, and Stevens Creek.

[14] Again the reader is reminded that these regional estimates total suspended sediment loads are subject to change if future interpretations are completed.

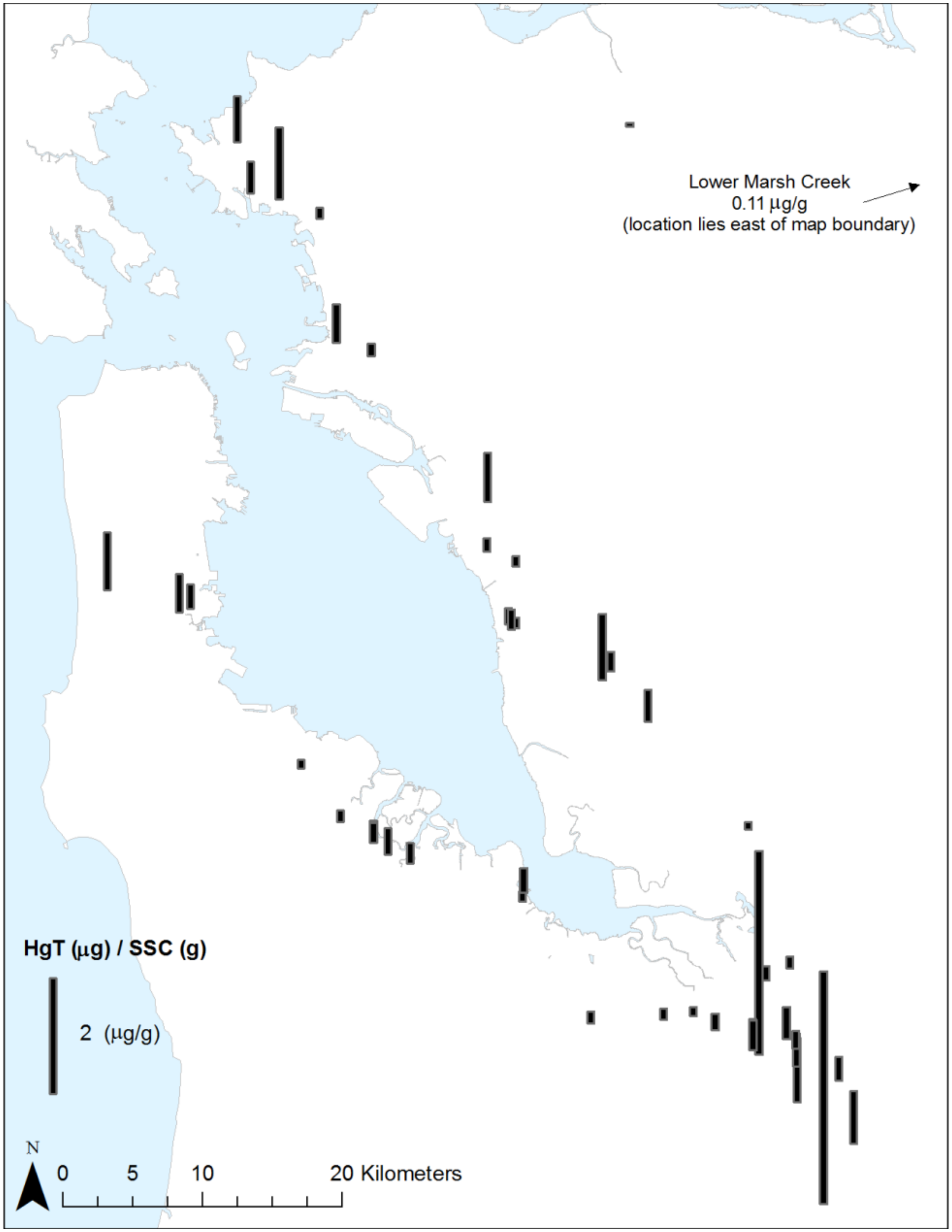

Figure 8. Regional distribution of sites and particle ratios of total mercury (HgT) in stormwater samples collected to date.

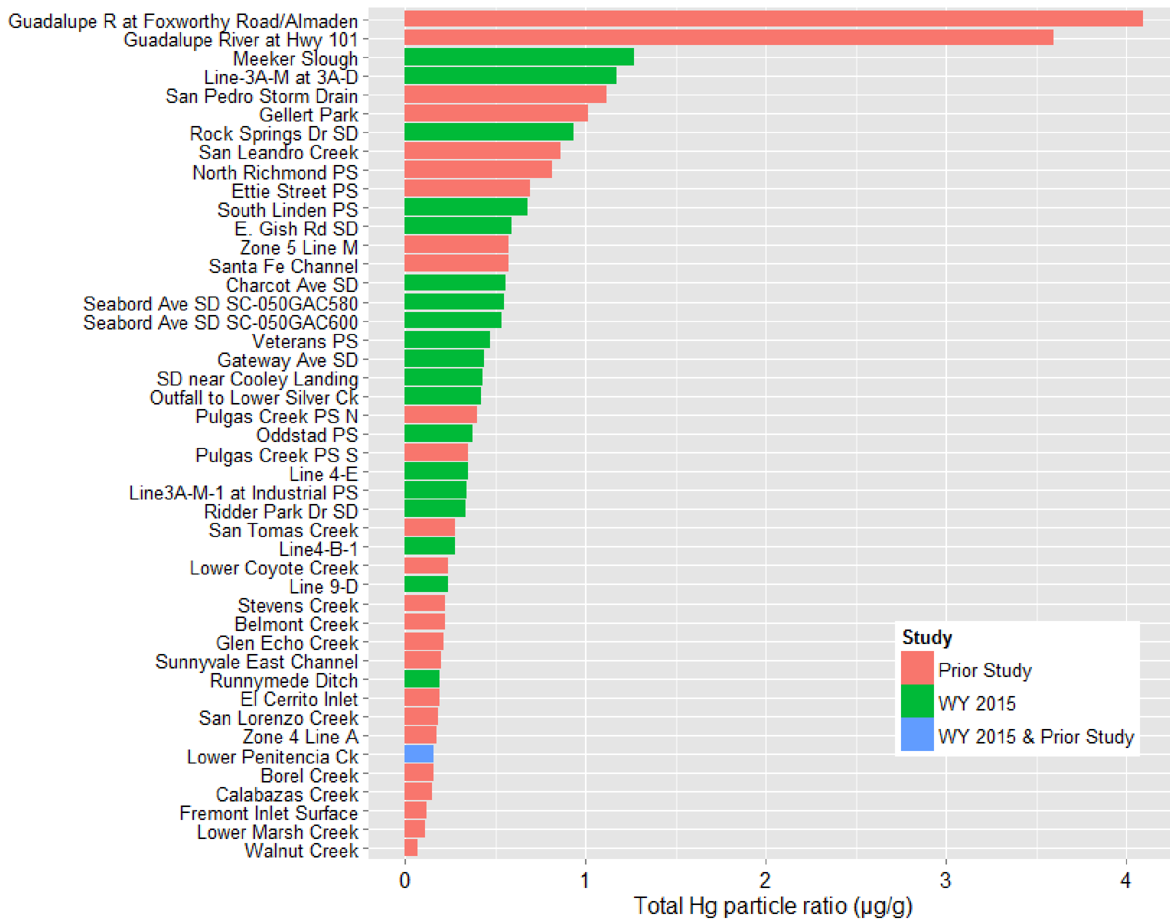

Figure 9. All watershed sampling locations measured to data ranked using total mercury (HgT) particle ratios.

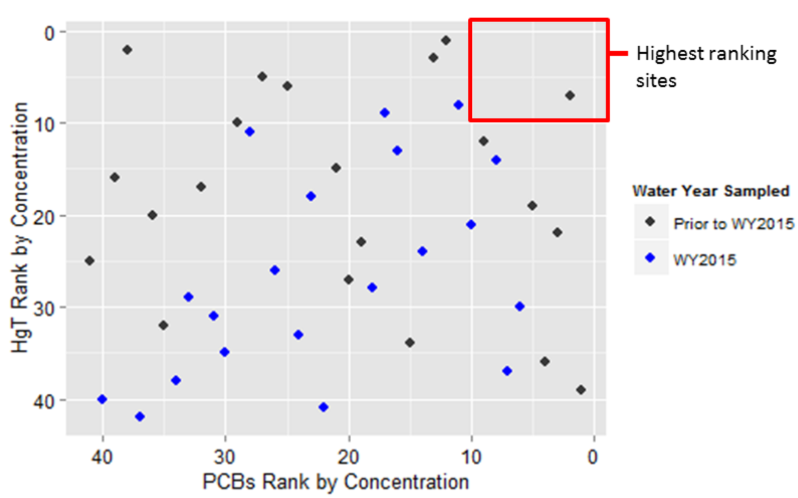

Figure 10. Relationship between site rankings for PCB water concentrations versus HgT water concentrations. 1 = highest rank; 41 = lowest rank. Only one watershed (Santa Fe Channel) ranks in the top 10 for both PCBs and HgT, while nine watersheds rank in the top 20 for both pollutants.

Unlike for PCBs, sites ranking high for HgT concentration are not necessarily ranked high for particle ratio. 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 (Figure 11). The best example of this is Walnut Creek that was ranked 5th highest in terms of stormwater composite averaged concentrations but lowest (42nd out of 42 ranked 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, Rock Springs Dr Storm Drain, San Leandro Creek, North Richmond Pump Station, Ettie Street Pump Station, and South Linden Pump Station (Table 8; Figure 9). Management in these watersheds might be most cost effective for HgT. The Daly City library bioretention demonstration project (at Gellert Park) 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 concerns about methylmercury production (David et al., 2015). Three of these top 10 locations were also identified as elevated for PCB particle ratios (Ettie Street Pump Station, Line-3A-M at 3A-D, North Richmond Pump Station (Figure 12)) 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.

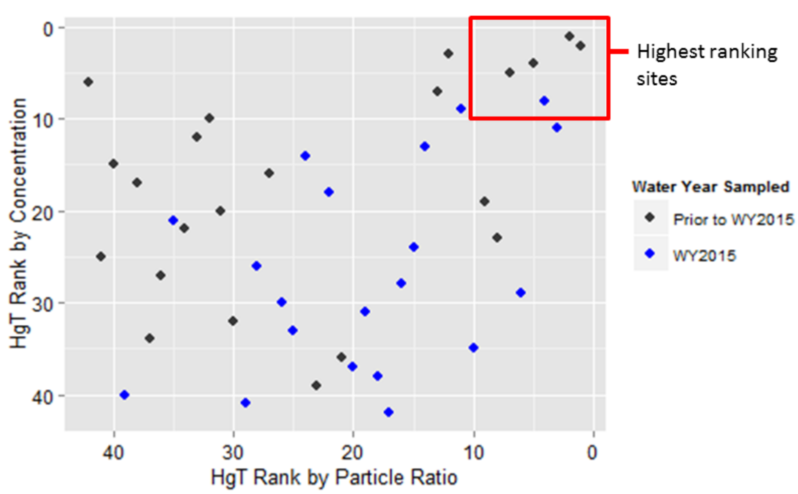

Figure 11. Relationship between sites ranking for HgT based on particle ratios versus water concentrations. 1 = highest rank; 42 = lowest rank.

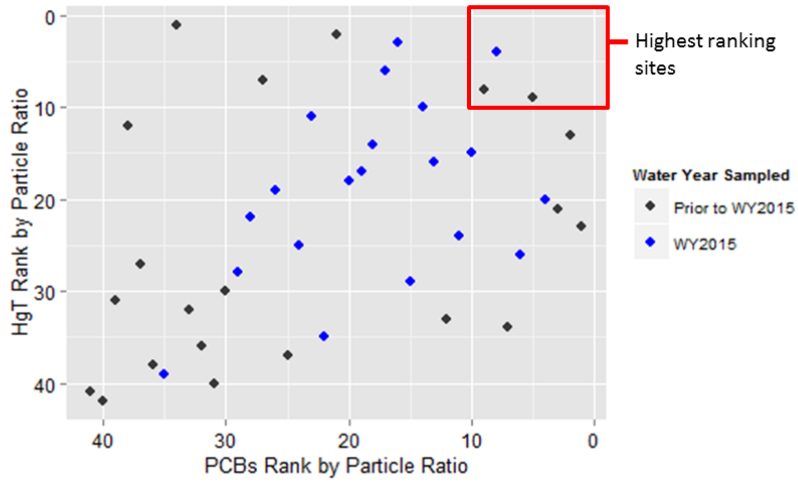

Figure 12. Relationship between site rankings for PCB particle ratios versus HgT particle ratios. 1 = highest rank; 41 = lowest rank. Three watersheds rank in the top 10 for both PCBs and HgT, while 13 watersheds rank in the top 20 for both pollutants.

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 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

[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 sources 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

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 weakly or inversely correlate with impervious cover and old industrial land use[16]. 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 surrogate investigative tool 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 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

[16] Copper and Zinc weakly positively correlate with impervious cover likely due to sources in tires and breakpads but due to general atmospheric circulation sources, it is likely that erosion of soils in rural and open space areas also contributes. This could be tested in the future by reanalyzing a subset of the data that excludes these mixed land use watersheds. Lead, after use bas in the 1970s have been trending down in the urban environment and is likely today more associated with atmospheric deposition and general soil erosion. We have no hypothesis as to why Arsenic particle ratios inversely correlate with impervious cover. Further investigation of these ideas could be completed in the next technical report.

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.

Summary and Recommendations

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

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 composite parameter that would not influence the calibration but would influence the regional loads estimates and the relative watershed rankings that result.
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	

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, 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 sampler trial 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 area 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.
- In the next progress report, complete and present a thorough reanalysis of the statistical potential of the composite, single storm sampling design to return false negative (low or moderate) results. Make

recommendations for a procedure to select and resample sites that return lower than expected concentrations or particle ratios.

- Although conceivably cheaper and logistically easier to deploy, preliminary results from the remote sampler pilot study suggest that results are overall less versatile and more challenging to interpret. That said, we recommend continuation of the trial for 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.
- Although the Spearman rank analysis did not support the use of other trace metals as good indicators of PCB or Hg sources, the analysis revealed positive and negative correlations that were perplexing and encouraging of further investigation. Why do copper and Zinc particle ratios weakly positively correlate with impervious cover and why do lead and arsenic particle ratios inversely correlate with impervious cover? Further investigation should be completed in the next technical report.

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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