2011 Annual Monitoring Results

A REPORT OF THE REGIONAL MONITORING PROGRAM FOR WATER QUALITY IN THE SAN FRANCISCO ESTUARY

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1) Introduction

Program Structure and Objectives

The Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP) is the primary source for long-term contaminant monitoring information for the Estuary. The RMP is an innovative and collaborative effort among the scientific community, the San Francisco Bay Regional Water Quality Control Board (Water Board), and the regulated discharger/dredging community. The Program was initiated by the Water Board as a pilot study in 1989 and has been collecting water, sediment, and bivalve tissue data since 1993. The RMP's annual budget is currently approximately $3.4 million, which is primarily funded through wastewater discharge and dredging permits issued by the Water Board (refer to **Appendix 1** for a current list of Program participants). The Status and Trends portion of the program includes long-term monitoring of the San Francisco Bay, while Special Studies change annually in response to changing management priorities and stakeholder needs.

The RMP is overseen by the Technical Review Committee (TRC), the Steering Committee (SC) and five workgroups, which consist of technical representatives from the Regional Board and discharger groups, scientists who are currently studying the Bay, invited scientists who are internationally recognized experts in their field, and federal and state regulators. The TRC oversees the activities of the workgroups and the technical content of the RMP as a whole. The SC determines the overall budget, allocation of program funds, tracks progress, and provides direction to the Program from a manager's perspective. The five workgroups, the Sources, Pathways and Loadings Workgroup, the Exposure and Effects Workgroup, the Contaminant Fate Workgroup, the Emerging Contaminants Workgroup, and the Sport Fish Workgroup directly guide planning and implementation of Special Studies and provide input on relevant aspects of the annual RMP Status and Trends monitoring. These workgroups meet typically one to two times per year to review progress and make recommendations. In 2009, strategy documents and long-term work plans were developed that articulated the priority questions to be answered and the longer-term information needs. Strategy documents have been developed for a number of topics including: small tributaries, modeling, mercury, polychlorinated biphenyls (PCBs), dioxins and nutrients. RMP workgroups have also developed long-term plans for studies of emerging contaminants and contaminant exposure and effects. These strategy documents and work plans lay the foundation for future environmental monitoring. These information needs and priorities have been summarized in the RMP Multi Year Plan.

The RMP management questions were revised in 2007 as part of the RMP's Five-year Program review process and refined and approved by the TRC and SC in 2008. The current Program uses the following management questions to guide changes in the Status and Trends monitoring elements and to prioritize which special studies to fund:

1. Are chemical concentrations in the Estuary at levels of potential concern and are associated impacts likely?

    a. Which chemicals have the potential to impact humans and aquatic life and should be monitored?

    b. What potential for impacts on humans and aquatic life exists due to contaminants in the Estuary ecosystem?

    c. What are appropriate guidelines for protection of beneficial uses?

    d. What contaminants are responsible for observed toxic responses?

2. What are the concentrations and masses of contaminants in the Estuary and its segments?

    a. Do spatial patterns and long-term trends indicate particular regions of concern?

3. What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary?

    a. Which sources, pathways, and processes contribute most to impacts?

    b. What are the best opportunities for management intervention for the most important contaminant sources, pathways, and processes?

    c. What are the effects of management actions on loads from the most important sources, pathways, and processes?

4. Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased?

    a. What are the effects of management actions on the concentrations and mass of contaminants in the Estuary?

    b. What are the effects of management actions on the potential for adverse impacts on humans and aquatic life due to Bay contamination?

5. What are the projected concentrations, masses, and associated impacts of contaminants in the Estuary?

    a. What patterns of exposure are forecast for major segments of the Estuary under various management scenarios?

    b. Which contaminants are predicted to increase and potentially cause impacts in the Estuary?

Status and Trends monitoring characterizes water and sediment quality and contaminants in water, sediment, and biota in the Estuary. The Water Board uses Status and Trends data for regulatory purposes, such as evaluating the Estuary for 303(d) listing of water bodies, calculating National Pollutant Discharge Elimination System (NPDES) permit conditions, estimating Total Maximum Daily Loads (TMDL), and evaluating whether management actions are successful in reducing contaminant loads to the Estuary through modeling. For questions regarding the RMP Status and Trends contact Meg Sedlak, meg@sfei.org.

Status and Trends monitoring includes water, sediment, bivalves, sport fish, and bird eggs. In 2011, the results, questions posed and frequency of sampling for the water, sediment and bivalve components of the Program were evaluated. Based on this review, the SC and TRC recommended that the frequency of sediment sampling be reduced to a biennial event and water sampling be reduced to a biennial event for inorganics and every four years for organics. The monitoring will be staggered so for any given year the RMP will be on the water collecting some matrix. The revised Status and Trends monitoring design was implemented in 2012, therefore both water and sediment monitoring occurred in 2011. A more detailed description of the latest Status and Trends monitoring design is presented below.

- Water monitoring occurs biennially during the dry season for analysis of water quality, trace metals, trace organics and ancillary parameters. Water toxicity is monitored on a five-year cycle and was last conducted in 2011. For details on the 2011 water sampling event see the Water Chapter or visit the Status and Trends web page.
- Sediment monitoring occurs biennially in alternating wet (winter) and dry (late summer) seasons for the analysis of trace metals, trace organics, sediment toxicity, benthic invertebrates and ancillary parameters. A reduced number of stations (27) are sampled in the wet season while 47 stations are sampled in the dry season. For details on the 2011 sediment sampling event see the Sediment Chapter or visit the Status and Trends web page.
- The RMP's bivalve bioaccumulation monitoring effort augments the long-term monitoring effort started by the State Mussel Watch Program. The current monitoring design includes the analysis of trace organics biennially and trace elements every 5 years. Bivalves were last analyzed for both trace element and trace organic parameters in 2008. Trace organics concentrations were most recently measured in bivalves in 2012. For more information refer to the Bivalve chapter or visit the Status and Trends web page.
- Benthic community assessments were added to the RMP Status and Trends program in 2008 as part of the State's Sediment Quality Objectives (SQO) methodology. The SQO methodology evaluates sediment quality using a triad approach with three lines of evidence (i.e., benthos, sediment chemistry and sediment toxicity) to conduct sediment assessments. Benthos samples and sediment toxicity samples are collected during scheduled RMP sediment sampling events at 27 sites (20 random sites and 7 historic sites).
- The Sport Fish Contamination Study screens fish tissue for contaminants of concern to human health. Sport Fish sampling will be conducted on a five-year basis. Sport fish sampling includes evaluation of key fish species for long-term trend assessment, combined with follow-up sampling of additional species. The 2009 RMP sport fish sampling was part of a two-year statewide evaluation of bioaccumulation in sport fish along the entire coast of California by the State Water Board's Surface Water Ambient Monitoring Program (SWAMP). Year 1 of the program focused on the Southern California Bight and the northern California coast near San Francisco Bay; Year 2 focused on the central coast and remaining locations along the northern California coast. Findings are published in the report: Contaminants in Fish from the California Coast, 2009-2010: Summary Report on a Two-Year Screening Survey. A similar sampling design to that used by the RMP for sampling the San Francisco Bay will be used for the entire State, allowing comparison of RMP data to results for similar species across California. The results from sampling popular sport fish species for mercury, PCBs, organochlorine pesticides, and PBDEs in 1994, 1997, 2000, 2003, 2006, and 2009 at several fishing locations are available via the Contaminant Data Display Download tool available via the RMP web site For more information visit the Sport Fish Monitoring Report page.
- The United States Geologic Survey (USGS) has collaborated with the RMP since the beginning of the Program. During 2011, it continued to supplement RMP monitoring with two on-going studies that address basic hydrographic and sediment transport processes. The Hydrography and Phytoplankton study collects monthly water quality measurements in the Estuary's deep channels from the Lower South Bay to the confluence of the Sacramento and San Joaquin Rivers. Details on this study can be found on our web site. For more information refer to the 2006 Pulse of the Estuary article What is Causing the Phytoplankton Increase in San Francisco Bay? and the *2009 Pulse of the Estuary* article

Recent Trends of Phytoplankton Increases in San Francisco Bay as well as presentations from the 2011 Nutrient Workshop. The 2011 Pulse of the Estuary featured the article A Growing Concern: Potential Effects of Nutrients on Bay Phytoplankton.

The Sediment Dynamics in San Francisco Bay study examines the role of several physical factors controlling suspended sediment concentrations in the Estuary for a variety of hydrologic, tidal, and wind conditions and generates time series measurements for calibration and validation of sediment transport models. Time series measurements of suspended sediment concentrations are collected at six sites using optical backscatter sensors deployed at mid-depth and near the bottom. Details on this study can be found on our web page Factors Controlling Suspended Sediment in San Francisco Bay. For more information refer to the *2003 Pulse of the Estuary* article Sediment Dynamics Drive Contaminant Dynamics and the *2009 Pulse of the Estuary* article Suspended Sediment in the Bay: Past a Tipping Point.

- Triennial bird egg monitoring (cormorant and tern) was most recently conducted in 2012. This element of the Status and Trends Program will help us understand spatial patterns of contaminant uptake into the food web and trends in biota over time. Cormorant and tern bird egg monitoring was included as part of the Status and Trends Program in 2008, with triennial sampling beginning in 2009. Cormorant eggs were analyzed for mercury, selenium, PBDEs, perfluorinated compounds, PCBs, and pesticides. Tern eggs were analyzed for mercury, selenium and PBDEs. Analysis of dioxin in bird eggs was completed in 2012.

In addition to these elements, various Special Studies are conducted annually. Each year Special Studies on select topics are vetted by the respective work groups, reviewed by the TRC and approved by the SC. The studies fill information gaps, address management needs, and further o0ur understanding of the Bay. Special Studies conducted by the RMP in 2011 are discussed later in this chapter. A summary of previous studies conducted by the RMP can be found by reading previous publications of the Annual Monitoring Results report. Specific details on the study development and selection processes can be accessed via the Selection Process web page.

The RMP synthesizes and distributes the results of our monitoring efforts and studies through conferences, workshops, work groups, literature reviews, technical reports, newsletters, and the *Pulse of the Estuary*. This Annual Monitoring Results report focuses on the Status and Trends Program. The RMP publishes separate technical reports, which are available on the web at RMP Documents and Reports. For more information on the RMP, refer to the RMP home page.

Changes to the Status and Trends Program

There have been numerous changes over the years to the RMP in order to better address management questions and to adapt to changing regulatory and scientific information needs. **Table 1.1** lists changes to the program during 2011 including changes to the sampling design, sampling target parameters, availability of data, sampling stations, laboratories conducting analyses, and laboratory methods. A table of changes to the RMP since 1993 can be found in **Appendix 8**. Tables of reported analytes by matrix for the long-term Status and Trends monitoring of water, sediment, and bivalve tissue beginning in 1993 can be found in **Appendices 5-7**.

Summary of Changes to the Sampling Design for Water and Sediment

2011 was the ninth year of the probabilistic sampling design for long-term water and sediment monitoring, which employs the EPA's Generalized Random Tessellation Stratified (GRTS) sample design (Stevens, 1997; Stevens and Olsen, 1999; Stevens and Olsen, 2000). This type of design is more appropriate for addressing the RMP's overarching goals to collect data and communicate information about water quality in the San Francisco Estuary in support of management decisions. An important advantage of random station selection is that estimates of regional condition derived from a probabilistic survey will have a known level of uncertainty associated with them. Prior to 2003, a targeted sampling design was used. The targeted stations were purposefully located along the central axis of the Estuary as far from anthropogenic sources as possible to monitor 'background' concentrations of pollutants of concern. A subset of those historic water and sediment stations were retained from the original RMP monitoring design, established in 1993, to provide continuity in the long-term monitoring program.

Table 1.1. Summary of Changes for the RMP Status and Trends Program, 2011

Action Codes: A= Analyte added or removed from sampling design; D= Data rejected or not available/data comparability issues; L= Change in laboratory conducting analysis or in laboratory methods; P= Change in program/sampling design; S= Station added or removed; T= Trends analysis performed.

Action Code	Year	Action	Detail/Rationale
A	**2011**	Range dropped from grainsize parameter names and is now stored in fraction field.	Changed as part of effort to incorporate SWAMP comparability to SFEI data reporting.
A	**2011**	Sediment toxicity test organisms changed at select sites.	The TWG and EEWG recently decided to change the test organisms at the fresh water river sites to Hyalella and Ceriodaphnia for 2011. Prior years used Eohaustorius and Mytilus.
A	**2011**	Three sums of PCBs: 40, 208, 209 will be reported through the Web Query Tool.	Three sums of PCBs: RMP 40, 208, 209 for all matrices and all studies. Sum of 209 PCBs is provided solely for comparison to other studies that use this statistic. SFEI does not recommend using this sum for comparison to any Aroclor-based thresholds (the TMDL target, OEHHA thresholds, etc.) - the Sum of 208 PCBs is better for that purpose because the sum of 208 does not include PCB 11.
D	**2011**	SWAMP has changed the definition of LCS Sample Type. The new definition indicates that LCS samples have gone through the entire QA process.	SWAMP has provided a new definition for samples that have not gone through the entire QA process. The new sample type cod e is 'UnkAcc' – Control Sample used to assess accuracy, unknown whether or not taken through the full analytical process. We will not go back and update the database for samples previously called LCS since we do not always know whether the samples have gone through the entire analytical process but in future data sets we will use the code 'UnkAcc'.
D	2011	Updated coelution flag for PCB 156(Surrogate) to DO156L. In previous years, the flag DO156 was reported.	The L indicates that it is a labeled compound. Including the 'L' in the coelution flag increases accuracy.
L	2011	Beginning in 2011, the MDLs from EBMUD for sediment trace organics are all 40CFRs.	EBMUD wanted to provide consistent MDLs between analytes.
P	2011	The name of the Web Query Tool (WQT) changed to Contaminant Data Download and Display (CD3).	This name is more descriptive and is more representative of what the SFEI data query tool does.
D	2011	Cyanide results are not available for SB061W	The sample was not analyzed due to hold time violations.

The RMP water and sediment monitoring stations are located in six hydrographic regions of the Estuary. Random design stations are located in five of those regions: Suisun Bay, San Pablo Bay, Central Bay, South Bay, and Lower South Bay. Historic stations are also located in each of those five regions, and additionally at the confluence of the Sacramento and San Joaquin Rivers in the freshwater Rivers region of the Estuary. The sampling frames for water and sediment monitoring (the area within which stations were allocated), are the three-foot and one-foot contours of the Estuary at mean lower low water, respectively (based on NOAA's NAD-83 bathymetry coverage). About seventy-two random water and sediment stations were allocated into the hydrographic regions. Each year, a subset of the water stations are sampled in sequential order, increasing the spatial density of monitoring over time. For sediment, a station re-visit schedule was incorporated into the design to better evaluate trends over time.

The number of random design sites sampled in each region can change based on management decisions. The initial number of sites sampled in 2002 was based on a power analysis using existing, targeted site data and Water Board management priorities. A power analysis is generally used to evaluate the number of samples needed to detect a change in contaminant concentrations over time with a known level of statistical confidence. The initial random design recommended that 26 water and 40 sediment sites be monitored while maintaining a subset of 5 historic water sites and 7 historic sediment sites (a total of 31 water and 47 sediment sites). A second power analysis was conducted in 2006 using the random design data (Melwani *et al*. 2008). Based on those results for key contaminants of current concern and discussions with the RMP oversight committees, which include Water Board staff, the number of water sites was reduced from 31 sites to 22 sites per year beginning in 2007, while the number of sediment sites was maintained at 47 sites per year.

In 2007/2008, a new redesign review was undertaken by the TRC. After a statistical review and consultation with the RMP participants, the RMP decided to add wet weather sediment sampling back into the Status and Trends program and recommended that wet weather sediment sampling alternates with dry weather sampling. The addition of wet weather sampling (typically done in February) will provide monitoring of contaminants that have higher ambient concentrations during the winter when runoff increases. Dry season sampling continues to include eight random sites per region (n = 40). Wet season sampling will include four random sites per region (n = 20). Sampling of the historic stations will not change, and samples from these sites will continue to be collected during each sampling event (maintaining one station per region plus the two Rivers stations (n = 7)). This change was first implemented in August/September 2009 (a dry season sampling year). The change in design necessitated an update from a five-year repeat sampling cycle to a six-year repeat sampling cycle to allow for balanced alternating season sampling. See the Memorandum on our web page for more details. Sites sampled in 2011 are listed in **Appendix 3** for water and sediment sampling.

For more information on the Status and Trends monitoring design, refer to the following articles and technical reports: Power Analysis and Optimization of the RMP Status and Trends Program (Melwani *et al*., 2008), Re-design Process of the San Francisco Regional Monitoring Program for Trace Substances (RMP) Status and Trends Monitoring Component for Water and Sediment (Lowe *et al*., 2005), and the 2000 Pulse of the Estuary.

Summary of Changes to the Sampling Design for Bivalve Bioaccumulation Monitoring

The RMP's bivalve bioaccumulation monitoring effort augments the long-term monitoring effort started by the State Mussel Watch Program. The current monitoring design includes the analysis of trace organics in bivalves biennially, and the analysis of trace metals about every 5 years. In 2008 bivalves were analyzed for both trace metals and trace organic contaminants. In 2012, bivalves were only analyzed for trace organic contaminants. Bivalve sampling will next occur in 2014 for organic and inorganic contaminants.

The bivalve bioaccumulation sample design remains a fixed sample design because deployment of caged bivalves requires secure moorings. Based on the findings from a series of special studies between 2000 – 2005 intended to redesign and improve technical aspects of the deployed bivalve bioaccumulation monitoring component of the RMP, several changes were made. These included:

1. Dropping three sites in the northern Estuary: Napa River (BD50) , Petaluma River (BD15) , and Horseshoe Bay (BC21) because only two to three sites were required per region to track long-term changes in contaminant concentrations.

2. Deploying only one bivalve species (*Mytilus californianus*). Because of the reduced salinity range of the study area due to the dropped sites, the program was able to deploy one, fairly salinity tolerant bivalve species, which makes comparing bioaccumulation results between regions possible.

3. Deploying bivalves in cages, rather than mesh bags, reduces the loss of organisms through predation.

4. Discontinuing the bivalve maintenance cruise. This was discontinued in 2006 after a study conducted from 2002-2005 showed no significant difference in survival of bivalves in maintained and non-maintained cages.

Changes in Parameter Reporting

During 2010, the RMP began reporting results for all 209 PCB congeners. SFEI generated Sums for 40, 208, 209 PCBs are available through the RMP web tool, Contaminant Data Display and Download (CD3). The Sum of 40 PCBs include the 40 historic target PCBs for the RMP. The Sum of 208 PCBs provides an index of the PCBs present in Aroclor mixtures. PCB 11 is excluded; it is abundant in some matrices but is derived from pigments and not Aroclors. PCB 11 does not have dioxin-like potency and has different sources than Aroclors. The Sum of 209 PCBs is provided solely for comparison to other studies that include all 209 congeners. SFEI does not recommend using this sum for comparison to any Aroclor-based thresholds (the TMDL target, OEHHA thresholds, etc.) - the Sum of 208 PCBs is better for that purpose.

RMP Workgroups

Five workgroups address the major technical subject areas covered by the RMP. Workgroups consist of scientists, regulators, stakeholders and nationally recognized experts who serve to advise the workgroups. The workgroups directly guide planning and implementation of Pilot and Special Studies and provide input on relevant aspects of the annual RMP Status and Trends monitoring.

Sources Pathways and Loadings Work Group

The Sources Pathways and Loadings work group (SPLWG) was formed in 1999 to address the objective developed during the 1997 five-year program review to "describe general sources and loadings of contamination to the Estuary" (Bernstein and O'Connor, 1997). The SPLWG makes recommendations for collection, interpretation, and synthesis of data on general sources and loadings of trace contaminants to the Estuary. Their goal is to create a functional connection between the RMP and efforts to identify, eliminate, and prevent sources of pollution to the Bay. The SPLWG ensures that RMP projects and products are relevant and help to answer developing management questions in the context of Total Maximum Daily Loads (TMDLs) and attainment of water quality standards. For further information, see the SPLWG web page.

Contaminant Fate Work Group

The Contaminant Fate Workgroup's (CFWG) objective is to improve our understanding of physical, chemical, and biological processes that redistribute and transform contaminants in the Estuary, ultimately leading to exposure of biota. Through improved information on Estuary processes, the work group aims to assist managers in directing limited resources and prioritizing actions for reducing negative impacts, both for new contaminants entering the system, as well as for legacy pollutants already in the Estuary. See the CFWG web page for further information.

Exposure and Effects Work Group

The Exposure and Effects Work Group (EEWG) developed a five-year biological effects pilot study (the Exposure and Effects Pilot Study (EEPS)) that would help address beneficial use management questions developed by the Regional Board. At the end of the study, EEWG was incorporated into the RMP as a permanent workgroup. The EEWG continues to better understand the effects of contaminants on biota. See the EEWG web page for more information.

Emerging Contaminants Work Group

The Emerging Contaminants Work Group (ECWG) evaluates the presence of chemicals of emerging concern in the Estuary, defined as chemicals that are not currently regulated, but believed to potentially pose significant ecological or human health risks (e.g., pharmaceuticals, flame retardants, and perfluorinated compounds). For additional information see the ECWG web page.

Sport Fish Work Group

The Sport Fish Work Group (SFWG) guides the effort to collect and analyze select species of sport fish for target parameters of concern (e.g., mercury, PCBs and dioxins) in the San Francisco Estuary. The Sport Fish Study is a human health study and various thresholds are used to evaluate sport fish contaminant concentrations. For additional information visit the SFWG web page.

Strategy Development

In addition to the work groups, teams from the workgroups and RMP stakeholders have been developing strategies for select issues that are of high priority to our stakeholders including dioxins, modeling, mercury, PCBs, small tributary loading and nutrients. A brief summary of strategies that have been completed are listed below. The crosswalk between the work plans and the strategies has been articulated in the Multi-year Plan for the RMP.

Dioxin Strategy

A Dioxin Strategy Team was convened in September 2008 to discuss information gaps. At that time, a dioxin strategy plan was prepared including priority questions and a five-year plan. The following questions articulate the needs and priorities for obtaining information on dioxins in the Bay:

1. Are the beneficial uses of San Francisco Bay impaired by dioxins?
2. What is the spatial pattern of dioxin impairment?
3. What is the dioxin reservoir in Bay sediments and water?
4. Have dioxin loadings/concentrations changed over time?
5. What is the relative contribution of each loading pathway as a source of dioxin impairment in the Bay?
6. What future impairment is predicted for dioxins in the Bay?

For additional information contact Don Yee (don@sfei.org).

Mercury Strategy

The RMP Mercury Strategy was formed in 2008 to articulate key questions that scientists and managers need to answer for the best management of mercury in the Bay. The Mercury Strategy addresses five priority questions:

1. Where is mercury entering the food web?
2. Which processes, sources, and pathways contribute disproportionately to food web accumulation?
3. What are the best opportunities for management intervention for the most important pollutant sources, pathways and processes?

4. What are the effects of management actions?

5. Will total mercury reductions result in reduced food web accumulation?

Studies supported by the Mercury Strategy Team are discussed in detail in the Special Studies section of this chapter. For more information on the RMP Mercury Strategy and the methylmercury synthesis see this presentation by Jay Davis at the 2012 Annual Meeting.

For additional information, please contact Jay Davis (jay@sfei.org).

Forcasting Strategy

The Forcasting Strategy team was formed in 2009 to develop a capacity to predict the effect of different management alternatives on loads from watersheds, the recovery of contaminated areas on the Bay margin, threats from emerging contaminants, and the recovery of the Bay as a whole. The Forcasting Strategy Team and the Contaminant Fate Workgroup identified the following priority questions:

1. What is the contribution of contaminated Bay margins to Bay impairment?

2. What patterns of exposure are forecast for major segments of the Bay under various management scenarios?

3. What are the projected impacts of Bay margin management actions to Bay recovery?

For additional information, please contact Don Yee (don@sfei.org).

PCB Strategy

PCBs are a pollutant of high concern in San Francisco Bay. This strategy has been developed to ensure that the RMP is providing the information most urgently needed by managers to find remedies to the Bay's PCB problem. The following management questions have been articulated to identify the information most urgently needed as a basis for the decisions listed above.

1. What are the rates of recovery of the Bay, its segments, and in-Bay contaminated sites from PCB contamination?

2. What are the present loads and long-term trends in loading from each of the major pathways?

3. What role do in-Bay contaminated sites play in segment-scale recovery rates?

4. What management actions have the greatest potential for accelerating recovery or reducing exposure?

5. What are appropriate guidelines for protection of beneficial uses?

6. What is the total maximum daily load of PCBs that can be discharged to the Bay without impairment of beneficial uses?

7. What potential for impacts on humans and aquatic life exists due to PCBs?

8. Which small tributaries and contaminated margin sites are the highest priorities for cleanup?

9. What is the most appropriate index for sums of PCBs?

For more information on this, please contact the strategy lead, Jay Davis (jay@sfei.org).

Small Tributary Loading Strategy

The Small Tributaries Loading Strategy (STLS) is overseen by the Sources, Pathways, and Loadings Workgroup. The STLS focuses on loadings from small tributaries (the rivers, creeks, and storm drains that enter the Bay downstream of Chipps Island), in coordination with the Municipal Regional Permit for Stormwater (MRP). It aims to refine pollutant loading estimates for future TMDL and management decisions, identify the highest priority small tributaries for cleanup, and evaluate the best actions for small tributary management. The STLS team articulated the following high priority management questions:

1. Which are the "high-leverage" small tributaries that contribute or potentially contribute most to Bay impairment by pollutants of concern?

2. What are the loads or concentrations of pollutants of concern from small tributaries to the Bay?

3. How are loads or concentrations of pollutants of concern from small tributaries changing on a decadal scale?

4. What are the projected impacts of management actions on loads or concentrations of pollutants of concern from the high-leverage small tributaries and where should management actions be implemented in the region to have the greatest impact?

For additional information contact Lester McKee (lester@sfei.org).

Special Studies

Special Studies allow for adaptive management of the RMP by allowing for short-term projects based on the changing regulatory priorities, management of the Estuary, and scientific understanding of the Estuary. Summaries of past and current Special Studies can be found on our web site.

Special Studies

Special Studies augment Status and Trends monitoring by focusing on specific topics and by providing a proactive approach to addressing management goals and needs. They help the RMP address specific gaps in data or management and scientific questions related to contaminants in the Estuary. Special Studies may eventually be incorporated into the Status and Trends Program. For example,

Special Studies identified and evaluated previously unknown organic contaminants and led to the addition of PBDEs to the RMP target analyte list to determine if they are prevalent in water, sediment, and tissue samples from the Estuary. The following special studies were in progress in 2011:

- Mercury Synthesis and Conceptual Model Update
- Mercury Food Web Uptake (Small Fish)
- PCB Conceptual Model
- Dioxin – Analysis of Water and Sediment
- Screening of SF Bay Mussels and Seals for Anthropogenic Pollutants – Year 2
- Chemicals of Emerging Concern Synthesis
- Regional Loading Spreadsheet Model
- Load Monitoring in Representative Watersheds
- STLS Management Support
- Olfactory Effects of Copper on Salmonids
- Sediment Quality Assessment of Toxic Hot Spots in SF Bay

Mercury Synthesis and Conceptual Model Update

Contact: Jay Davis (jay@sfei.org)

Over the past few years the RMP Mercury Strategy has funded a significant body of work including: a study that uses Diffusive Gradient in Thinfilm (DGT) to assess sources of bioavailable methymercury (Hintelmann *et al*. 2011), a study that employed mercury isotopes to assess sources and uptake of methylmercury into the food web (Gehrke *et al*. 2011 and Gehrke *et al*. 2011), and an intensive study on mercury bioaccumulation in small fish (Greenfield and Jahn 2010). The Strategy team consequently recommended evaluating and synthesizing all of the information acquired in the last several years. The resulting mercury synthesis will be used to plan for the next few years of mercury studies. The synthesis also evaluates progress relative to the Conceptual Model of Mercury in San Francisco Bay developed by Tetra Tech (2006) for the Clean Estuary Partnership.

The findings of the Mercury Synthesis were incorporated into an article published in a special issue of Environmental Research as part of the Coastal and Marine Mercury Ecosystem Research Collaborative (C-MERC), sponsored by the Dartmouth College Toxic Metals Superfund Research Program.

Mercury Food Web Uptake (Small Fish)

Contact: Meg Sedlak (meg@sfei.org)

Since 2005, SFEI has been monitoring forage fish in the San Francisco Estuary to assess the sources and pathways of mercury entering the Estuary. Monitoring to date has shown season variation in mercury bioaccumulation. By monitoring small fish at three long term sites, this study increased understanding of the patterns and magnitude of seasonal variation and helped determine what times of the year present the greatest potential risks to piscivorous wildlife.

The results of the study were published in 2013 as an article in Science of the Total Environment, titled "Seasonal and annual trends in forage fish mercury concentrations, San Francisco Bay."

PCB Conceptual Model

Contact: Jay Davis (jay@sfei.org)

The PCB Strategy Team emphasized the need for a PCB Conceptual Model to synthesize a significant body of new information that has been generated since the PCBs TMDL Staff Report was prepared. Some of the important new datasets include: surface sediment data using more accurate analytical methods (high resolution mass spectrometry) and the randomized sampling design; additional trend data from sport fish, bivalves, and bird eggs; surprising data from small fish showing higher than expected concentrations; and information on the entire suite of 209 congeners for sediment, water and biota.

The goal of the synthesis effort was to produce a technical report that answers, to the extent possible, the PCB Strategy questions based on the information that has been compiled to date. The PCB Conceptual Model report will be available in June 2013.

Dioxin – Analysis of Water and Sediment

Contact: Don Yee (don@sfei.org)

RMP studies of contaminants in Bay sport fish conducted every three years since 1994 have found that dioxin concentrations have remained unchanged over this time period and in some species, continue to greatly exceed screening values for human consumption. However, understanding of dioxin in the Bay is extremely limited. This study focused on analysis of water samples from the Bay during the Status and Trends water cruise and analysis of surface sediment samples collected in 2008 (dry season) and 2010 (wet season). The results of the study were presented at the December 2011 Technical Review Committee Meeting (view the power point).

Screening of SF Bay Mussels and Seals for Anthropogenic Pollutants – Year 2

Contact: Meg Sedlak (meg@sfei.org)

Significant advances in analytical techniques present an excellent opportunity for the RMP to conduct broad non-targeted scans of San Francisco Bay biota to identify chemicals of emerging concern. The National Institute for Standards and Technology (NIST) applied broadscan approach to San Francisco Estuary samples (using two-dimensional gas chromatography Time of Flight Mass Spectrometry) to identify previously unmonitored anthropogenic chemicals.

Year one of the study analyzed harbor seal blubber and liver for chemical contaminants. In the second year mussel tissue was analyzed. The report will be available in the first quarter of 2013. A Power Point summarizing the results for year 1 is available here.

Chemicals of Emerging Concern Synthesis

Contact: Meg Sedlak (meg@sfei.org)

Since 2006, the RMP has been collecting data on contaminants of emerging concern (CECs) to proactively identify unregulated chemicals that have the greatest potential to adversely affect the health of San Francisco Bay wildlife and humans that are linked to the Bay food chain.

The objective of this study was to prepare a summary report that will synthesize all the CEC occurrence data available for San Francisco Bay, including a comparison of Bay data to other locations, and to use the data to make prioritization and monitoring recommendations for CECs in the Bay.

The final report will be available in the first quarter of 2013.

Regional Loading Spreadsheet Model

Contact: Alicia Gilbreath (alicia@sfei.org)

The Regional Watershed Spreadsheet Model (RWSM) is being developed as a tool to refine annual regional load estimates and to assess how these loads might be reduced. A GIS-based model is being developed to calculate stormwater volumes and POC loads on a long-term average monthly basis. The RWSM will become a useful and cost-efficient tool for estimating regional scale watershed loads.

The study will be conducted over multiple years. In 2011, the focus was monitoring multiple watersheds to better understand the variation of stormwater loads based on watershed types.

The year one progress report, "Development of Regional Suspended Sediment and Pollutant Load Estimates for San Francisco Bay Area Tributaries using the Regional Watershed Spreadsheet Model (RWSM): Year 1 Progress Report," was published in 2011.

Load Monitoring in Representative Watersheds

Contact: Lester McKee (lester@sfei.org)

There is an urgent need for estimates of stormwater loads by watershed and by region. In 2010, the RMP conducted an evaluation of approximately 30 watersheds and identified 17 high priority watersheds to be monitored in 2011. This study sampled at the 17 watersheds and the sites will then be ranked from most contaminated to least contaminated for each analyte. The objective of the study was to determine POC loads from small tributaries and to distinguish "high-leverage" small tributaries that contribute most to Bay impairment.

The results of the study were published in the RMP Report "Pollutants of concern (POC) loads monitoring data, water year (WY) 2011."

STLS Management Support

Contact: Lester McKee (Lester@sfei.org)

This task consisted of a series of STLS meetings in which stakeholders provided input and reviewed the regional loads model, vetted the use of land-based event mean concentrations and their application to Bay Area watersheds, and recommended a list of candidate "land-use" monitoring sites.

Olfactory Effects of Copper on Salmonids

Contact: Meg Sedlak (meg@sfei.org)

Copper has been a priority concern due to its acute toxicity to aquatic life. Site-specific objectives (SSO) for copper were developed in 2007 that establish criteria for various segments within the Bay. The SSO specifically called for further study on the potential toxicity of copper to the olfactory system of salmonids. Exposure to dissolved copper has been shown to cause olfactory impairment at relatively low concentrations in freshwater fish, resulting in an impaired avoidance respond to predators.

The goal of this study was to determine the impact of dissolved copper on the olfactory system of fish in estuarine systems. The work was conducted by NOAA Marine Fisheries, which also contributed matching funds. The final report was published in 2012, titled "Impact of dissolved copper on the olfactory system of seawater-phase juvenile salmon."

Sediment Quality Assessment of Toxic Hot Spots in SF Bay

Contact: Ellen Willis-Norton (ellenwn@sfei.org)

In 2009, the State Water Resources Control Board adopted Sediment Quality Objectives (SQOs) for marine (polyhaline) waters in Enclosed Bays and Estuaries. The SQOs are based on a triad evaluation of sediment chemistry, benthos, and sediment toxicity.

This study sampled six sites in two previously identified hotspots, Mission Creek and San Leandro Bay. The SQO methodology was used to analyze the six samples and determine if the sites are still impacted. Results from these evaluations were compared to 2011 RMP S&T data, for which SQOs were also performed. The final report will be available in March 2013.

Additional Reports Published in 2011

Several journal articles and RMP reports were published in 2011 that were primarily associated with 2009 and 2010 Pilot and Special Studies. All previously unnamed 2011 publications are listed below:

RMP Technical Reports:

1. "Apparent Tolerance of Common Tern (Sterna hirundo) Embryos to a Penta-brominated Diphenyl Ether Mixture (DE-71)"
2. "RMP Sediment Study 2009-2010 Determining Causes of Sediment Toxicity in the San Francisco Estuary"
3. "Contaminants of Emerging Concern in the San Francisco Estuary: Triclosan and Triclocarban"
4. "Guadalupe River Watershed Loading HSPF Model: Year 3 final progress report"
5. "Age Estimates and Pollutant Concentrations of Sediment Cores from San Francisco Bay and Wetlands"

Published Manuscripts:

6. Thompson, B., Weisberg, S.B., Melwani, A., Lowe, S., Ranasinghe, A., Cadien, D.B., Dauer, D.M., Diaz, R.J., Fields, W., Kellogg, M., Montagne, D.E., Ode, P.R., Reish, D.J., Slattery, P.N. 2011. Low levels of agreement among experts using best professional judgment to assess benthic condition in the San Francisco Estuary and Delta. Ecological Indicators. 12: 167-173.

7. Stapleton, H.M., Klosterhaus, S., Keller, A., Ferguson, P.L., van Bergen, S., Cooper, E., Webster, T.F., Blum, A. 2011. Identification of Flame Retardants in Polyurethane Foam Collected from Baby Products. Environmental Science and Technology. 45: 5323-5331.

Annual Monitoring Online Graphics and Data Access Tools

Web Tools: Contaminant Data Display and Download (CD3)

The 2011 data are now available online using a dynamic mapping and graphing tool. The online Contaminant Data Display and Download (CD3) allows water, sediment, and tissue monitoring results from 1993 to 2011 to be summarized graphically for many trace contaminants and important ancillary measures. The CD3 tool displays the data graphically on maps and in cumulative distribution function (CDF) plots (**Figure 1.1**).

Several software programs were used to develop the online graphics. The R statistical analysis software package spsurvey, which is designed specifically by EPA for GRTS sample designs was used to calculate estimates of the regional and Estuary-wide contaminant mean, variance, standard deviation, standard error, and CDFs. The R program is an implementation of the S language developed at AT&T Bell Laboratories and can be downloaded for free from the Comprehensive R Archive Network (CRAN). The spsurvey library for the analysis of probability surveys is available from USEPA's Aquatic Resources Monitoring - Monitoring Design and Analysis.

All RMP results, from 1993-2011, can be downloaded using the RMP CD3 web tool. The online data includes only those results that have met specific data quality objectives and have passed a rigorous QA/QC evaluation as outlined in the RMP's Quality Assurance Project Plan. Values reported below the method detection limit (MDL) are estimated to be ½ of the MDL in all calculations and graphics. Some organic compounds are summed based on the target list of RMP congeners (**Appendix 5**) for that specific compound group (e.g., PBDEs, PAHs, and PCBs). When laboratory or field replicate data are available, the average of all the replicate concentrations is provided.

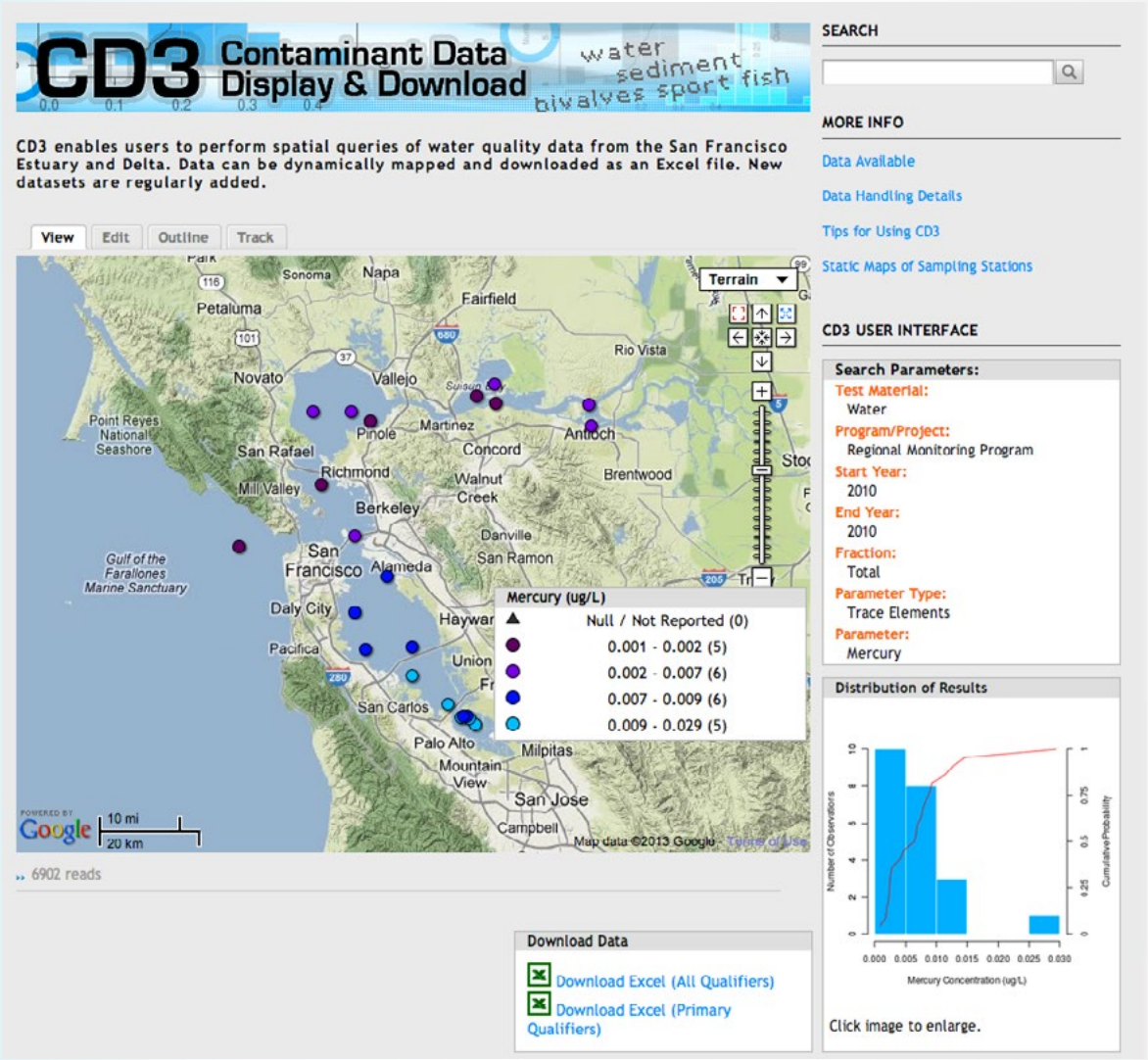

Figure 1.1 Web Map Interface Using the CD3 Tool

References

Bernstein, B., A. Mearns, D. Boesch, R. Cushman, W. Crooks, S. Metzger, T. O'Connor, A. Stewart-Oaten, J.M. O'Connor. 1997. Five-Year Program Review: Regional Monitoring Program for Trace Substances in the San Francisco Estuary. San Francisco Estuary Institute. Oakland, CA.

Kelley, Kevin M. and Jesus A. Reyes. 2009. Environmental Endocrine Disruption in Wild Fish of San Francisco Bay. Report submitted to the RMP. 126 pp.

Lowe, S., B. Thompson, R. Smith, D. L. Stevens, R. Hoenicke, K. Taberski, and J. Leatherbarrow. 2005. Re-design Process of the San Francisco Estuary Regional Monitoring Program for Trace Substances (RMP) Status & Trends Program for Water and Sediment Monitoring. SFEI Contribution #109. San Francisco Estuary Institute. Oakland, CA.

Stevens, Jr., D.L. 1997. Variable density grid-based sampling designs for continuous spatial populations. Environmetrics 8:167-195.

Stevens, Jr., D.L. and A.R. Olsen. 1999. Spatially restricted surveys over time for aquatic resources. Journal of Agricultural, Biological, and Environmental Statistics 4:415-428.

Stevens, Jr., D.L. and A.R. Olsen. 2000. Spatially-restricted random sampling designs for design-based and model-based estimation. In Accuracy 2000: Proceedings of the 4th International Symposium on Spatial Accuracy Assessment in Natural Resources and Environmental Sciences. Delft University Press, the Netherlands, pp. 609-616.

2) Water Monitoring

Background

Trace contaminants are introduced into the water column of the San Francisco Estuary through several major transport pathways such as runoff from rivers and creeks, atmospheric deposition, municipal and industrial wastewater effluent discharge, and remobilization of contaminants from surface sediments to the overlying water column. Contaminants of current environmental concern in the Estuary primarily originate in areas of the watershed that have been altered or disturbed by human activities through urbanization, industrial development, and agriculture. Historic mining activities have also contributed contaminants to the Estuary (e.g., mercury). The transport of contaminants from these various sources and pathways, coupled with the dynamic nature of water and sediment movement, creates complex and constantly varying conditions of contamination throughout the Estuary. For over a decade, the Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP) has monitored waters of the Estuary for trace elements, organic contaminants, and conventional water quality parameters to develop a better understanding of the cycling and distribution of contaminants in the Estuary and the management actions necessary to reduce their potential exposure to wildlife and humans. Information gained from contaminant monitoring in Estuary water assists the RMP in addressing priority management questions listed in the *Introduction*. All water samples were collected aboard the *RV Endeavor* between September 13 and September 22, 2011.

The Status and Trends program for water and sediment was revised in 2002 to include a randomized sampling design. From 2002 to 2006, five historic stations and 26 randomly allocated stations in each Bay segment were monitored for contaminants in water. In 2007, the number of random sites was reduced from 26 to 17 because power analysis showed that sampling fewer sites per year could still detect trends. The five historic sites continue to be sampled.

During the first four years (1993-1996) of the Program, the RMP used a polyurethane foam plug sampler to collect water for trace organics analyses (Risebrough *et al*., 1976; de Lappe *et al*., 1980, 1983) and phased in a new, modified, commercially available resin (XAD-2) extraction sampler in 1996, beginning with side-by-side comparisons of both sampling systems. XAD/XAD-2 resins have been used throughout the world to measure synthetic organic contaminants in both water and air (Infante *et al*., 1993). The sampler comparisons were continued in 1997, and results from both years were presented in the RMP 1997 Annual Report (SFEI, 1999). Since 1997, an AXYS Infiltrex system (AXYS Analytical Services Ltd., Sidney, B.C.) has been used to collect all RMP water samples for analysis of trace organic contaminants. Whole water samples are collected as ongoing tests to verify the comparability of the Infiltrex solid phase extraction method to more traditional methods of sample extraction and analysis of organic compounds in water samples. Whole water sample results are not included in the site average reported values.

As of 2008, water samples are analyzed annually for PBDEs and biennially for PCBs, PAHs, and legacy pesticides. This reduction in sampling frequency for PCBs, PAHs, and legacy pesticides was based on recommendations from the redesign process and is discussed in detail in the report Power Analysis and Optimization of the RMP Status and Trends Program. In 2008, an exception was made to analyze water for PAHs as a result of the recent Cosco Busan oil spill that occurred in November 2007. The PAH water concentrations in Central Bay (the region most impacted by the spill) in 2008 were generally within range of historical data, indicating no apparent increase due to residual oil from the Cosco Busan spill. PAH analysis will continue to occur biennially.. See **Appendix 5** for the 2011 target analyte list and **Appendix 6** for a table of analytes reported by the RMP in water from 1993-2011.

As discussed in the introduction, the TRC and SC reviewed the frequency of water monitoring in 2011 and recommended, based on the relatively stable concentrations observed in water, that the

program move to monitoring water biennially. The next water sampling will occur in 2013. In addition, the TRC and SC recommended that the frequency of organic analyses be reduced to every four years. Inorganic analyses will occur biennially.

Sites

For 2011, the RMP Status and Trends Program continued with implementation of the stratified, random sampling design started in 2002 and revised in 2007. Water sampling for the Status and Trends Program is currently only conducted during the dry season, specifically in late summer.

In 2011, 22 sites were sampled for water (**Figure 2.1** for site map). Five of these were the historic targeted stations (BA30-Dumbarton Bridge, BC10-Yerba Buena Island, BC20-Golden Gate, BG20-Sacramento River, and BG30-San Joaquin River). The remaining 17 sites were distributed through the five segments as follows: three per region with the exception of the Lower South Bay, which had five.

Sampling of the 22 sites was successfully completed, with one change made to the sampling plan: the sampling location for site BC20 was shifted approximately 20 meters to avoid a pilot boat in the vicinity. Station names, codes, location, and sampling dates for 2011 are listed in **Appendix 3**. A map of the station locations is shown in **Figure 2.1**.

Field Methods for Water Sampling

One of the RMP objectives is to evaluate if water quality guidelines are being met in the Estuary. Therefore, the sampling and analytical methods must be able to detect and, when analytically possible, quantify substances below guideline levels. In order to attain the low detection limits used in the RMP, ultra-clean sampling methods were used in all trace metal and organic sampling procedures (Flegal and Stukas, 1987; U.S. EPA, 1995).

Water was collected for trace metal, trace organic, select water quality analysis (Chlorophyll-a (Chla), Phaeophytin (Phaeo), dissolved organic carbon (DOC), particulate organic carbon (POC), Nitrates, Nitrites, Phosphate, Ammonia, Salinity, Hardness, Silica, and Suspended Sediments), and aquatic toxicity by personnel from the San Francisco Estuary Institute (SFEI) with assistance from Applied Marine Sciences (AMS) using ultra-clean sample handling techniques. AMS collected real-time data at each station over the duration of sampling for conductivity, optical backscatter (OBS), dissolved oxygen (DO), and temperature (1 meter CTD cast for duration of sampling, followed by a full water column profile where water depth allowed). SFEI collected in situ DO, pH, salinity, conductivity, and temperature measurements at 10 of the stations using a YSI 556. At twelve stations (BA30, BC20, LSB050W, LSB051W, LSB053W, CB035W, SPB033W, SPB034W, SPB035W, SU041W, SU042W, and SU043W), the YSI was either not calibrated or not functional during sampling. Current and recent weather conditions were documented for each site.

Water samples were collected by pumping water from approximately one meter below the water surface. The sampling intake ports for both the trace organic and trace element samplers were attached to aluminum poles that were oriented up-current from the vessel and upwind from equipment and personnel. The vessel was anchored and the engines turned off before the sampling began. Total and dissolved fractions of Estuary water were collected for trace element analyses. Particulate and dissolved fractions were collected for trace organics analyses using the AXYS Infiltrex system. Whole water samples were collected at four sites to evaluate the adsorption capacity of the Infiltrex filter system.

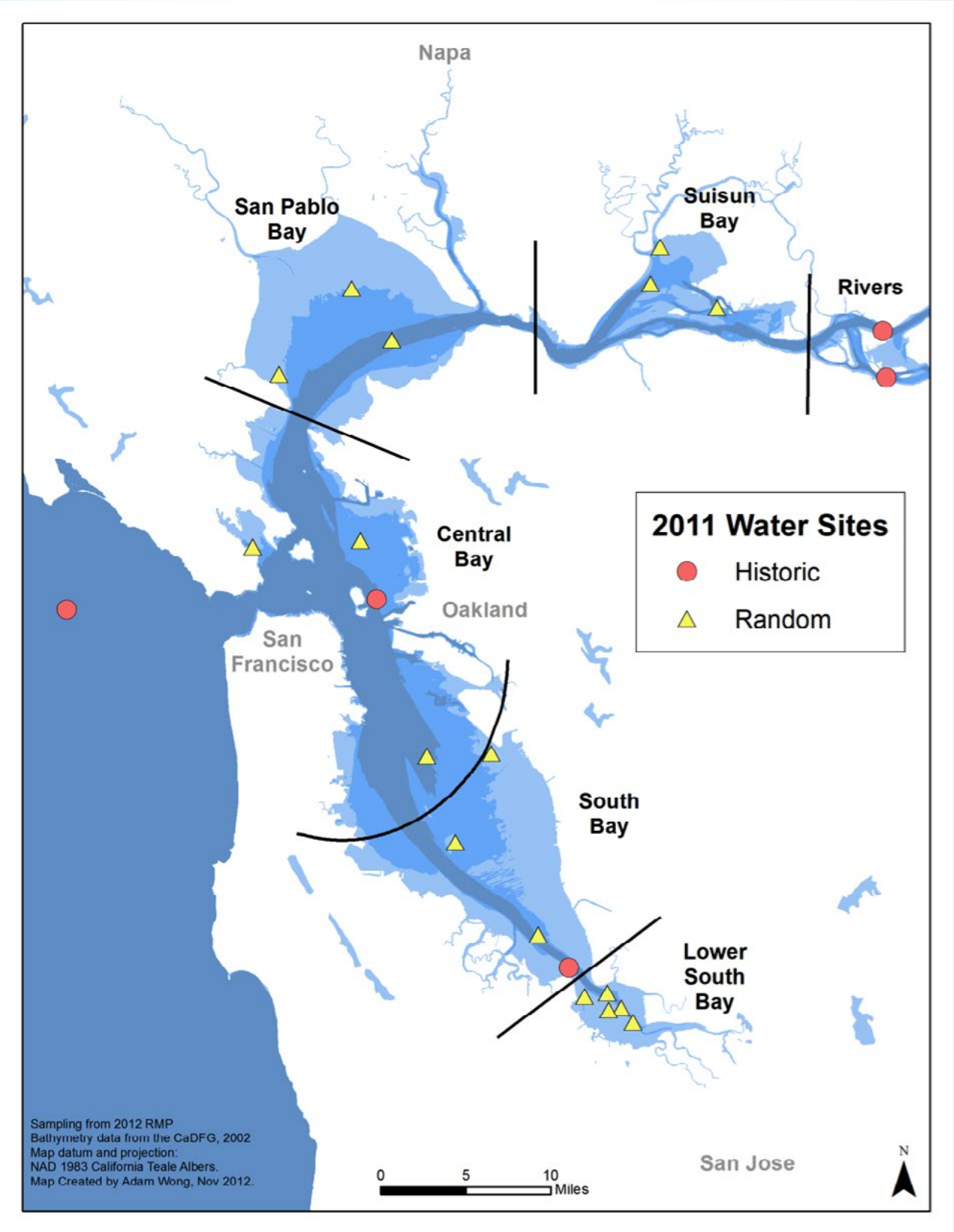

Figure 2.1 Map showing location of 2011 Water Stations

Shipboard Measurements

Conductivity, temperature and depth (CTD) casts were taken at all stations to document their water column profiles. CTD casts were taken by AMS using a Sea-Bird SBE19 CTD probe to measure water quality parameters at depths throughout the water column. At each site, the CTD was lowered to approximately one meter below the water surface and allowed to equilibrate to ambient temperature for 3 minutes. Following the sampling, the CTD was then lowered to the bottom at approximately 0.15 meters per second and raised. However, only data from the down cast were kept. Data were downloaded onboard the ship and processed in the laboratory using Sea-Bird software.

The CTD probe measured temperature, conductivity, pressure, dissolved oxygen, and backscatter at a sampling rate of two scans per second. These data were compiled and averaged into 0.25 m depth bins during processing. At this time, salinity (based on conductivity measurements), and depth (based on pressure) are calculated from the indicated measures. Although the CTD data are not available for download using the Web Query Tool, SFEI maintains these data in a database. Data are available upon request (contact Cristina@sfei.org).

Collection of Water Samples for Ancillary Parameters

Samples for conventional water quality parameters were collected using the same apparatus as for trace metals. Water samples for (dissolved) nitrate and nitrite analysis were collected into a 500 mL PE bottle at each site and were frozen on dry ice in the field. Samples for analysis of particulate organic carbon (POC) and chlorophyll/phaeophytin were field filtered on glass fiber filters (GFF) using a vacuum pump. POC samples were filtered on pre-ashed GFF. Chlorophyll/phaeophytin samples (the residue retained on the filter) were stored in 90% methanol in amber vials and were frozen on dry ice in the field. Bottles for water samples of ammonia, phosphate, and silica were filled without rinsing because the bottles contained pre-measured preservative acid (sulfuric acid for ammonia and phosphate samples and nitric acid for silica samples). The pH of these samples was checked using pH paper to assure that they were appropriately preserved (pH 2 or less).

Collection of Water Samples for Trace Element Parameters

For trace metals, water samples were collected 1 m below the surface using a peristaltic pump system equipped with C-Flex tubing in the pump head using “clean hands, dirty hands” techniques. Sample containers, which were stored double-bagged, were filled on deck on the windward side of the ship to minimize contamination from shipboard sources (Flegal and Stukas, 1987). Unfiltered (total) water samples were pumped directly into acid-cleaned containers. Filtered (dissolved fraction) water samples were collected through an acid-cleaned polypropylene filter cartridge (Voss Technologies or Micron Separations, Inc., 0.45 µm pore size) on the outlet of the pumping system. In 2011, the filter cartridge may have been positioned incorrectly, with the flow entering the filter outlet, for seven stations (BG20, LSB050, LSB052, LSB054, SB061W, SB062W, and SB063W). The error was noted in the sample ID spreadsheet. Prior to collecting water samples, several liters of water were pumped through the system and sample bottles were rinsed three times with site water before filling, except those containing a preservative, which were filled without rinsing. The bottles were always handled by the “clean hands” collector wearing polyethylene-gloves. The sample tubing and fittings were acid-cleaned polyethylene or fluoropolymer, and the inlets and outlets were kept covered except during sampling.

For total mercury water samples, 250 to 500 mL of Estuary water was collected in mercury-clean fluorinated polyethylene (FLPE) bottles, then double-bagged in zip-lock bags. The samples were immediately placed in a cooler on ice.

For methylmercury analyses, samples were collected into 250 mL FLPE bottles, then double-bagged in zip-lock bags. Samples were preserved with 1 – 2 mL 50% sulfuric acid in the field, and immediately placed on ice in a cooler.

For cyanide analyses, samples were preserved with NaOH to a pH or 12 or greater in the field. The samples were not placed on wet ice.

Filtered field blanks were collected prior to the collection of samples using the same acid-cleaned sampling assembly that samples were collected through. Ultra-clean deionized (DI) water was pumped through the apparatus and an acid-cleaned filter and was collected in sample bottles. The field blanks received the same handling and analyses in the laboratory as the field samples.

Collection of Water Samples for Trace Organic Parameters

Water for analysis of trace organics was collected one meter below the surface using the AXYS Infiltrex system consisting of a constant-flow, gear-driven positive displacement pump, 3/8 inch outer diameter fluoropolymer tubing, 1 µm glass fiber cartridge particulate filter, and two parallel Teflon® columns filled with XAD-2 resin beads (size range of 300-900 µm). Amberlite XAD-2 resin is a macroreticular, styrene-divinyl benzene copolymer, nonionic bead, and each bead is an agglomeration of microspheres. The hydrophobic nature of the resin leads to excellent retention of hydrophobic contaminants. At station BC10, a leaking column caused a loss of resin.

To remove large debris that may interfere with sample collection, the sample water was first passed through a coarse screen before the fluoropolymer intake line. Particles greater than 140 µm were removed by a second inline pre-filter. The water then passed through the pump head and a pressure gauge, before it was passed through a four-inch diameter, wound-glass fiber filter (1 µm nominal pore size). Flow may be redirected to a second installed filter if the first filter becomes clogged. Material retained on the glass-fiber filter (or filters) was designated the particulate fraction. After passing through the filter, the water was split and routed through two Teflon® columns, packed with 75 mL of XAD-2 resin. Two columns were used simultaneously to permit a flow of approximately 1.5 L/min. The compounds adsorbed to the XAD-2 resin were designated as the dissolved fraction. Lastly, the water passed through a flow meter and out the exit tube, where the extracted water volume (97.5 L per sample) was verified by filling five pre-measured (19.5 L) carboys.

Field blanks were taken for both the resin columns and the glass fiber filters. The two column blanks were collected by opening and closing both ends of a column to simulate loading of columns into the sampler. Similarly, a glass-fiber filter blank was collected by exposing a filter to the air to mimic loading the sample filters into the cartridges. The field blanks receive the same analytical treatment in the laboratory as the field samples.

Whole water samples were collected in clean 4L amber glass bottles for select trace organic analysis using the AXYS Infiltrex System to pump the water (without filters and columns). Once the AXYS Infiltrex system was flushed, the exit tubing was pulled on board and the water samples were collected in 4L amber bottles being careful not to touch the inside of the bottle or neck of the bottle with the tubing (the outside of the tubing is considered to be contaminated – considerable care was taken not to contaminate the sample). The samples were placed on wet ice. Whole water samples collected for

pesticide analysis were transported to SFEI at the end of each day, preserved with dichloromethane, stored in a refrigerator overnight, and shipped to the lab the following day.

Whole water samples were collected at 22 sites for pesticides and at 4 sites for PAHs, PCBs, and PBDEs.

Collection of Aquatic Bioassay Samples

In 2002, aquatic bioassays (toxicity tests) were conducted at a subset of shallow sites in the Estuary and, since then, the frequency of sampling for aquatic toxicity testing was reduced to every five years since no aquatic toxicity had been observed in the Estuary during the summer in many years. The Technical Review Committee decided that aquatic bioassays would be conducted at five-year intervals as a screening measure to assure that any long-term change in toxicity would not be missed.

Aquatic bioassay sampling occurred at 9 sites (one per segment and 4 historical sites) in 2011. The next aquatic bioassay sampling will occur in 2015.

An overview of toxicity testing in water and sediment over the past ten years of Status and Trends monitoring was summarized by Anderson, Ogle, and Lowe (2003) in the 2003 Pulse of the Estuary.

Laboratory Methods for Water Analysis

SFEI contracts with a number of laboratories that provide high quality analytical services. Qualifications for our labs include ISO registration, NELAP accreditation and certification by the California Department of Public Health. SFEI maintains copies of SOPs for all laboratory analyses. Please contact SFEI (cristina@sfei.org) for more details.

Laboratory Methods for Water Quality Parameters

In 2011, conventional water quality parameters were measured for the RMP by Columbia Analytic Services (CAS) and by the East Bay Municipal Utility District (EBMUD, a wastewater treatment facility) laboratory.

CAS analyzed water samples for dissolved organic carbon using EPA Method 9060A. CAS determined particulate organic carbon concentration using EPA Method 440.

EBMUD analyzed salinity by Standard Method 2520B, using electrical conductivity. Hardness as CaCO3 was measured at all sites using Standard Method 2340C Version 20, a titrimetric procedure using EDTA. In the past Ammonium as N has been analyzed using EPA method 350.1 by flow injection analysis. Since 2009, it has been measured using a method based on the indophenol reaction with o-phenylphenol (OPP) (Solorzano, L., 1969). Nitirite and Nitrate as N were analyzed by EBMUD using EPA method 353.2 by flow injection analysis. Phosphate as P was analyzed using EPA 365.3 by colorimetry. Pheophytin-a and Chlorophyll-a were analyzed by Standard Method10200 H-M Version 20, using spectrophotometric determination. Suspended sediment concentration was measured using ASTM

D3977. Silica as SiO2 was measured using a combination of Standard Method 4500-SiO2 C and EPA Method 370.1 and concentrations were determined spectophotometrically.

In past years, shipboard measurements for temperature, salinity, pH, and dissolved oxygen content were made using a hand-held Solomat 520 C multi-functional chemistry and water quality monitor. Beginning in 2007, shipboard measurements of temperature, salinity, conductivity, pH, and dissolved oxygen were made using a hand-held YSI (556 MPS).

Laboratory Methods for Trace Elements

Brooks Rand Labs LLC (BR) analyzed water samples for Trace Elements (Arsenic, Cadmium, Cobalt, Copper, Iron, Lead, Manganese, Nickel, Selenium, Silver, and Zinc).

Upon receipt by the lab, all samples to be prepared for analysis by reductive precipitation and analyzed using inductively coupled plasma – mass spectrometry (ICP-MS) were preserved by the addition of pre-tested concentrated HNO_3 to 0.2% (v/v).

BR determined concentrations of Ag, As, Cd, Co, Cu, Ni, Pb, and Zn by reductive precipitation, followed by filtration, and measured using inductively coupled plasma-mass spectrometry (ICP-MS) by EPA Method 1640, modified. Mn and Fe concentrations were determined by digestion with HCl and HNO_3 in a sand bath and measured using ICP-MS by EPA Method 1638. Selenium analysis was also conducted by BR using preconcentrations and ICP-MS in accordance with EPA Method 1640.

The 2007 copper results suggested a discrepancy between reductive precipitation used by the commercial laboratory, BR, and the column chelating method used by the City of San Jose (CSJ) and UCSC. In 2008, 2009, 2010, and 2011 a laboratory inter-comparison exercise was conducted for analyses of copper and nickel using the two different methods by CSJ and BR. For 2008-2010 data, the results showed good agreement between the reductive precipitation method and the column chelating methods. The 2011 results cannot be compared until BR completes its data re-analysis. Both labs followed procedures outlined in EPA Method 1640.

Total Mercury Analysis in Water Samples

In 2011, total mercury analysis of water samples was conducted by BR. Samples were collected in acid-cleaned 250 mL fluorinated polymer (FLPE) bottles with an additional 500 mL High Density Polyethylene (HDPE) bottle collected at one station for QA analysis. BR analyzed total mercury samples using a modified version of EPA Method 1631E. Samples are digested by 24 hour oxidation, reduction, Purge&Trap and detected using cold vapor atomic fluorescence spectrometry.

Methylmercury Analysis in Water Samples

In 2011, total methylmercury analysis of water samples was conducted by BR. Samples were collected in acid-cleaned 250 mL fluorinated polymer (FLPE) bottles pre-preserved at the lab with one to two mL 50% sulfuric acid.

BR analyzed methylmercury in water samples using a modified version of EPA method 1630. Samples were analyzed by distillation, aqueous phase ethylation, trapping pre-collection, isothermal gas chromatography (GC) separation, and cold vapor atomic fluorescence spectrophotometer (CVAFS) detection.

Cyanide Analysis in Water Samples

In 2011, Central Costa Costa Sanitary District (CCSD) analyzed water samples for cyanide. Samples were collected in 1L High Density Polyethylene (HDPE) bottles and preserved with NaOH to a pH of 12 or greater. CCSD analyzed cyanide in water samples using Standard Method 4500-CN-I version 20. Samples were analyzed by distillation and purging with air, followed by colorimetry.

Laboratory Methods for Trace Organics

In 2011, trace organic water analyses were conducted for PCBs, pesticides, PBDEs, PAHs, and Dioxins and Furans . **Appendix 5** contains a list of individual parameters reported by the RMP in 2011 and **Appendix 6** contains a table of analytes reported by the RMP in water from 1993-2011.

A brief overview of the extraction and analytical methods used for the target trace organics are described below. The SOPs that describe the laboratory methods in more detail are on file at SFEI. Please contact SFEI (cristina@sfei.org) for more details. PCBs (AXYS MLA-010, revision 10), Pesticides (AXYS MLA-035, revision 6), PBDEs (AXYs MLA-033, revision 6), PAHs (AXYS MLA-021, revision 10), and Dioxins and Furans (AXYS MLA-017, revision 20) were analyzed by AXYS Analytical Services, Ltd. (AXYS).

Two parallel XAD-2 resin columns and one or two wound glass filter(s) contained the organic compounds extracted from ~100 L of water at each site. The XAD and the filter samples were analyzed together, except at three sites the extracts were analyzed separately as dissolved and particulate fractions (three sites plus two duplicates plus one blank). Each XAD-2 column and filter sample was spiked with labeled surrogate standards. The filters were extracted by ambient temperature sonication, and XAD-2 columns with soxhlet extraction. Extract subsamples were subject to different cleanup procedures and analytical instrumentation, depending up on the target analytes.

PCBs were analyzed using a procedure that is general accordance with USEPA Method 1668, Revision A. Samples were spiked, extracted, and then cleaned up with chromatographic procedures. Extracted samples were analyzed using high-resolution gas chromatograph (HRGC) coupled to a high resolution mass spectrometer (HRMS).

Prior to 2008, AXYS used gas chromatography coupled to low resolution mass spectrometry (GC/LRMS) to determine pesticides in water. In 2008, AXYS developed a new method for detecting pesticides in whole water samples. The new method uses high resolution gas chromatography coupled to high resolution mass spectrometry (HRGC/HRMS, multi-residue pesticides referred to as MRES), in accordance with AXYS MLA-035. In 2008, an Inter-comparison study was conducted between the old method and the new MRES method. The results indicated that there was no significant difference between samples collected with the Infiltrex high volume system and whole water samples when analyzed using MRES. The new MRES method is now used to analyze pesticide data.

PBDEs were analyzed using a modified version of USEPA 1614. The dissolved fraction was soxhlet extracted while the particulate fraction was solvent extracted using Ambient Temperature Extraction (ATX). Extracted samples were analyzed using high-resolution gas chromatograph (HRGC) coupled to a high resolution mass spectrometer (HRMS).

PAHs were analyzed using a modified version of USEPA method 8270/1625, which uses gas chromatograph coupled to a low resolution mass spectrometer. Incremental C_{13} labeled surrogates are used prior to extraction, through relative recovery factors (RRF), to improve accuracy.

Starting in 2008, AXYS has analyzed water samples for Dioxins and Furans using a procedure that in is general accordance with USEPA Method 1613, Revision B. Extracts were spiked and cleaned up using acid/base silica, Florisil and Alumina chromatographic columns prior to instrumental analysis. Analysis was then performed using a high-resolution mass spectrometer coupled to a high-resolution gas chromatograph equipped with a DB-5 capillary chromatographic column. A second column was used for confirmation of specific congener identification.

Laboratory Methods for Water Toxicity

The aquatic toxicity screening study occurs every five years. In 2011, aquatic toxicity was evaluated at nine sites. The analysis was conducted by Pacific EcoRisk in accordance with USEPA method 1007.0, "*Americamysis bahia* (formerly *Mysidopsis bahia*) Chronic (7-Day) Survival, Growth, and Fecundity Bioassay." This test is based on a 7-day static-renewal exposure of 7-day old *Americamysis bahia* to different concentrations of effluents and/or receiving waters during the life period when eggs are produced by females. The primary test endpoints are survival and growth (measured as biomass value and/or dry weight); an additional fecundity endpoint can also be used.

Table 2.1. Target Water Analytes: A summary table of the 2011 target analytes, special field handling requirements and analytical laboratories

Analyte	Special Field Handling Requirements	Analytical Lab
Dissolved oxygen, conductivity, temperature, pH, OBS	None	Collected in field by AMS
Dissolved oxygen, conductivity, pH, , temperature, salinity	None	Collected in field by SFEI
Trace Elements (Ag, As, Cd, Co, Cu, Fe, Mn, Ni, Pb, Se, Zn)	Cooled with wet ice and refrigerated	Brooks Rand Labs LLC
Methylmercury	Preserved with sulfuric acid, cooled with wet ice and refrigerated	Brooks Rand Labs LLC
Total Mercury	Cooled with wet ice and refrigerated	Brooks Rand Labs LLC
Copper and Nickel	Cooled with wet ice and refrigerated	City and County of San Jose
Cyanide	Preserved with NaOH to a pH ≥ 12	Contra Costa County Sanity District
PBDEs	Cooled with wet ice and refrigerated	AXYS Analytical Services Ltd.
Pesticides	Cooled with wet ice and refrigerated	AXYS Analytical Services Ltd.
PCBs	Cooled with wet ice and refrigerated	AXYS Analytical Services Ltd.
PAHS	Cooled with wet ice and refrigerated	AXYS Analytical Services Ltd.
Dissolved Organic Carbon	Field filtered, preserved with 1-2 mL Sulfuric acid, cooled with wet ice and refrigerated	Columbia Analytical Services
Particulate Organic Carbon	Field filtered, field frozen on dry ice	Columbia Analytical Services
Chlorophyll/Phaeophytin	Field filtered, filter stored in 90% methanol in amber bottle, frozen on dry ice	East Bay Municipal Utility District
Salinity and Hardness	Cooled with wet ice and refrigerated	East Bay Municipal Utility District
Ammonia	Preserved with sulfuric acid, cooled with wet ice and refrigerated	East Bay Municipal Utility District
Phosphate, Nitrate and Nitrite	Frozen on dry ice	East Bay Municipal Utility District
Silica	Preserved with nitric acid, cooled with wet ice and refrigerated	East Bay Municipal Utility District
Suspended Sediment Concentration	Cooled with wet ice and refrigerated	East Bay Municipal Utility District
Aquatic Toxicity	Cooled with wet ice and refrigerated	Pacific EcoRisk

Quality Assurance / Quality Control (QA/QC)

All samples results reported by SFEI have undergone a rigorous Quality Assurance/Quality Control (QA/QC) process by trained SFEI staff. Highlights for the 2011 water samples are summarized below.

QA/QC of Ancillary Parameters

Dissolved Organic Carbon and Particulate Organic Carbon analyzed by Columbia Analytical Services (CAS)

Analysis of DOC and POC in water samples and field collected filters respectively was performed by Columbia Analytical Services. Measurements of POC and DOC proceeded routinely. Both analytes were measured in all samples, with no non-detects. DOC was found averaging slightly over the MDL, so all DOC results were flagged, but blank concentrations were about 20 times lower than the lowest field sample. Precision on lab replicates was good, with average RSDs <5%, and results on recovery samples were good, with <5% average error for both DOC and POC, no added flags were needed. Similar to previous years, DOC concentrations were generally higher than those for POC, and average concentrations of both were in a similar range as previous years.

Ancillary/Water Quality analysis by East Bay Municipal Utility District Laboratory (EBMUD)

The results on ancillary water quality parameters were acceptable for most analytes, with the only non-detects being salinity (at the two river stations), and blank contamination found only for nitrite. Because of typically very low ambient levels of nitrite, most results were censored for being not sufficiently (<3x) above blank levels to quantitate. Precision on most analytes was good, with only SSC moderately variable (21% RSD) in field replicates, but good (6%) in CRMs, so results were not censored. Recoveries on most analytes were good, with only ammonium slightly outside the target range of 15% error and flagged (but not censored). Nitrite, chlorophyll a, and pheophytin a have no recovery samples measured and were flagged for partial QC. Concentration averages and ranges were similar to previous years' except for a few: average nitrite was higher than usual because only high concentration samples less impacted by blank contamination were not censored; Chloropyll a averaged 3x lower than in recent past years (2006-2010); Pheophytin a was also lower than usual, but less so than chlorophyll, leading to higher concentrations than for chlorophyll in many samples.

QA/QC of Trace Elements

Trace Elements by Brooks Rand Labs LLC (BR)

Water trace element results are pending reanalysis of several samples by the laboratory to investigate some atypically high concentrations of iron, lead, and zinc. However, lead and zinc concentrations are still far below levels at which toxicity is expected. Silver represents the greatest challenge to method sensitivity, with non-detects in over half the samples (for both dissolved and total fractions). Precision measures on lab replicates were within target average RSDs of <25%, except for dissolved zinc and total silver, which were flagged for marginal precision but not censored. Recoveries on most analytes were within the target <25% average error except for total cadmium, dissolved iron, and total and dissolved silver, slightly outside the target range and flagged but not censored. A few results showed likely interferences in total fraction extraction with concentrations over 35% lower

than in dissolved phase; these total results (Arsenic for SU043w and BC20, and Cobalt for BA30) were therefore censored based on best professional judgment.

Cyanide by Central Contra Costa Sanitary District (CCCSD)

Cyanide was analyzed as weak acid dissociable (WAD) cyanide; WAD cyanide concentrations were generally around the detection limit, but MDLs were sufficient to provide slightly over 50% detected results. It was not detected in blanks. Lab and field duplicates of field samples averaged <3x the MDL, so precision was evaluated on matrix spike dupes, within target with average 20% RSDs. Recovery samples were also within target with average 17% error, so no results were qualified. Concentration ranges were similar to previous results in the Bay, with only one sample over 3x the MDL (over 1.5 ug/L).

QA/QC of Trace Organics

QA/QC for Trace Organics by AXYS Analytical Services Ltd. (AXYS)

Organic compounds reported in water samples for 2011 included PAHs, PCBs, PCDDs/PCDFs (dioxins), and PBDEs, all analyzed by AXYS Analytical.

Dioxins

Despite use of the most sensitive analytical methods possible, the greatest challenge in dioxins analysis is the extremely low concentrations of most congeners. Dissolved concentrations of most dioxins were too low to detect in the few samples analyzed as separate dissolved and particulate fractions, but at least a few were detected in all samples analyzed as combined fractions. Some congeners were found in the method blank near the detection limit, at concentrations similar to those in field samples, so many of those results were censored. Because of the low concentrations, most analytes were not detected in replicates, but the few that were quantified had acceptable precision (<35% RSD, most ~10%). Recoveries were good in spiked blank spikes for dissolved and total fraction samples, but showed a high bias (150% of target) for all congeners in particulate phase. As expected, OCDD (the only congener measured in both fractions) was much higher in particulate versus dissolved fractions. Concentrations were similar to (averaging 140% of) past years.

PAHS

In the few samples analyzed as separate fractions, dissolved concentrations of PAHs were often too low to detect, with nearly half the analytes not detected in a majority of samples. Reported as combined fractions, only one (Benz(a)anthracene) was not detected in a majority of samples. Alkylated PAHs were detected more consistently, all were detected in at least half the combined fraction samples. Blank contamination was more problematic for particulate samples, with all particulate phase results censored (for concentrations less than 3 times those in blanks) for 4 PAHs and half the alkylated PAHs. Fortunately, contamination was less significant in samples analyzed as combined fractions, with no PAHs and only a few alkylated PAHs with significant blank contamination. Precision was good for most analytes, with only 3 PAHs in the dissolved phase and 1 particulate alkylated PAH censored for showing poor precision, perhaps due in part to low concentrations. Blank spikes were used to assess accuracy of PAHs as there are no marine water PAH CRMs and insufficient sample material to split to create Matrix Spikes. Alkylated PAH recoveries could not be evaluated, as standards only exist for a few individual compounds, not groups of alkylated PAHs. Recoveries were marginally over the target 135% upper limit for 3 PAHs, which were flagged but not censored. Only a few samples were analyzed for both

dissolved and particulate phases, with a general trend as expected of higher dissolved to particulate concentrations for lower molecular weight PAHs compared to those with more rings. Concentrations overall were in a similar range as previous years, ranging several hundred to several thousand pg/L for various individual compounds. As an ongoing check of the potential bias introduced by on-site solid phase extraction of water samples, smaller (4 L) whole water samples from a few sites are collected and analyzed. Samples showed fair agreement when results were quantifiable by both methods, with a median ratio of whole water to solid phase extracted results of around 85%. However, these intercomparison samples results are not normally reported in RMP maps and site averages.

PBDES

Generally low concentrations, sporadic blank contamination, and variability in field replicates potentially resulting from those factors posed the largest challenges to measurement of PBDEs in water. Detection limits for the 49 reported PBDEs were generally 2-4 times higher than in 2010; consequently, around half the analytes (up from around 20% in 2010) had non-detects in over half the samples. Nearly 20% of the analytes were found in blank samples; these were significant (over 1/3 concentrations in field samples and thus censored) for only a few mostly minor congeners (only PBDEs 197, 203, and 207 had >50% of combined fraction samples censored), although other analytes had a few of their lowest results censored. Field replicates were used to evaluate measurement precision, which was variable for separately analyzed dissolved and particulate fractions, in part due to low concentrations and sporadic blank contamination. A few of the typically more abundant congeners, PBDE 206 in dissolved fraction samples, and PBDEs 047, 207, and 209 in particulate samples, were among the analytes censored for poor precision (>70% RSD) in field replicates. To assess the recovery of PBDEs, Blank Spikes were used, as no CRMs or Matrix Spike results were available. Recovery for the majority of PBDEs was good, with less than the target 35% average error for all reported analytes. Partitioning followed expected patterns, with higher dissolved to total ratios for lower substituted congeners. For the most part average concentrations of PBDEs in the integrated water samples were similar to previous years (2006-2010). PBDEs in whole water samples were also measured in 2011 to compare to solid phase extracted samples, with similar issues found; non-detects in over half the samples for many (~2/3 of) analytes, and blank contamination >1/3 ambient concentrations (resulting in censoring) in a majority of field samples for many analytes, including some of the usually abundant congeners such as PBDE 99, 100, and 209. Discussions have been ongoing with the laboratory on approaches to reduce blank contamination and improve PBDE quantitation in water samples, but further improvements have been difficult due to the extremely low detection limits sought combined with the ubiquity of PBDEs in building interiors.

PCBS

Among the organic analytes in water, PCBs showed the fewest issues due to the maturity of the methods and the relative lack of ongoing contamination sources in laboratory environments. The analytical method (a lab implementation of EPA 1668) provides measurement of all congeners, most individually but some in small groups of several congeners. A few of the less abundant congeners were not detected in a majority of combined fraction samples. Some congeners were found in method blanks, but were significant (>1/3 of the field sample result) and censored for only a handful of congeners in integrated samples. Precision on field replicates was generally good, with only PCB 8 in particulate phase censored for very poor precision (RSD >70%). Recovery on the blank spike sample was good for all analytes, averaging within 35% of the target value for all analytes, (within 15% for most). Ratios of dissolved to particulate phases were as expected, larger for lower less-substituted congeners. For the most part concentrations of the abundant congeners were similar to previous years, mostly within 2x of previous years' averages. Ongoing intercomparison of solid phase extracted samples to smaller whole water samples was conducted at a few stations to evaluate potential bias introduced by different sampling methods, showing generally good agreement between them.

Pesticides

Analysis of water for pesticides was performed on whole water samples, and included a mix of legacy and current use pesticides. Due to use of whole water samples, detection limits were similar to 2009 results (also whole water), but higher than in previous RMP monitoring using large volume solid phase extracted samples. Many (21 out of 28) pesticides were not detected in over half the samples. Hexachlorobenzene was detected in blanks; in a majority of samples its concentration was less than 3x higher and was censored. Precision was evaluated in field replicates, or in blank spikes for analytes not detected in field samples. Precision was good for all analytes except gamma-HCH, censored for poor precision (72% RSD). There are no CRMs for pesticides in marine water, and there was insufficient material for matrix spikes, so recovery was evaluated using blank spikes. Recovery was good, with average errors less than the target 35% for all reported pesticides. Concentrations were generally similar to 2009 results (also whole water samples), but with many fewer detected results than in prior years due to the difference in sampling method.

QA/QC of Water Toxicity

Water Toxicity by Pacific Eco Risk (PER)

Toxicity test conditions were generally within recommended limits, with a few deviations generally not expected to significantly impact test results. One sample (BA30) had a hold time outside of the recommended 36 hours (of 6 days) and was flagged to indicate the deviation.

Mean control survival was always >80% as required, and toxicant controls were narratively described as being within limits, although the lab data did not submit the supporting data. There was also some drift in pH over the course of the toxicity outside the ±0.3 pH recommended range, although the EPA method notes problems do not usually appear unless the shift is >1 pH unit.

References

Anderson, B., S. Ogle, and S. Lowe. 2003. Ten years of testing for the effects of Estuary contamination. In: 2003 Pulse of the Estuary: Monitoring and managing contamination in the San Francisco Estuary. SFEI Contribution 74. San Francisco Estuary Institute. Oakland, CA.

De Lappe, B.W., R.W. Risebrough, A.M. Springer, T.T. Schmidt, J.C. Shropshire, E.F. Letterman, and J. Payne. 1980. The sampling and measurement of hydrocarbons in natural waters. In Hydrocarbons and Halogenated Hydrocarbons in the Aquatic Environment, B.K. Afghan and D. Mackay, eds. Plenum Press, NY, pp. 29-68.

De Lappe, B.W., R.W. Risebrough, and W. Walker II. 1983. A large-volume sampling assembly for the determination of synthetic organic and petroleum compounds in the dissolved and particulate phases of seawater. *Canadian Journal of Fisheries and Aquatic Sciences* 40:322-336.

Flegal, A.R. and V.J. Stukas. 1987. Accuracy and precision of lead isotopic composition measurements in seawater. *Marine Chemistry* 22:163-177.

Infante, A.P., N.C. Guajardo, J.S. Alonso, M.C.M. Navascues, M.P.O. Melero, M.S.M. Cortabitarte, and J.L.O. Narvion. 1993. Analysis of organic water pollutants isolated by XAD-2 resins and activated carbon in the Gallego River, Spain. *Water Research* 7:1167-1176.

Risebrough, R.W., B.W. de Lappe, and W. Walker II. 1976. Transfer of higher-molecular weight chlorinated hydrocarbons to the marine environment. In Marine Pollutant Transfer, H.L. Windom and R.A. Duce, (eds.), D.C. Heath Company, Lexington, Massachusetts and Toronto, pp. 261-321.

SFEI. 1999. 1997 Annual Report: San Francisco Estuary Regional Monitoring Program for Trace Substances. RMP Report 37. San Francisco Estuary Institute, Richmond, CA pp. A67-A80.

Solorzano, L., 1969. Determination of ammonia in natural waters by the phenolhypochlorite method. *Limnology and Oceanography* 14:799-801.

U.S. EPA. 1992. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants. 57 Federal Register 60848. December 22, 1992. U.S. Environmental Protection Agency.

U.S. EPA. 1994a. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Second Edition. EPA-600-4-91-003. U.S. Environmental Protection Agency. Environmental Monitoring Systems Laboratory. Cincinnati, OH. 97:11181-11186.

U.S. EPA. 1994b. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms. Third Edition. EPA-600-4-91-002. U.S. Environmental Protection Agency. Environmental Monitoring Systems Laboratory. Cincinnati, OH.

U.S. EPA. 1995. Method 1669: Sampling ambient water for trace metals at EPA water quality criteria levels. EPA 821-R-95-034, United States Environmental Protection Agency, Washington, D.C.

U.S. EPA. 1999. National recommended water quality criteria – correction. Office of Water. EPA 822-Z-99-001. U.S. Environmental Protection Agency.

U.S. EPA. 2000. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Rule. Federal Register Vol. 65, No. 97, May 18, 2000. U.S. Environmental Protection Agency.

3) Sediment Monitoring

Background

Since 1993, the Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP) has routinely monitored contaminants in surface sediments (top 5 cm) collected at stations throughout the San Francisco Estuary. The RMP underwent a programmatic change in 2002 and the sediment sampling component was changed from 26 targeted sites sampled annually to a randomized sampling design with 47 sites sampled annually, 40 random sites and 7 historic sites retained from the original sampling design. In 2011, the Technical Review Committee (TRC) and the Steering Committee (SC) recommended that sediment be sampled biennially. Details of this change are highlighted in the Introduction.

Sediments are monitored because they are a fundamental component of the Bay ecosystem and they play a key role in the fate and transport of contaminants. Sediments serve as contaminant sources and sinks, and most contaminants are usually found in concentrations orders of magnitude higher in the upper few centimeters of sediments than in the water column. Sediment contamination information is used in making decisions related to many important management concerns: the identification of sediment "toxic hot spots" and reference areas; the clean-up of numerous sites in the region that require information about background contaminant levels; and the continued dredging throughout the Estuary that requires testing and comparisons to a reference concentration. Information about sediments addresses several of the RMP questions listed in the *Introduction*. Beginning in 2010, sediment sampling has alternated biennially between wet season and dry season collections, with wet season collections limited to 27 sampling sites where the full sediment quality triad is analyzed.

Sites

In 2011, RMP Status and Trends Program continued with implementation of the stratified, random sampling design started in 2002 (see Chapter 1, *Introduction*). During the years 2002 – 2009, sediment contaminant monitoring was conducted each year during the dry season (September) at 47 stations, which included seven targeted historical sites. In 2010, a new sampling design was implemented where sampling began alternating each year between wet and dry seasons. This was implemented because there appears to be a seasonal element to sediment toxicity, with wet weather sampling exhibiting higher toxicity. In the new design, 27 samples will be collected during the wet season (20 at random sites and 7 at historic fixed locations) while 47 samples will continue to be collected during the dry season. In 2011, the sediment collection was conducted during the dry season and included a special study re-visiting an additional six sampling sites originally sampled through the Bay Protection and Toxic Cleanup Program ("Hotspots"). Sediments were collected from 40 of the random sites, all seven historic sites, and the six special study "Hot Spot" sites (**Figure 3.1**). In addition, benthos and sediment toxicity samples were collected at 33 sites. Samples were collected aboard the R/V *Questuary* operated by Rhomburg Tiburon Center (RTC) during August 22, 2011 – August 30, 2011. Two of the "Hot Spot" samples were unable to be accessed on the planned day (August 25th) and were collected September 1, 2011 from a back-up vessel, the RV *Kansas City*. Station names, codes, coordinates, and sampling dates for the 2011 sediment monitoring effort are listed in **Appendix 3**.

In order to allow for analysis of long-term temporal trends, repeat sampling of a subset of random sites and continued (yearly) monitoring of historic sites in each of the six regions is conducted. The Rivers Region has two historic sites, the Sacramento River (BG20) and the San Joaquin River (BG30). All other regions have one historic site each: Suisun Bay (Grizzly Bay - BF21), San Pablo Bay (Pinole Point - BD31), Central Bay (Yerba Buena Island - BC11), South Bay (Redwood Creek - BA41) and Lower South Bay (Coyote Creek - BA10). These seven historic sites were selected because they have long-term synoptic chemistry and toxicity measures associated with them (SFEI, 2005).

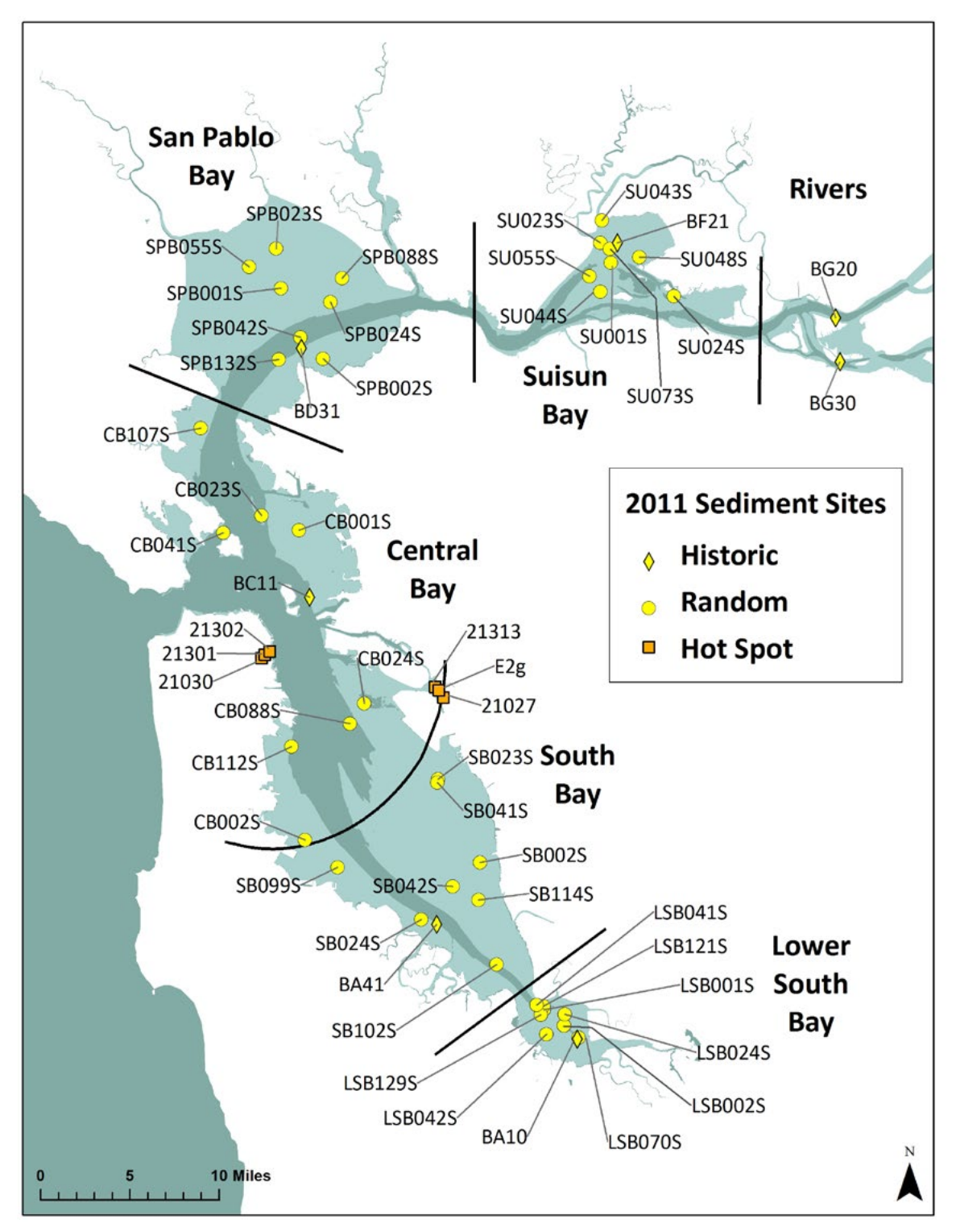

Figure 3.1 Map showing location of 2011 Sediment Stations

Sites ending with 001S or 002S were randomly allocated during the initial restructuring of the sampling scheme in 2002 and are sampled annually while those ending in 003S and 004S are sampled every 5 years.

Every attempt is made to procure acceptable sediments from the target coordinates. Acceptable sediment consists of at least 60% fines and is determined by qualitative analysis. In the event that acceptable sediment is not able to be collected, the vessel is repositioned within a 100 m radius of the given coordinates. If sediment collection is still unsuccessful, the sampling operations will proceed to the next scheduled site and the failed site will be replaced with the next site on the list of available alternative sites, referred to as an oversample site.

In 2008, one of the annual sites, SU001S, located in Suisun Bay, was permanently replaced with oversample site SU073S. Historically, SU001S was a sandy site which resulted in repeatedly failed attempts at obtaining acceptable grabs. The area was then subject to active dredging which changed the bottom profile significantly. In 2011 six sites were abandoned in the planning stage due to their inaccessibility. One additional site was abandoned in the field due to lack of suitable substrate. All abandoned sites were replaced with oversample sites.

Field Methods for Sediment Sampling

Multiple (two to three) sediment grabs were taken at each site, with sediment sub-samples collected for ancillary, chemical and toxicity analyses. Sediment samples were collected using a Young-modified Van Veen grab with a surface area of 0.1 m2. The grab is made of stainless steel, and the jaws and doors are coated with Dykon® (formerly known as Kynar®) to make them chemically inert. All scoops, buckets, and stirrers used to collect and homogenize sediments are constructed of Teflon® or stainless steel coated with Dykon®. Sediment sampling equipment was thoroughly cleaned (sequentially with detergent, acid, methanol, and rinsed with ultrapure water) at each sampling location prior to each sampling event. In order to further minimize sample contamination, personnel handling samples wore gloves and employed clean hands techniques.

To ensure the quality of the sediment samples, each grab must satisfy several criteria in order to be accepted: complete closure, no evidence of sediment washout through the doors, even distribution of sediment in the grab, minimum disturbance of the sediment surface, and minimum overall sediment depth appropriate for the sediment type. Overlying water was drained off an accepted grab. At 33 of the stations, Surface Water Interface Core (SWIC) samples were collected for toxicity testing using estuarine species. Due to the area requirements associated with the collection of SWICs, no sediment for chemical analysis is able to be collected from these grabs. The top 5 cm of sediment was collected from each of the grabs (avoiding portions cored or probed) and placed in a compositing bucket to provide a single composite sample for each site. Between sample grabs, the compositing bucket was covered with aluminum foil to prevent airborne contamination. After all sediment grabs (or at least two if complications prevent collection of sufficient material within 20 minutes) were placed into the compositing bucket, the bucket was taken into the ship's cabin and thoroughly mixed to obtain a uniform, homogeneous mixture. Aliquots were subsequently split into appropriate containers for analysis of sediment quality, trace metals, trace organics, and toxicity analyses. Samples were also collected for trace metals archive and trace organics archive. Cruise Reports documenting RMP sampling events are available on our website.

Shipboard Measurements

Conductivity, Temperature, and Depth (CTD) measurements were taken by Applied Marine Sciences (AMS-CA) at each site. A Sea-Bird SBE19 CTD probe was used to measure water quality parameters at depths throughout the water column. At each site, the CTD probe was lowered to approximately one meter below the water surface and allowed to equilibrate to ambient temperature for 3 minutes. Following the sampling, the probe was then lowered to the bottom at approximately 0.15 meters per second and raised. However, only data from the down cast were kept. Data were downloaded onboard the ship and processed in the laboratory using Sea-Bird software.

The CTD probe measured temperature, conductivity, pressure, dissolved oxygen, and backscatter at a sampling rate of two scans per second. These data were compiled and averaged into 0.25 m depth bins during processing. At this time, salinity (based on conductivity measurements), and depth (based on pressure) were calculated from the recorded measurements. Although the CTD data are not available via the online Contaminant Data Display and Download tool (CD3), the RMP maintains these data in a database, and they are available upon request.

Oxidation-Reduction Potential (ORP) and pH shipboard measurements were taken by SFEI staff at each site. Two measurements of *in situ* pH were recorded onboard the sampling vessel by submerging a Hach$_{TM}$ pH probe directly into the sediment sample to approximately 1" in depth after the Van Veen grab was brought on deck. A total of four measurements (two from each grab) were recorded at each station. Measurement of sediment ORP was resumed in 2003, measured in a cored sub-sample of the Van Veen by probe inserted (WTW Sentix ORP, KCl electrolyte) to depths of 1 cm and 6 cm from the sediment surface, and 1 cm from the core bottom. The probe was equilibrated for 10 minutes before recording each measurement.

Collection of Sediment Samples for Ancillary Parameters

The RMP analyzed sediments collected at 53 sites within the San Francisco Estuary for grainsize, percent solids, total organic carbon (TOC), and tbodyotal nitrogen (TN). Moss Landing Marine Laboratories (MLM) conducted the grainsize analysis. Sediments for grainsize analysis were collected in Whirl-pak bags and were stored without refrigeration. Sediment samples collected for TOC, % solids and TN were analyzed by Columbia Analytical Services (CAS). Sediments for these analyses were collected in 60 ml glass jars and frozen at the end of the day.

Collection of Sediment Samples for Trace Element Parameters

Sediment was collected at 53 sites within the San Francisco Estuary for analysis of the trace elements aluminum (Al), cadmium (Cd), copper (Cu), iron (Fe), Manganese (Mn), nickel (Ni), lead (Pb), silver (Ag), zinc (Zn), and % solids by the City and County of San Francisco laboratory (CCSF). CCSF supplied factory cleaned I-Chem 200 series (or equivalent) 250 ml HDPE containers. After collection, samples were placed on dry ice and kept frozen until delivered to CCSF.

Analysis of additional trace elements arsenic (As), mercury (Hg), methylmercury (MeHg), selenium (Se), and % solids was conducted by Brooks Rand Ltd. (BR). BR provided I-Chem 300 series factory cleaned 250 ml HDPE containers. Due to special handling requirements, samples collected for methylmercury analysis were placed on dry ice within 20 minutes of collection. All other samples were placed on dry ice as soon as possible. All samples were kept frozen until analyses.

Collection of Sediment for Trace Organic Parameters

Sediment was collected at 53 sites for the analysis of the trace organics parameters polycyclic aromatic hydrocarbons (PAHs), polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyls (PCBs), and pesticides by East Bay Municipal Utility District (EBMUD). EBMUD provided factory cleaned I-Chem 200 series (or equivalent) 250 ml glass containers. Samples were placed on dry ice immediately after collection and kept frozen until delivered to EBMUD.

Sediment was collected at 27 sites for analysis of pyrethroids at the California Department of Fish and Game Water Pollution Control Laboratory (CDFG-WPCL). Samples were collected in factory cleaned I-Chem 200 series (or equivalent) 250 ml glass containers and stored on dry ice after homogenization. Samples were kept frozen until analysis.

Collection of Sediment for Toxicity Testing

Two types of samples were taken for analysis of sediment toxicity by the UC Davis Marine Pollution Studies Laboratory at Granite Canyon (UCD-GC). Whole sediments samples were taken from 33 stations for analysis of toxicity to Eohaustorius estuarius. In 2008, the RMP reinstated collection of surface water interface cores (SWICs). This year, SWICs were collected at 33 stations for development tests using the bivalve Mytilus galloprovincialis. Additional SWICs were collected at the two river stations for tests using freshwater species Ceriodaphnia dubia and *Hyalella azteca*.

One liter plastic containers were provided by UCD-GC for the collection of homogenized sediment for the amphipod toxicity tests. Eight-inch cores were used to collect intact cores (~1.5 inches deep) for the SWIC toxicity tests. Each core was capped with a lid that contained air holes and sealed around the edges using parafilm. The cores were kept upright and stored in a refrigerator or on wet ice until analysis by UCD-GC.

All sampling containers were pre-cleaned by the lab using the following procedures: containers were scrubbed with dilute micro solution, rinsed with deionized water (DI), rinsed with hexane, and rinsed with DI again. The containers were then soaked for 24 hours in an acid bath, rinsed with DI and then soaked for 24 hours in a DI bath. Containers were rinsed again with DI water and placed in a drying oven overnight.

Collection of Sediment Benthos

The RMP collected benthos samples at the same 33 sites where sediment toxicity was tested. Samples were screened through 0.5 and 1.0 mm nested sieves while onboard ship. The material retained on the screen was placed in sample jars, and a solution of relaxant was added to the jar. After approximately 15 minutes, 10% sodium borate buffered formalin was added to fix each sample. Samples were rinsed and transferred from formalin to 70% ethanol 3-14 days after collection. Taxonomic identification of benthic organisms is led by City and County of San Francisco – Oceanside Biology Laboratory (CCSF-OBL) with additional assistance from James Oakden (Moss Landing Marine Lab), and Susan McCormick.

Collection of Sediment for Archive Storage

Sediment was collected at 53 sites for short-term and long-term archive storage. After homogenization, sediment was allocated into 60 ml glass jars with Teflon lids and 250 ml HDPE jars for short-term archive storage while sediment for long-term archive storage was allocated into 10 ml plastic cryovials or 22 ml Teflon vials. Containers are stored on dry ice while awaiting transport to their respective storage facilities. For more information on the RMP Archive strategy see the report Procedures for the Collection and Storage of Environmental Samples in the RMP Specimen Bank.

Laboratory Methods for Sediment Analysis

SFEI contracts with a number of laboratories that provide high quality analytical services. Qualifications for our labs include ISO registration, NELAP accreditation and certification by the California Department of Public Health. A brief overview of the laboratory methods used for RMP target analytes are described below. SFEI maintains SOPs for all laboratory analyses. Please contact Donald Yee donald@sfei.org or Cristina Grosso cristina@sfei.org for more details.

Laboratory Methods for Percent Solids

Percent solids are the percent content by weight of solid material in a sediment sample. Brooks Rand LLC (BR) measured percent solids in sediment using Method SM 2540G. For this method, a solid sample was homogenized, then portioned, dried, measured, and the percent of dried solid material calculated.

ALS Laboratory Group, formerly Columbia Analytical Services, analyzed percent solids as part of their analysis of Total Organic Carbon and Total Nitrogen using EPA method 1684. Sample aliquots of 25-50 g are dried at 103 to 105 degrees C to drive off water in the sample.

City and County of San Francisco (CCSF) analyzed percent solids as part of their analysis of trace metals using a modification of EPA method 6020A. When analyzing for trace metals in sediment a separate homogeneous aliquot of the sample must be dried to determine total percent solids.

EBMUD analyzed percent solids using EPA Method 160.3.

Laboratory Methods for Grainsize

Grainsize analysis prior to 2008 was conducted by the University of California Santa Cruz – Department of Environmental Toxicology (USCS-DET). In 2008 grainsize determination changed to an optical method and was analyzed by Moss Landing Marine Lab - Geological Oceanography (MLML-GeoOc) using a Beckman-Coulter laser particle size analyzer after digestion with hydrogen peroxide according to Aiello and Kellett (2006). In addition to silt (0.0039 to <0.0625 mm) and sand (0.0625 to <2.0 mm), granule and pebble (2.0 to <64 mm) and clay particles (<0.0039 mm) were also analyzed with the LS 13 320 laser particle sizer in 2011.

Laboratory Methods for Total Organic Carbon (TOC) and Total Nitrogen (TN)

Analysis of TOC and TN was performed by Columbia Analytical Services (CAS) using EPA 440. The samples were prepared for analysis by air drying followed by grinding in a mini ball mill. All samples were then analyzed for TOC and TN on HCL acidified samples using combustion at 950°C with thermoconductivity detection.

Laboratory Methods for Trace Elements

Trace metals in sediment were analyzed by the City and County of San Francisco (CCSF) and Brooks Rand Ltd. (BR).

Total trace metals analyzed by CCSF consisted of aluminum (Al), cadmium (Cd), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), nickel (Ni), silver (Ag) and zinc (Zn). These metals were measured using a modification of the EPA digest method 3050B, and modified EPA analysis method 6020A. For the digestion of samples, a representative 1 – 2 gram (wet weight) or 1 gram (dry weight) sample was digested with repeated additions of nitric acid (HNO_3) and hydrogen peroxide (H_2O_2). Samples were analyzed using Inductively Coupled Plasma-Mass Spectrometry (ICP-MS).

Sediments were analyzed for mercury by BR using a modified version of EPA Method 1631. Samples were digested in HNO_3 and H_2SO_4, and then further oxidized with bromine monochloride (BrCl). Samples were analyzed with stannous chloride ($SnCl_2$) reduction, single gold amalgamation and cold vapor atomic fluorescence spectroscopy (CVAFS) detection using a BR Model III CVAFS Mercury Analyzer. All sample results for low-level mercury analysis were blank corrected.

Arsenic and selenium concentrations were measured in sediments using proprietary method BR-0020 Rev 007 by BR. Samples were first oxidized by heating with specific reagents. For the analysis of arsenic, sample concentrations were determined by hydride generation – cryogenic trapping – atomic absorption spectrometry (HG-CT-AAS). For the determination of selenium, samples were reduced in HCl with addition of hydroxylamine hydrochloride (NH_2OH HCl) and heating, converting all selenium to Se(IV). After that HG-CT-AAS was performed.

Methylmercury in the sediment samples was analyzed by BR using a modified EPA Method 1630. The sediment samples were prepared by acid bromide/methylene chloride extraction. The samples were analyzed by aqueous phase ethylation, Tenax trap collection, gas chromatography separation, isothermal decomposition, and cold vapor atomic fluorescence spectroscopy (CVAFS).

Laboratory Methods for Trace Organics

In 2008, pyrethroids were added to the suite of organic contaminants monitored in sediments by the RMP in order to investigate the potential toxicity of pyrethroids in the bay. In 2011 analysis was again conducted by California Department of Fish and Game Water Pollution Control Laboratory (CDFG-WPCL). Samples were prepared using an automated extraction system and analyzed using a modified version of EPA 8081B by dual column gas chromatography with dual electron capture detectors (GC-ECD) and/or gas chromatography with triple quadruple mass spectrometry (GC-MSMS).

Sediment organics were analyzed by EBMUD. Samples are generally analyzed based on the methods followed by the National Oceanic and Atmospheric Administration's (NOAA's) National

Status and Trends Program. PAHs were analyzed using gas chromatography/mass spectrometry (GC/MS), and PCBs, PBDEs, and organochlorine (OC) pesticides were analyzed using high resolution gas chromatography – mass spectrometry (HRGC-MS).

EBMUD used the following extraction and concentration procedure for all sediment trace organic compounds of interest. Samples were homogenized and then extracted using a Dionex Accelerated Solvent Extraction (ASE; EPA Method 3545). The sample extracts were dried with anhydrous granular Na2SO4. Extracts were cleaned up with an alumina/copper column and concentrated to 1 ml in dichloromethane (DCM).

Just prior to analysis of PAHs the sample extracts were spiked with deuterated internal standards (fluorine-d10 and benzo[a]pyrene-d12). PAHs were then analyzed using U.S. EPA Method 8270, which was slightly modified to provide sufficient sensitivity for PAHs in sediments.

Samples were analyzed for OC pesticides using a modification of EPA method 1668A. Just prior to analyses, injection internal standards were added to the sample extracts, and then an aliquot of the extract was injected into the gas chromatograph. The analytes were separated by the gas chromatograph and detected by a high resolution (>8,000) mass spectrometer (HRMS). Two exact mass-to-charge ratios (m/z's) were monitored throughout a predetermined detention time.

Samples were analyzed for PCBs using EPA Method 1668A. A cleanup standard was spiked into the extract prior to analyses. The extract was then put through a drying column and concentrated. After drying and concentrating, the samples were cleaned up using gel permeation and activated alumina column chromatography. After cleanup, the solvent was exchanged to hexane. Injection internal standards were added to each extract before injection into the gas chromatograph. The analytes were separated by gas chromatography and detected by a high-resolution (>10,000) mass spectrometer (HRMS). Similar to the oc-pesticide analyses, two exact m/z's were monitored throughout a predetermined detention time.

Sediments were analyzed for PBDEs using a modification of EPA method 1614. A cleanup standard was spiked into the extract, which was then dried and concentrated. The samples were then purified using an activated alumina column, and the solvent in the samples was exchanged to hexane. Just prior to the analysis, injection internal standards were added to each extract and an aliquot was injected into the gas chromatograph. Similar to OC pesticides and PCB analyses, the PBDE congeners were separated by the gas chromatograph and detected by a high-resolution (>5,000) mass spectrometer (HRMS) with two exact m/z's monitored for each compound.

Quality Assurance/ Quality Control (QA/QC)

QA/QC of Ancillary Parameters

Percent Solids

Percent solids were measured individually along with analyzed samples by all chemical analytical labs in order to determine chemical concentrations on a dry weight basis. Variations of a few percent among subsamples between labs (and within labs for replicates) frequently result due to slight heterogeneity within samples.

3.1 Target Sediment Analytes: A summary table of the 2011 target analytes, analytical laboratories, reporting units, and method codes.

Parameter	Lab(s)	Reporting Unit	Method Code(s)
Depth	AMS-CA	m	NA
pH (porewater, interstitial sediment)	AMS-CA	pH	Cole Parmer pH meter Model 20
% solids	BR/ALS/CCSF/ DFG-WPCL / EBMUD	%	Various
Arsenic (As)	BR/CCSF	mg/Kg	EPA 1638 Mod./ EPA 6020A Mod.
Mercury (Hg)	BR	mg/Kg	EPA 1631M
Mercury, Methyl (MeHg)	BR	µg/Kg	EPA 1630 Mod.
Selenium (Se)	BR/CCSF	mg/Kg	(EPA 1632A Mod.)/ EPA 6020A Mod.
Total Nitrogen	CAS	%	EPA 440
Total Organic Carbon	CAS	%	EPA 440
Aluminum (Al)	CCSF	mg/Kg	EPA 6020A Mod.
Cadmium (Cd)	CCSF	mg/Kg	EPA 6020A Mod.
Copper (Cu)	CCSF	mg/Kg	EPA 6020A Mod.
Iron (Fe)	CCSF	mg/Kg	EPA 6020A Mod.
Lead (Pb)	CCSF	mg/Kg	EPA 6020A Mod
Manganese (Mn)	CCSF	mg/Kg	EPA 6020A Mod.
Nickel (Ni)	CCSF	mg/Kg	EPA 6020A Mod.
Silver (Ag)	CCSF	mg/Kg	EPA 6020A Mod.
Zinc (Zn)	CCSF	mg/Kg	EPA 6020A Mod.
Pyrethroids	DFG-WPCL	µg/Kg	EPA 8081BM
PAHs (Low and High Molecular Weight, Alkylated)	EBMUD	µg/Kg	EPA 8270 Mod.
Cyclopentadienes	EBMUD	µg/Kg	EPA 1668A Mod.
Chlordanes	EBMUD	µg/Kg	EPA 1668A Mod.
DDTs	EBMUD	µg/Kg	EPA 1668A Mod.
HCHs	EBMUD	µg/Kg	EPA 1668A Mod.
Other Synthetic Biocides (Fipronil , Fipronil desulfinyl , Fipronil sulfide , Fipronil sulfone Hexachlorobenzene, Mirex,)	EBMUD	µg/Kg	EPA 1668A Mod.
PBDEs	EBMUD	µg/Kg	EPA 1614 Mod.
PCBs	EBMUD	µg/Kg	EPA 1668A
Grainsize	MLML-GeoOc	%	Beckman-Coulter Laser Particle Size Analyzer
Sediment Toxicity – *Eohaustorius estuarius*	UCD-GC	%	EPA 600/R·94-025
Sediment Toxicity – *Mytilus galloprovincialis*	UCD-GC	%	EPA 600/R-95-136M
Sediment Toxicity – Fresh Water *Hyalella azteca*	UCD-GC	%	EPA 600/R-99-064
Sediment Toxicity – Fresh Water *Ceriodaphnia dubia*	UCD-GC	%	EPA 821/R-02-012M

Grain Size by Moss Landing Marine laboratory

Starting in 2008, grainsize for particles <2mm was determined by an optical (laser scattering) method, which measures particle size distribution as a percentage of volume (rather than mass from sieving and weighing methods in prior years). Currently, the larger than sand fraction >2mm (typically bivalve shells and shell fragments) was determined as a percentage of bulk sediment mass, with the size distribution of the remaining (<2mm) fraction determined by the optical method. Comparisons of optical versus sieving/weighing particle size distribution determinations in the literature have shown good agreement for deep marine sediments, although RMP split samples measured by weighing have shown some variation between methods (% fines within 10% for most samples, but up to 30% difference in some cases). The lab has implemented a procedure of performing the optical analyses in replicate for all samples, but there remained variations among lab replicates for sand in some samples, so sand data were flagged variable precision but not censored. The data are generally as expected for the bay, dominantly fine material in most samples. Intercomparisons between sieved and laser determined grain size in samples analyzed by the lab showed generally similar results, about 10-20% difference in the % fine (<63um) material determined by the two methods.

Total Organic Carbon and Total Nitrogen by Columbia Analytical Services (CAS)

Analyses of Total Organic Carbon (TOC) and Total Nitrogen (TN) showed no major problems. All TOC and TN results were above the detection limits. Some blank contamination was observed for TOC with only one sample censored for concentration less than 3 times the blank. Accuracy and precision were fine with results on QC samples within the targeted acceptance ranges (for average recovery errors and replicate RSDs) of 15% for TN and 5% for TOC. Average concentrations reported for TN and TOC were within similar ranges as reported by the RMP Status and Trends program in previous years

QA/QC of Trace Elements

Sediment sample trace elements (other than As, Hg, and Se) were measured at the City and County of San Francisco (Southeast Wastewater Treatment Plant Laboratory) and showed no major issues. Method sensistivity was sufficient for all target analytes to be detected in all field samples. Of the target analytes, only Nickel was found in blanks, always at concentrations at least 3 times lower than in field samples, so results were flagged but not censored. Precision on lab replicates was good for all analytes, with RSDs <25%. Recoveries were good (<25% average error) for all target analytes except Aluminum, which showed a low bias (<50% recovery in CRMs), but it was recognized that samples were digested by a method that typically does not fully recover aluminum in natural minerals. Aluminum is typically not toxic in natural mineral forms, so this low recovery does not impact estimates of toxicity posed by sediments. Concentrations were similar to previous years' averages for the target elements.

Brooks Rand measured As, Hg, MeHg, and Se in sediment samples, with generally good data quality. Detection limits were sufficient for measurement of most analytes in all samples, except Se, which was not detected in about 15% of the samples. No target analytes were detected in blanks. Recoveries on SRMs all averaged within 25% of target values, and precisions on lab replicates were good, averaging <25% RSD. Concentrations were similar to past years, with average and maximum concentrations similar to previous 5 years. Ratios of methyl to total mercury also looked reasonable, with MeHg around 0.1% of total Hg.

QA/QC of Trace Organics

PAHs, PBDEs, PCBs, and pesticides (aside from pyrethroids) were analyzed in sediment by the East Bay Municipal Utility District Treatment Plant Laboratory. Pyrethroids were analyzed by CA Department of Fish and Game.

Detection limits were sufficient to measure most of the targeted PAHs in a majority of samples, but over half of the alkylated PAHs were not detected in all samples. Three of the 25 reported PAHs and two of 19 alkylated PAHs were detected in method blanks. Blanks were over 1/3 concentrations in field samples for 2-Methylnaphthalene and C1-Naphthalenes and were censored in around 10% of samples for those analytes. Replicate RSDs for field samples or matrix spikes (for analytes where ambient concentrations were too low to measure) were within the target 35% average for most analytes except Acenaphthylene and Anthracene, which were flagged but not censored. Recoveries on CRMs and matrix spikes were generally good, with only Chrysene and Fluoranthene showing recovery errors averaging >35%, flagged but not censored. The alkylated PAHs do not have any recovery checks as groups, only for selected compounds as individual (mostly methylated) PAHs. Most of the analytes were in the same general concentration range as previous years (2004-2010), with no unusual concentration differences indicating analytical or reporting problems.

PBDE detection limits were sufficient to quantify in a majority of samples for the expected most abundant PBDEs (47, 99, 100, 153, and 209). No PBDE congeners were found in blanks above MDLs. Average RSDs on matrix spike replicates were within the target <35% for most analytes except PBDEs 066 and 153, flagged but not censored for being moderately above that range. Recoveries on matrix spikes averaged <35% error for all reported compounds. Concentrations were generally similar to previous years for most PBDEs at the RMP S&T stations, although expected hotspot locations sampled at the same time showed higher concentrations.

PCB analyses showed only minor QC issues with a few of the less abundant congeners. Detection limits were sufficient to report a majority of PCBs, with only a quarter of the less abundant congeners showing non-detects in a majority of samples. Four of the PCBs were found in method blanks, censored (for concentrations <3 times those in blanks) in <10% of samples, except PCB 003, censored in 26 of sample results. Replicates on field samples or matrix spikes were generally good, within the target 35% average RSD except for PCB 009, flagged but not censored. Recoveries on CRMs and matrix spikes were good, with errors averaging <35%. Most of the PCBs were in the same general concentration range as previous years. Similar to 2010, a Sum of 208 PCBs is reported due to the prevalence of PCB 011, a synthetic dye by-product. Unlike Aroclor PCB mixtures, PCB 011 does not contain notable amounts of coplanar (dioxin-like) PCB congeners, which account for nearly all the risk associated with PCBs. A sum of 208 PCBs (that is, excluding PCB 011) is thus expected to be a better surrogate measurement of the presence of the toxic dioxin-like PCBs, which individually are often below detection limits.

Pesticides reported by EBMUD included primarily legacy organochlorine pesticides, and fipronil. Detection limits yielded non-detects in over half the samples for 9 of the 26 pesticides, but the method was sufficiently sensitive for the remainder. Only a few fipronil analytes and alpha HCH were found in blanks, with 10-20% of the samples censored for concentrations less than 3 times those in blanks. Precision was within the target 35% average RSD for all analytes except o,p'-DDT and p,p'-DDT, with the latter censored for very high (>70% RSD) variability. Recoveries on CRMs and MSs were generally good, averagingi within 35% of target values except for p,p'-DDT, trans-Nonachlor, and Fipronil, which were flagged but not censored. Delta-HCH, Heptachlor, Mirex , and Oxychlordane were over four times higher than previous years averages, but concentrations were still low relative to expected toxicity levels.

The California Department of Fish and Game lab at Rancho Cordova measured sediment concentrations of 14 pyrethroid analytes (some co-eluting compounds that could not be resolved). Detection limits ranged from 0.14 to 1.12 ng/g dw, with non-detects in 100% of samples for all analytes except bifenthrin, with non-detects in just under half the samples. LC50s for bifenthrin in sediments are ~2-10ng/g, with slightly higher LC50s for most other pyrethroids, so despite many NDs, MDLs are probably low enough to measure levels that would be acutely toxic. None of the target compounds were found in lab blanks. Precision was good, with RSDs averaging less than the 35% target for all analytes (in matrix and/or blank spike replicates). Matrix spike recoveries had average errors slightly above the target of 35% for Allethrin, Resmethrin, Tetramethrin, and total Esfenvalerate/Fenvalerate, but only Cis-Permethrin had large errors (>70%) and was censored. The average concentration of Bifenthrin, the only pyrethroid detected, was similar to those in past RMP S&T sediment samples.

Sediment Toxicity

Two types of sediment bioassays were conducted at 27 of the RMP stations in 2011 (**Figure 3.2**). Homogenized whole-sediment was tested for toxicity using the amphipod *Eohaustorius estuarius* in the 10-day amphipod survival test (EPA 600/R-94-025). Sediment was re-homogenized in the sample jars by placing them on a rolling apparatus and manually stirring with a polypropylene spoon. Samples were then distributed to replicate test beakers. Overlying water was added to the test containers, and sediment was allowed to equilibrate overnight before the amphipods were added. Randomly selected amphipods were placed into replicate containers and allowed to burrow into the test sediments. Amphipods were exposed to whole sediment for ten days with percent survival as the endpoint. The negative control for the *E. estuarius* solid-phase test consisted of home sediment, which was clean, well-sorted fine-grained sand collected at the same place and time as the test amphipods.

Surface-water interface (SWI) cores were tested using the bivalve *Mytilus galloprovincialis* in a 48-hour static embryo-larval development toxicity tests (EPA 600/R-95-136M). SWI cores were prepared for analysis by adding overlying water and allowing the cores to equilibrate overnight. Bivalve embryos were added by placing a 25 µm screen tube into each core. At the end of each test the larvae were isolated from the cores by removing the screen tubes and rinsing the larvae into 20 ml scintillation vials. The contents were preserved with formalin. The mussel larvae were counted to determine the percentage of embryos that developed into live normal larvae. The negative controls for the *M. galloprovincialis* tests consisted of SWI cores filled with clean home sediment as described above.

A sample was considered toxic if:

1. There was a significant difference between the laboratory control and test replicates using a separate variance t-test (alpha = 0.01), and

2. % survival for amphipods or % normal alive for bivalves was less than the evaluation threshold of effect (the Control minus the MSD). The difference between the mean endpoint value in the control and the mean endpoint value in the test sample was greater than the 90th percentile minimum significant difference (MSD).

A sample must meet both criteria to be considered toxic, because a t-test can often detect small differences between samples when there is low variance among laboratory replicates. One way to ensure that statistical significance is determined based on large differences between means, rather than on a small variation among replicates, is to use the MSD. MSD is a statistic that indicates the difference between the two means (the mean of the sample and control replicates) that will be

considered statistically significant given the observed level of among-replicate variation and the alpha level chosen for the comparison. MSD values generated from RMP *E. estuarius* and *M. galloprovincialis* tests were used by UCD-GC to establish a 90th percentile MSD threshold. This analysis indicates that the *E. estuarius* test is capable of identifying statistically significant differences in 90% of cases, where the difference between the treatment and the control is 18.8%. The threshold is calculated by subtracting 18.8% from the control response. The bivalve larvae 90th percentile MSD is 15.2% (Phillips et al., 2001). The control response for the amphipod test were 93% and 95%, and the toxicity threshold were 74.2% and 76.2%. Control response for the bivalve larvae test 89.4%, 95.8%. and 72.4%%, and the toxicity thresholds were 74.2%, 80.6%, and 57.2%.

Sediments were not toxic to amphipods, *Eohaustorius estuaries*, or mussel, *Mytilus galloprovincialis,* larvae at 6 out of 27 stations (**Figure 3.2**). Amphipod toxicity was observed at 13 stations: Suisun Bay (Grizzly Bay (BF21), SU048S, and SU073S), San Pablo Bay (SPB023S), Central Bay (CB088S), South Bay (Redwood Creek (BA41), SB002S, SB024S, SB041S, and SB102S), and Lower South Bay (Coyote Creek (BA10) LSB002S and LSB024S). Sediment samples from 13 stations were toxic to larval mussels:, Suisun Bay (Grizzly Bay (BF21), SU024S, SU044S, and SU048S), San Pablo Bay (SPB023S), Central Bay (Yerba Buena Is. (BC11), CB001S, CB023S, CB088S, and CB112S), South Bay (SB002S, and SB024S), and Lower South Bay (LSB024S). A toxic sample indicates the potential for biological effects to estuarine organisms. However, since sediments contain numerous contaminants, it is difficult to determine which contaminant(s) may have caused the observed toxicity. Further laboratory tests, Toxicity Identification Evaluations (TIEs), are required to investigate the potential causes of an observed toxic hit.

The RMP only performs TIEs on sediments that have less than 50% survival (or normal-development). The RMP program managers authorize these additional studies on a case-by-case basis based on the annual bioassay results. No sediment TIEs were performed in 2011. The Exposure and Effects Work Group (EEWG) recommended that work to address the causes of the observed toxicity be continued over the next five years, and recommended a workgroup process to develop and oversee new studies. Please see the report RMP Sediment TIE Study 2007-2008 for a more detailed account of the initial study, and the EEWG website for an update on new RMP special studies addressing current issues related to the causes of toxicity.

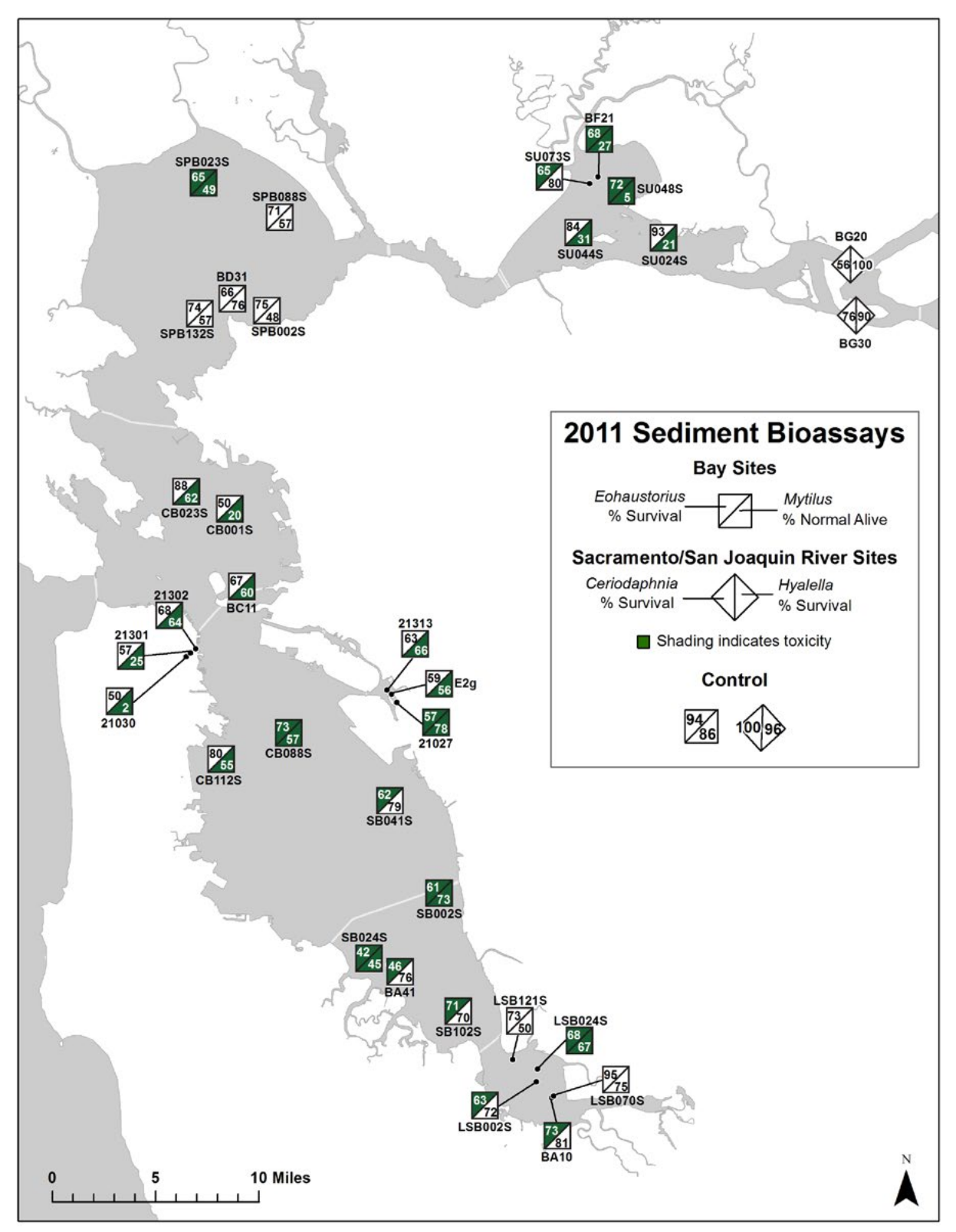

Figure 3.2 Sediment bioassay results for 2011.

Table 3.2. Sediment Quality (dry weight basis).

Effects Range-Low (ERL) and Effects Range-Median (ERM) values from Long et al. (1995, 1998).
Effects Range-Low; values between this and the ERM are in the possible effects range.

Effects Range-Median; values above this are in the probable effects range.

San Francisco Bay Ambient Sediment Concentrations (ASC) from Gandesbery et al. (1999).
Ambient sediment levels from background sediments in the Estuary allow one to assess whether a site has elevated levels or is "degraded".

Background sediment concentrations for selected trace elements in the San Francisco Bay, from Hornberger et al. (1999)
Chromium and nickel concentrations observed throughout the core. All trace elements, except Ag, measured by Inductively Coupled Argon Plasma Emission Spectroscopy (ICAPES). Ag measured by Graphite Furnace Atomic Absorption Spectrometry (GFAAS).

Near total metals are extracted with a weak acid for a minimun of one month, therefore, concentrations approximate the bioavailability of these metals to Estuary biota.

Parameter	unit	ERL	ERM	ASC-sandy <40% fines	ASC-muddy >40% fines	Background Concentrations (Bay wide ranges)	
						Total	Near Total
Arsenic	mg/Kg	8.2	70 †	13.5	15.3		
Cadmium	mg/Kg	1.2	9.6 †	0.25	0.33		
Chromium	mg/Kg	81	370 †	91.4	112	110 - 170	70 - 120
Copper	mg/Kg	34	270 †	31.7	68.1	20 - 55	20 - 41
Mercury	mg/Kg	0.15	0.71 †	0.25	0.43		0.05 - 0.07
Nickel	mg/Kg	20.9	51.6	92.9	112	70 - 100	50 - 100
Lead	mg/Kg	46.7	218 †	20.3	43.2	20 - 40	10 - 20
Selenium	mg/Kg			0.59	0.64		
Silver	mg/Kg	1	3.7 †	0.31	0.58	0.7 - 0.11	0.7 - 0.11
Zinc	mg/Kg	150	410 †	97.8	158	60 - 70	50 - 100
Sum of HPAHs (SFEI)	µg/Kg	1700	9600	256	3060		
Fluoranthene	µg/Kg	600	5100 †	78.7	514		
Perylene	µg/Kg			24	145		
Pyrene	µg/Kg	665	2600 †	64.6	665		
Benz[a]anthracene	µg/Kg	261	1600 †	15.9	244		
Chrysene	µg/Kg	384	2800 †	19.4	289		
Benzo[b]fluoranthene	µg/Kg			32.1	371		
Benzo[k]fluoranthene	µg/Kg			29.2	258		
Benzo[a]pyrene	µg/Kg	430	1600 †	18.1	412		
Benzo[e]pyrene	µg/Kg			17.3	294		
Dibenz[a,h]anthracene	µg/Kg	63.4	260 †	3	32.7		
Benzo[g,h,i]perylene	µg/Kg			22.9	310		
Indeno[1,2,3-c,d]pyrene	µg/Kg			19	382		
Sum of LPAHs (SFEI)	µg/Kg	552	3160	37.9	434		
1-Methylnaphthalene	µg/Kg			6.8	12.1		
1-Methylphenanthrene	µg/Kg			4.5	31.7		
2,3,5-Trimethylnaphthalene	µg/Kg			3.3	9.8		
2,6-Dimethylnaphthalene	µg/Kg			5	12.1		
2-Methylnaphthalene	µg/Kg	70	670 †	9.4	19.4		
Naphthalene	µg/Kg	160	2100 †	8.8	55.8		

Parameter	unit	ERL	ERM	ASC-sandy <40% fines	ASC-muddy >40% fines	Background Concentrations (Bay wide ranges)	
Acenaphthylene	µg/Kg	44	640 †	2.2	31.7		
Acenaphthene	µg/Kg	16	500 †	11.3	26.6		
Fluorene	µg/Kg	19	540 †	4	25.3		
Phenanthrene	µg/Kg	240	1500 †	17.8	237		
Anthracene	µg/Kg	85.3	1100 †	9.3	88		
Sum of PAHs (SFEI)	µg/Kg	4022	44792	211	3390		
p,p'-DDE	µg/Kg	2.2	27 †				
Sum of DDTs (SFEI)	µg/Kg	1.58	46.1 †	1.58	46.1		
Total Chlordanes (SFEI)	µg/Kg	0.5	6	0.42	1.1		
Dieldrin	µg/Kg	0.02	8	0.18	0.44		
TOTAL PCBs (NIST 18)	µg/Kg			5.9	14.8		
Sum of 40 PCBs (SFEI)	µg/Kg	22.7	180 †	8.6	21.6		

† Values used to calculate mean ERM quotients (Hyland et al. 1999).

Assessment of Sediment Quality

Estuary sediments are evaluated through comparisons to several sets of sediment quality guidelines (**Table 3.2**). Although these guidelines hold no regulatory status, they provide concentration guidelines that are useful in assessing the potential for toxic and benthic effects.

Sediment contamination and toxicity results were used to evaluate the quality of the 2011 Regional Monitoring Program samples (**Table 3.3**). Sediment contamination was estimated for each site by considering the number of contaminants in a sample that exceeded the San Francisco Estuary Ambient Sediment Concentration (ASC: Gandesbery et al., 1999), Effects-Range guidelines (ERL and ERM: Long et al., 1995), and the ERM quotients (Long et al., 1998). The number of sediment contaminants above the ERL or ERM guidelines has been used previously to predict potential biological effects (Long et al., 1998). Long et al. (1998) found that samples with more than four ERM exceedances showed toxicity in 68% of amphipod tests, while 51% of samples were toxic to amphipods when more than nine ERLs were above the guidelines. Based on these results the 2011 RMP sediment samples were considered potentially toxic if either four or more ERMs, or nine or more ERLs were exceeded. Samples that did not have values for at least 80% of the parameters (24 of 30 for ERL and ERM) were not included in the calculations.

ERM values were used to calculate a mean ERM quotient (mERMq) for each sample. The mERMq has been used in previous RMP reports and San Francisco Estuary publications as an index of cumulative sediment contaminant concentrations (Thompson et al., 1999; Hunt et al., 2001a,b; Fairey et al., 2001; Thompson and Lowe, 2004). The primary reason for using the mERMq is that it provides a measure of potential additive contaminant effects. For example, amphipod survival has been found to be significantly and inversely correlated to mERMq (Thompson et al., 1999), suggesting that contaminants individually present in relatively low concentrations in sediments may act together to adversely influence amphipod survival. In past reports and publications, however, the mERMq has been calculated in several different ways. However, if comparisons to other U.S. estuaries are to be accomplished, a standard method of calculation is necessary. Therefore, the calculation of mERMq was changed in order to make the RMP ERM quotients comparable to other studies from around the U.S. (Hyland et al.,

1999; Long et al., 2002; Hyland et al., 2003). The 2011 mERMqs were calculated using 24 parameters as indicated in **Table 3.2** per the Hyland method (Hyland et al., 1999). Samples that did not have at least 19 of the 24 parameters were not included in the calculations. Twenty-three analytes were reported for all but four of the 2011 sediment samples. Twenty two analytes were reported for BG20, SU024S, SU044S, SU055S (2-Methylnaphthalene was not reported for these samples).

Long et al. (1998) showed that 49% of sediment samples were toxic to amphipods when mERMq values were greater than 0.5, and 71% of samples were toxic when mERMq values were greater than 1.0. Mean ERM quotients, calculated with 24 contaminants, were used in a previous study of the San Francisco Estuary in which values greater than 0.15 were associated with increased risks of benthic impact (Thompson and Lowe, 2004). These values were used to evaluate the 2011 RMP sediment samples for potential adverse ecological effects.

In 2011, four stations were considered potentially toxic by the RMP (CB002S, CB122S, LSB002S, and SB099S) because nine or more contaminant concentrations were above the ERL guidelines. No stations sampled in 2011 had four or more contaminant concentrations above the ERM guidelines (**Table 3.3**). Only one station had a mERMq value greater than 0.15 (SB099S) and at least 9 results above the ERL guidelines (**Table 3.3**).

Sediment evaluations are useful tools that incorporate sediment contamination and toxicity into a weight of evidence assessment of the condition of sediments in the Estuary. Each component is analyzed independently and weighted equally, but although they should be related the results do not always agree. The complexity of sediment evaluations demonstrate the need to consider as much data as possible in assessing the condition of Estuary sediments and the importance of performing future studies to reconcile and understand the observed contradictions.

Table 3.3. Summary of sediment quality for the RMP in 2011.

. indicates not tested, * indicates number of exceedances above ASC guidelines for sandy samples.

Code	Site Name	Date	% Fines	mERMq	No. of ASC above Guidelines	No. of ERL above Guidelines	No. of ERM above Guidelines	Toxic to Amphipods Eohaustorius?	Toxic to Bivalves Mytilus?	Toxic to Ceriodaphnia dubia?	Toxic to Hyalella azteca?
BG20	Rivers	8/30/11	38	0.0179	0*	2	1	.	.	no	no
BG30	Rivers	8/30/11	82	0.0585	2	4	1	.	.	no	no
BF21	Suisun Bay	8/30/11	100	0.0775	1	7	1	yes	yes	.	.
SU001S	Suisun Bay	8/29/11	99	0.0333	1	3	1	.	.	.	.
SU023S	Suisun Bay	8/30/11	90	0.0530	0	6	1	.	.	.	.
SU024S	Suisun Bay	8/30/11	74	0.0304	0	1	1	no	yes	.	.
SU043S	Suisun Bay	8/30/11	98	0.0502	1	5	1	.	.	.	.
SU044S	Suisun Bay	8/29/11	41	0.0260	0	1	1	no	yes	.	.
SU048S	Suisun Bay	8/30/11	99	0.0704	0	7	1	yes	yes	.	.
SU055S	Suisun Bay	8/29/11	63	0.0607	0	6	1	.	.	.	.
SU073S	Suisun Bay	8/29/11	99	0.0740	1	7	1	yes	no	.	.
BD31	San Pablo Bay	8/26/11	100	0.0656	0	7	1	no	no	.	.
SPB001S	San Pablo Bay	8/29/11	100	0.0739	1	6	1	.	.	.	.
SPB002S	San Pablo Bay	8/26/11	100	0.0722	0	6	1	no	no	.	.
SPB023S	San Pablo Bay	8/26/11	99	0.0702	0	6	1	yes	yes	.	.
SPB024S	San Pablo Bay	8/29/11	98	0.0617	0	6	1	.	.	.	.
SPB042S	San Pablo Bay	8/26/11	98	0.0393	0	3	1	.	.	.	.
SPB055S	San Pablo Bay	8/29/11	100	0.0756	0	6	1	.	.	.	.
SPB088S	San Pablo Bay	8/29/11	99	0.0335	0	1	1	no	no	.	.
SPB132S	San Pablo Bay	8/26/11	99	0.0543	0	5	1	no	no	.	.
BC11	Central Bay	8/25/11	96	0.0757	0	5	1	no	yes	.	.
CB001S	Central Bay	8/26/11	99	0.0904	2	7	1	no	yes	.	.
CB002S	Central Bay	8/23/11	100	0.1296	19	14	1	.	.	.	.
CB023S	Central Bay	8/25/11	76	0.0724	1	5	1	no	yes	.	.
CB024S	Central Bay	8/24/11	96	0.0611	0	4	1	.	.	.	.

Code	Site Name	Date	% Fines	mERMq	No. of ASC above Guidelines	No. of ERL above Guidelines	No. of ERM above Guidelines	Toxic to Amphipods Eohaustorius?	Toxic to Bivalves Mytilus?	Toxic to Ceriodaphnia dubia?	Toxic to Hyalella azteca?
CB041S	Central Bay	8/25/11	96	0.0796	1	6	1	.	.	.	.
CB088S	Central Bay	8/24/11	99	0.0743	0	6	1	yes	yes	.	.
CB107S	Central Bay	8/26/11	100	0.0867	2	6	1	.	.	.	.
CB112S	Central Bay	8/24/11	96	0.1299	20	17	1	no	yes	.	.
BA41	South Bay	8/23/11	84	0.0887	1	6	1	yes	no	.	.
SB002S	South Bay	8/23/11	99	0.0825	2	5	1	yes	yes	.	.
SB023S	South Bay	8/24/11	61	0.0682	2	4	1	.	.	.	.
SB024S	South Bay	8/23/11	100	0.1137	8	8	1	yes	yes	.	.
SB041S	South Bay	8/24/11	61	0.0531	0	2	0	yes	no	.	.
SB042S	South Bay	8/23/11	90	0.0873	3	5	1	.	.	.	.
SB099S	South Bay	8/23/11	98	0.1559	23	15	1	.	.	.	.
SB102S	South Bay	8/23/11	100	0.1006	3	7	1	yes	no	.	.
SB114S	South Bay	8/23/11	61	0.0567	0	3	1	.	.	.	.
BA10	Lower South Bay	8/22/11	88	0.0789	1	5	1	yes	no	.	.
LSB001S	Lower South Bay	8/22/11	100	0.0944	1	7	1	.	.	.	.
LSB002S	Lower South Bay	8/22/11	97	0.1031	2	9	1	yes	no	.	.
LSB024S	Lower South Bay	8/22/11	95	0.0956	1	7	1	yes	yes	.	.
LSB041S	Lower South Bay	8/22/11	100	0.0960	0	8	1	.	.	.	.
LSB042S	Lower South Bay	8/22/11	100	0.0957	0	5	1	.	.	.	.
LSB070S	Lower South Bay	8/22/11	81	0.0446	0	4	1	no	no	.	.
LSB121S	Lower South Bay	8/22/11	100	0.0914	0	7	1	no	no	.	.
LSB129S	Lower South Bay	8/22/11	99	0.1002	0	8	1	.	.	.	.

Code	Site Name	Date	% Fines	mERMq	No. of ASC above Guidelines	No. of ERL above Guidelines	No. of ERM above Guidelines	Toxic to Amphipods Eohaustorius?	Toxic to Bivalves Mytilus?	Toxic to Ceriodaphnia dubia?	Toxic to Hyalella azteca?
Hot Spot Special Study											
21027	Central Bay	8/25/11	60	0.4081	28	21	5	yes	yes	.	.
21030	Central Bay	9/1/11	65	0.8737	35	29	8	no	yes	.	.
21301	Central Bay	9/1/11	100	0.3083	31	25	3	no	yes	.	.
21302	Central Bay	8/25/11	100	0.1215	13	12	1	no	yes	.	.
21313	Central Bay	8/25/11	85	0.1898	8	12	2	no	yes	.	.
E2g	Central Bay	8/25/11	86	0.1954	13	13	3	no	yes	.	.

References

Beegan, C. 2008. Staff Report: Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality. State Water Resources Control Board, California Environmental Protection Agency.

Fairey, R., E. R. Long, C. A. Roberts, B. S. Anderson, B. M. Phillips, J. W. Hunt, H. R. Puckett, and C. J. Wilson. 2001. An evaluation of methods for calculating mean sediment quality guideline quotients as indicators of contamination and acute toxicity to amphipods by chemical mixtures. *Environmental Toxicology and Chemistry* 20:2276–2286.

Gandesbery, T., F. Hetzel, R. Smith, and L. Riege. 1999. Ambient concentrations of toxic chemicals in San Francisco Bay sediments: Summary. In 1997 Annual Report: San Francisco Estuary Regional Monitoring Program for Trace Substances. San Francisco Estuary Institute, Richmond, CA. pp. 140–147.

Hornberger, M., S. Luoma, A. van Geen, C. Fuller, and R. Anima. 1999. Historical trendsof metals in the sediments of San Francisco Bay, California. *Marine Chemistry* 64:39-55.

Hunt, J. W., B. S. Anderson, B. M. Phillips, J. Newman, R. S. Tjeerdema, R. Fairey, H. M. Puckett, M. Stephenson, R. W. Smith, C. J. Wilson, and K. M. Taberski. 2001a. Evaluation and use of sediment toxicity reference sites for statistical comparisons in regional assessments. *Environmental Toxicology and Chemistry* 20:1266–1275.

Hunt, J. W., B. S. Anderson, B. M. Phillips, R. S. Tjeerdema, K. M. Taberski, C. J. Wilson, H. M. Puckett, M. Stephenson, R. Fairey, and J. Oakden. 2001b. A large-scale categorization of sites in San Francisco Bay, USA, based on the sediment quality triad, toxicity identification evaluations, and gradient studies. *Environmental Toxicology and Chemistry* 20:1252–1265.

Hyland, J. L., R. F. van Dolah, and T. R. Snoots. 1999. Predicting stress in benthic communities of southeastern U.S. estuaries in relation to chemical contamination of sediments. *Environmental Toxicology and Chemistry* 18:2557-2564.

Hyland, J. L., W. L. Balthis, V. D. Engle, E. R. Long, J. F. Paul, J. K. Summers, and R. F. Van Dolah. 2003. Incidence of stress in benthic communities along the U.S. Atlantic and Gulf of Mexico coasts within different ranges of sediment contamination from chemical mixtures. *Environmental Monitoring and Assessment* 81:149-161.

Long, E. R., D. D. MacDonald, S. L. Smith and F. D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. *Environmental Management* 19:18–97. Long, E. R., L. J. Field, and D. D. MacDonald. 1998. Predicting toxicity in marine sediments with numerical sediment quality guidelines. *Environmental Toxicology and Chemistry* 17:714-727.

Long, E. R., M. J. Hameedi, G. M. Sloane, and L. B. Read. 2002. Chemical contamination, toxicity, and benthic community indices in sediments of the lower Miami River and adjoining portions of Biscayne Bay. *Estuaries* 25:622-737.

Phillips, B., B. Anderson, and J. Hunt. 2000. Investigations of sediment elutriate toxicity at three estuarine stations in San Francisco Bay, California. Draft Regional Monitoring Program Technical Report. San Francisco Estuary Institute, Richmond, CA. 16 pp.

Phillips B. M., J. W. Hunt, and B. S. Anderson. 2001. Statistical significance of sediment toxicity test results: threshold values derived by the detectable significance approach. *Environmental Toxicology and Chemistry* 20:371-373.

Thompson, B., B. Anderson, J. Hunt, K. Taberski, and B. Phillips. 1999. Relationships between sediment contamination and toxicity in San Francisco Bay. *Marine Environmental Research* 48:285-309.

Thompson, B. and S. Lowe. 2004. Assessment of macrobenthos response to sediment contamination in the San Francisco Estuary, California, USA. *Environmental Toxicology and Chemistry* 23:2178-2187.

4) Bivalve Monitoring

Background

The RMP has been analyzing bivalve tissue samples for trace contaminants since 1993. Bivalves bioaccumulate chemical contaminants through their food by ingesting sediment and assimilating contaminants that are sorbed to particles and by filtering dissolved contaminants directly from the water column. Bivalves act as transfer vectors of contaminants to higher trophic levels of the aquatic and sediment food webs. Contaminant concentrations in living organisms can accumulate to levels much greater than those found in ambient water and sediment due to an organism's inability to metabolize certain contaminants (Vinogradov, 1959) and a high affinity of some contaminants for lipid-rich tissue in bivalves (Stout and Beezhold, 1981). Biomonitoring using bivalves has been widely applied by the California State Mussel Watch Program (Phillips, 1988; Rasmussen, 1994) and other studies (Young *et al*., 1976; Wu and Levings, 1980; Hummel et al., 1990; Martincic *et al*., 1992, Gunther *et al*., 1999; O'Connor, 2002). Bivalves are excellent organisms for biomonitoring of contaminants since they accumulate contaminants from the ambient environment, have limited mobility and are fairly resistant to contaminant effects (O'Connor, 2002). The RMP is continuing the long-term monitoring of the State Mussel Watch Program, which monitored sites throughout the Estuary beginning in 1976.

The objectives of the RMP Bioaccumulation Monitoring Program are to:

1. Describe the distribution and trends of pollutant concentrations in the Estuary.

2. Measure pollution exposure and effects on selected parts of the Estuary ecosystem.

3. Compare monitoring information to relevant benchmarks, such as TMDL targets, tissue screening levels, water quality objectives, and sediment quality objectives.

These general goals implicitly address the RMP objective (see Chapter 1 *Introduction*) of determining long-term trends in contaminant levels. This program component also complements the water and sediment sampling. Unlike the water quality sampling, which gives an indication of water quality at one particular point in time, contaminant concentrations measured in transplanted bivalves serve to integrate water quality over the period of deployment (typically 90 to 100 days). Also, while measurement of contaminant concentrations in water and sediment are useful for trend monitoring over time, they do not reveal the extent to which various contaminants are able to transfer into the food web and pose risks to consumers.

In 2001, trace metals measurements in bivalves were reduced from every year to every fifth year as a cost reduction measure for metals not on the 303(d) List or the Water Board's "pollutants of concern" for San Francisco Bay list. Trace metals were last measured in bivalve tissue in 2008. Trace organics are measured biennially.

In 2006, the RMP Status and Trends program was re-evaluated to determine whether current sampling size and frequency are appropriate for meeting the needs of RMP stakeholders (Melwani et al., 2008). Based on this evaluation, bivalve sampling was modified from an annual to a biennial frequency. Accordingly, bivalves have been monitored in 2008, 2010 and 2012. Monitoring did not occur in 2011.

Sites

Bivalves were initially deployed at eleven sites throughout the Estuary to represent both the spine and margins of the Estuary. In 1994, four deployment sites were added, for a total of 15. Specific site locations were heavily influenced by the availability of a fixed structure to easily relocate the subsurface moorings.

Based on a new biogeographical delineation of the Estuary, it was apparent that the newly defined segments were not represented equally by the 15-station bivalve deployment design. Consequently, an analysis was undertaken to determine the optimum number and distribution of bivalve deployment sites needed to track trends in bioavailable contaminants in the Estuary. Based on this analysis, several sites were removed from the project and, in 2003, the design of the Program study sites was modified to its current configuration of 11 sites, consisting of three transplant sites within the Lower South Bay-South Bay, Central Bay and San Pablo Bay Estuary segments, respectively, and collection of resident bivalves at two sites within the Rivers segment.

Analysis

Target Analytes

Bivalves are analyzed for trace metals aluminum, cadmium, copper, lead, nickel, selenium, silver and zinc every five years. Trace metals were last measured in bivalve tissue in 2008.

Bivalves are analyzed biennially for trace organics and ancillary parameters. Trace organics include PAHs, PBDEs, PCBs , Chlordanes, Cyclopentadienes, DDTs, HCHs, Hexachlorobenzene, and Mirex. Bivalves were last measured for trace organics in 2012.

Data are available for downloading via the RMP website using the Contaminant Data Display and Download tool.

References

Bayne, B.L. (Ed.) 1976. Marine mussels, their ecology and physiology. International Biological Programme. Cambridge University Press, Cambridge, UK.

Gunther, A.J., J.A. Davis, D. Hardin, J. Gold, D. Bell, J.R. Crick, G.M. Scelfo, J. Sericano, and M. Stephenson. 1999. Long-term bioaccumulation monitoring with transplanted bivalves in the San Francisco Estuary. *Marine Pollution Bulletin* 38:170-181.

Hummel, H., R.H. Bogaards, J. Nieuwenhiuze, L. DeWolf, and J.M. VanLiere. 1990. Spatial and seasonal differences in the PCB content of the mussel Mytilus edulis. Science of the *Total Environment* 92:155-163.

Martincic, D., Z. Kwokal, Z. Peharec, D. Margus, and M. Branica. 1992. Distribution of Zn, Pb, Cd, and Cu between seawater and transplanted mussels (*Mytilus galloprovincialis*). *Science of the Total Environment* 119:211-230.

Melwani, A.R., B.K. Greenfield, A. Jahn, J.J. Oram, M. Sedlak, and J. Davis. 2008. Power Analysis and Optimization of the RMP Status and Trends Program. San Francisco Estuary Institute, Oakland, CA.

O'Connor, T.P. 2002. National distribution of chemical concentrations in mussels and oysters in the USA. *Marine Environmental Research* 53:117-143.

Phillips, P.T. 1988. California State Mussel Watch ten year data summary, 1977-1987. Water Quality Monitoring Report No. 87-3, Division of Water Quality, State Water Resources Control Board.

Rasmussen, D. 1994. State Mussel Watch Program, 1987–1993 Data Report. State Water Resources Control Board 94-1WQ.

Stephenson, M.1992. A report on bioaccumulation of trace metals and organics in bivalves in the San Francisco Bay submitted to California Regional Water Quality Control Board San Francisco Region. California Department of Fish and Game.

Stout, V.F. and F.L. Beezhold. 1981. Chlorinated hydrocarbon levels in fishes and shellfishes of the northeastern Pacific Ocean including the Hawaiian Islands. *Marine Fisheries* Review 43:1-12.

U.S. EPA. 1995. Methods for Sampling and Analyzing Contaminants in Fish and Shellfish Tissue. U.S. EPA document #823-R-95-007. http://www.epa.gov/OST/fishadvice/vol1/doc2ndx.html.

US Food and Drug Administration, 1994. Pesticide Analytical Manual, Vol. 1, 3rd Edition. Chapter 3, Multi-residue Methods, Section 303-C1. http://www.fda.gov/Food/ScienceResearch/LaboratoryMethods/PesticideAnalysisManualPAM/ucm111455.htm

Vinogradov, A.P. 1959. The geochemistry of rare and dispersed chemical elements in soils. Chapman and Hall, London.

Wu, R.S.S. and C.D. Levings. 1980. Mortality, growth and fecundity of transplanted mussel and barnacle populations near a pulp mill outfall. *Marine Pollution Bulletin* 11:11¬15.

Young, D.R., T.C. Heesen, and D.J. McDermott. 1976. An offshore biomonitoring system for chlorinated hydrocarbons. *Marine Pollution Bulletin* 7:156-159.

5) Appendix Tables

RMP Program Participants in 2011

Municipal Dischargers

Burlingame Waste Water Treatment Plant
Central Contra Costa Sanitary District
Central Marin Sanitation Agency
City of Benicia
City of Calistoga
City of Palo Alto
City of Petaluma
City of Pinole/Hercules
City of Saint Helena
City and County of San Francisco
City of San Jose/Santa Clara
City of San Mateo
City of South San Francisco/San Bruno
City of Sunnyvale
Delta Diablo Sanitation District
East Bay Dischargers Authority
East Bay Municipal Utility District (SD#1)
Fairfield-Suisun Sewer District
Las Gallinas Valley Sanitation District
Marin County Sanitary District #5, Tiburon
Millbrae Waste Water Treatment Plant
Mountain View Sanitary District
Napa Sanitation District
Novato Sanitation District
Rodeo Sanitary District
San Francisco International Airport
Sausalito Sanitation District
Sewer Agency of Southern Marin
Sonoma County Water Agency
South Bayside System Authority
Town of Yountville
Union Sanitary District
Vallejo Sanitation & Flood Control District
West County Agency

Cooling Water

Mirant of California, Pittsburgh and Potrero

Industrial Dischargers

C & H Sugar Company
Chevron Products Company
Crockett Cogeneration
Dow Chemical Company
Shell Oil Products - Martinez Refinery
Rhodia, Inc.
Tesoro Golden Eagle Refinery
ConocoPhillips - Rodeo Refinery
USS – POSCO Industries
Valero Refining Company

Dredgers

Berkeley Marina
BP West Coast Products
Brickyard Cover Homeowners Association #1
Chevron Richmond Long Wharf
Conoco Phillips Rodeo Terminal
Glen Cover Marina
Marin Co. Service Area 29, Paradise Cay
Oyster Cove Marina
Oyster Point Marina
Port of Oakland
Port of San Francisco
San Francisco Marina
San Francisco Yacht Club
Valero Refinery Terminal
Vallejo Yacht Club

Storm Water

Alameda Countywide Clean Water Program
California Department of Transportation
City and County of San Francisco
Contra Costa Clean Water Program
Fairfield-Suisun Urban Runoff Management Program
Marin County Stormwater Pollution Prevention Program
San Mateo Countywide Stormwater Pollution Prevention Program
Santa Clara Valley Urban Runoff Pollution Prevention Program
Vallejo Sanitation and Flood Control District

RMP Contractors AND Principal Investigators in 2011

Logistical Coordinator; Shipboard Conductivity, Temperature, and Depth (CTD) Readings	Mr. Paul Salop Applied Marine Sciences (AMS), Livermore, CA	
Ship Captain - Sediment Cruise	Mr. Nick Sakata Captain, RV Endeavor United States Bureau of Reclamation	
Ship Captain – Water Cruise	Mr. Nick Sakata Captain, RV Endeavor United States Bureau of Reclamation	
Water Trace Element Chemistry	Ms. Tiffany Stilwater Brooks-Rand Ltd. (BR), Seattle, WA	
Water Trace Organic Chemistry	Ms. Georgina Brooks AXYS Analytical Services Ltd. (AXYS), Sidney, BC	
Water Cyanide	Ms. Mary Lou Esparza Central Contra Costa Sanitary District	
Water Ancillary Measurements	Water Cognates: Ms. Nirmela Arsem and Mr. Ken Gerstman East Bay Municipal Utility District (EBMUD), Oakland, CA	Water DOC and POC: Mr. Pradeep Divvela and Mike Shelton Columbia Analytical Services (CAS), Kelso, WA
Sediment Trace Element Chemistry	Sediment As, Se, Hg, and Methyl Mercury Ms. Tiffany Stilwater Brooks-Rand Ltd. (BR), Seattle, WA	Sediment Al, Ag, Cd, Cu, Fe, Hg, Mn, Ni, Pb,and Zn Mr. Anthony Rattonetti and Mr. Lonnie Butler City and County of San Francisco (CCSF), San Francisco, CA
Sediment Trace Organics Chemistry	Mr. François Rodigari and Ms. Saskia van Bergen East Bay Municipal Utility District (EBMUD), Oakland, CA	
Sediment Toxicity Testing	Dr. John Hunt, Dr. Brian Anderson, and Dr. Bryn Phillips Marine Pollution Studies Lab (MPSL), Granite Canyon, CA	
Sediment Ancillary Measurements (Grainsize, TOC, TN)	Sediment TOC, TN and % Solids Mr. Pradeep Divvela and Mr. Mike Shelton Columbia Analytical Services (CAS), Kelso, WA	Sediment Grainsize Dr. Ivano Aiello and Ms. Autumn Bonnema Geological Oceanography Lab at Moss Landing, Moss Landing, CA
USGS Water Quality	Dr. James Cloern, USGS, Menlo Park, CA	
USGS Sediment Transport	Dr. David Schoellhamer, USGS, Sacramento, CA	

Summary of 2011 RMP Sampling Stations

Cruise Type	Region	Site Code	Historic Site	Collection Date	Latitude	Longitude	Site Depth (m)
Water	South Bay	BA30	X	9/14/11	37.51348	-122.13458	2
Water	Central Bay	BC10	X	9/16/11	37.82213	-122.34968	7.5
Water	Central Bay	BC20	X	9/19/11	37.80688	-122.68243	31.5
Water	Rivers	BG20	X	9/22/11	38.05957	-121.8114	9.7
Water	Rivers	BG30	X	9/22/11	38.0204	-121.80643	11.8
Water	Central Bay	CB033W		9/16/11	37.87172	-122.36898	4.2
Water	Central Bay	CB034W		9/16/11	37.69003	-122.29173	6
Water	Central Bay	CB035W		9/19/11	37.86403	-122.4843	6
Water	Lower South Bay	LSB050W		9/13/11	37.4802	-122.07758	5
Water	Lower South Bay	LSB051W		9/14/11	37.48915	-122.1169	3.4
Water	Lower South Bay	LSB052W		9/13/11	37.47805	-122.09085	6.1
Water	Lower South Bay	LSB053W		9/14/11	37.49253	-122.09265	5
Water	Lower South Bay	LSB054W		9/13/11	37.46833	-122.06432	2.4
Water	South Bay	SB061W		9/15/11	37.61758	-122.25923	4
Water	South Bay	SB062W		9/15/11	37.54092	-122.1682	3
Water	South Bay	SB063W		9/15/11	37.6937	-122.22285	3
Water	San Pablo Bay	SPB033W		9/20/11	38.08548	-122.38517	3
Water	San Pablo Bay	SPB034W		9/20/11	38.04255	-122.34018	10
Water	San Pablo Bay	SPB035W		9/20/11	38.01122	-122.46102	2.7
Water	Suisun Bay	SU041W		9/21/11	38.09582	-122.063	10
Water	Suisun Bay	SU042W		9/21/11	38.0764	-121.99052	5.7
Water	Suisun Bay	SU043W		9/21/11	38.12727	-122.05355	2
Sediment	Lower South Bay	BA10	X	8/22/11	37.46812	-122.06385	3.2
Sediment	South Bay	BA41	X	8/23/11	37.55908	-122.21067	2.6
Sediment	Central Bay	BC11	X	8/25/11	37.82207	-122.349	6.4
Sediment	San Pable Bay	BD31	X	8/26/11	38.02408	-122.36375	7.6
Sediment	Suisun Bay	BF21	X	8/30/11	38.11563	-122.04057	2.3
Sediment	Rivers	BG20	X	8/30/11	38.0583	-121.81407	9.5
Sediment	Rivers	BG30	X	8/30/11	38.02285	-121.80845	6.4
Sediment	Central Bay	CB001S		8/26/11	37.87645	-122.36132	2.9
Sediment	Central Bay	CB002S		8/23/11	37.62498	-122.34735	4.8
Sediment	Central Bay	CB023S		8/25/11	37.88765	-122.40032	7.3
Sediment	Central Bay	CB024S		8/24/11	37.73712	-122.29017	3.8
Sediment	Central Bay	CB041S		8/25/11	37.87284	-122.43913	2.7
Sediment	Central Bay	CB088S		8/24/11	37.72018	-122.3042	9.8
Sediment	Central Bay	CB107S		8/26/11	37.95715	-122.46503	2.9
Sediment	Central Bay	CB112S		8/24/11	37.70052	-122.36365	8.8

Summary of 2011 RMP Sampling Stations (*cont.*)

Cruise Type	Region	Site Code	Historic Site	Collection Date	Latitude	Longitude	Site Depth (m)
Sediment	Lower South Bay	LSB001S		8/22/11	37.49168	-122.09868	6.8
Sediment	Lower South Bay	LSB001S		8/22/11	37.49168	-122.09868	6.8
Sediment	Lower South Bay	LSB024S		8/22/11	37.48828	-122.07725	1.4
Sediment	Lower South Bay	LSB041S		8/22/11	37.49543	-122.10618	14.3
Sediment	Lower South Bay	LSB042S		8/22/11	37.47168	-122.09555	1.3
Sediment	Lower South Bay	LSB070S		8/22/11	37.46953	-122.06247	4.9
Sediment	Lower South Bay	LSB121S		8/22/11	37.49452	-122.09932	8.8
Sediment	Lower South Bay	LSB129S		8/22/11	37.48743	-122.10162	2.3
Sediment	South Bay	SB002S		8/23/11	37.61025	-122.16757	2.1
Sediment	South Bay	SB023S		8/24/11	37.67688	-122.21237	3.2
Sediment	South Bay	SB024S		8/23/11	37.56268	-122.22643	2.5
Sediment	South Bay	SB041S		8/24/11	37.67433	-122.21303	3
Sediment	South Bay	SB042S		8/23/11	37.58997	-122.19477	3.7
Sediment	South Bay	SB099S		8/23/11	37.60348	-122.3131	4.3
Sediment	South Bay	SB102S		8/23/11	37.52765	-122.14828	6.7
Sediment	South Bay	SB114S		8/23/11	37.57972	-122.16817	2.1
Sediment	San Pablo Bay	SPB001S		8/29/11	38.07262	-122.38622	2.7
Sediment	San Pablo Bay	SPB002S		8/26/11	38.01615	-122.34122	3.3
Sediment	San Pablo Bay	SPB023S		8/26/11	38.10478	-122.39208	2
Sediment	San Pablo Bay	SPB024S		8/29/11	38.06228	-122.33493	2
Sediment	San Pablo Bay	SPB042S		8/26/11	38.03313	-122.36492	10.8
Sediment	San Pablo Bay	SPB055S		8/29/11	38.08932	-122.41952	2
Sediment	San Pablo Bay	SPB088S		8/29/11	38.08192	-122.32355	2.4
Sediment	San Pablo Bay	SPB132S		8/26/11	38.0146	-122.38682	9.5
Sediment	Suisun Bay	SU001S		8/29/11	38.09935	-122.04668	7
Sediment	Suisun Bay	SU023S		8/30/11	38.11552	-122.05783	2.1
Sediment	Suisun Bay	SU024S		8/30/11	38.07347	-121.98092	5.5
Sediment	Suisun Bay	SU043S		8/30/11	38.13368	-122.057	2.9
Sediment	Suisun Bay	SU044S		8/29/11	38.07597	-122.05687	2.9
Sediment	Suisun Bay	SU048S		8/30/11	38.10448	-122.01747	2.4
Sediment	Suisun Bay	SU055S		8/29/11	38.08808	-122.06838	3.8
Sediment	Suisun Bay	SU073S		8/29/11	38.11078	-122.04807	3

RMP Target Parameter List in 2011

Field Measures – CTD Meter (Water, Sediment and Bivalve Cruises)	Reporting Units
Backscatter	Ftu
ElectricalConductivity	S/m
Temperature	Deg C
Density	kg/m3
Oxygen, Dissolved	mg/L
Pressure	Db
Salinity	psu
Field Measures - Shipboard (Water Cruise)	**Reporting Units**
Oxygen, Dissolved	mg/L
pH	pH
Salinity	ppt
SpecificConductivity	uS/cm
Temperature	Deg C
Field Measures - Shipboard (Sediment Cruise) *pH from interstitial water in undisturbed section of sediment grab	**Reporting Units**
pH*	pH
Eh	mV

[Basis codes: dw=dry weight, ww=wet weight]

Conventional Water Quality Parameters	Reporting Units	Basis
Ammonium as N	mg/L	ww
Chlorophyll a	mg/m^3	ww
Dissolved Organic Carbon	ug/L	ww
Hardness as CaCO3	mg/L	ww
Nitrate as N	mg/L	ww
Nitrite as N	mg/L	ww
Oxygen, Dissolved	mg/L	ww
Particulate Organic Carbon	ug/L	ww
pH	pH	ww
Pheophytin a	mg/m^3	ww
Phosphate as P	mg/L	ww
Salinity	psu	ww
Silica as SiO2	mg/L	ww
SpecificConductivity	umho	ww
Suspended Sediment Concentration	mg/L	ww
Temperature	Deg C	ww

Water Toxicity Parameters – Homogenate (*Americamysis bahi*)	Reporting Units	Basis
Cell Count	-	ww
Mean % Normal Development	%	ww
Mean % Survival	%	ww
SWI Mean % Normal Alive	%	ww
Sediment Quality Parameters	**Reporting Units**	**Basis**
% Solids	%	dw
CollectionDepth	m	
Nitrogen, Total	%	dw
Total Organic Carbon	%	dw
Grainsize Parameters [Sum of Clay and Silt]**	**Reporting Units**	**Basis**
Clay <0.0039 mm	%	dw
Fine <0.0625 mm**	%	dw
Granule + Pebble 2.0 to <64 mm	%	dw
Sand 0.0625 to <2.0 mm	%	dw
Silt 0.0039 to <0.0625 mm	%	dw
Sediment Toxicity Parameters – Homogenate (RMP tests CHIR, EOHA and HYAL) SD = Standard Deviation	**Reporting Units**	**Basis**
Mean % Survival	%	dw
SD - Mean % Survival	%	dw
Mean mg/Individual (af growth)	mg	na
Mean mg/Individual (growth)	mg	na
Sediment Toxicity Parameters - Surface Water Interface (RMP tests MCAL)	**Reporting Units**	**Basis**
SWI Mean % Normal Alive	%	dw
SWI SD - Mean % Normal Alive	%	dw
Bivalve Tissue Parameters 1. Reported with Trace Metals 2. Reported with Trace Organics	**Reporting Units**	**Basis**
% Solids[1]	%	dw
% Survival per Species	%	dw
% Survival per Species (caged)	%	dw
Dry Weight	g	dw
Dry Weight Standard Error	g	dw
Growth Mean	g	dw
Growth Standard Error	g	dw
Lipid	%	dw
Moisture[2]	%	dw

Fish Tissue Parameters	Reporting Units	Basis
Lipid	%	ww or dw
Moisture	%	ww or dw
Length	cm	

Trace elements analyzed in water, sediment, and tissue samples:

Target Method Detection Limits (MDLs) are in parentheses following the reporting units.
Basis codes: dw=dry weight, ww=wet weight.
- Parameter is not sampled for the matrix.
* Dry and wet weight mercury concentrations are reported for fish tissue

	Water	Sediment	Bivalve Tissue	Fish Tissue
Basis	ww	dw	dw	ww
Aluminum	-	mg/Kg (200)	ug/g (1)	-
Arsenic	ug/L (0.1)	mg/Kg (0.2)	-	-
Cadmium	ug/L (0.001)	mg/Kg (0.001)	ug/g (0.01)	-
Cobalt	ug/L (.0005)	-	-	-
Copper	ug/L (0.01)	mg/Kg (2)	ug/g (0.2)	-
Cyanide	ug/L (0.4)	-	-	-
Iron	ug/L (10)	mg/Kg (200)	-	-
Lead	ug/L (0.001)	mg/Kg (0.5)	ug/g (0.01)	-
Manganese	ug/L (0.01)	mg/Kg (20)	-	-
Mercury*	ug/L (.0001)	mg/Kg (0.00001)	-	ug/g
Mercury, Methyl	ng/L (0.005)	ug/Kg (0.005)	-	ug/g
Mercury, Acid Labile	ug/L	-	-	-
Mercury (II)R	ug/L	-	-	-
Nickel	ug/L (0.01)	mg/Kg (5)	ug/g (0.2)	-
Selenium	ug/L (0.02)	mg/Kg (0.01)	ug/g (0.01)	ug/g
Silver	ug/L (0.0001)	mg/Kg (0.001)	ug/g (0.001)	-
Zinc	ug/L (0.005)	mg/Kg (5)	ug/g (10)	-

Trace organic parameters (reporting units) analyzed in water (pg/L), sediment (ug/Kg), and bivalve tissue (ng/g)

Note: PAHs, Pesticides and PCBs are reported biennially in water. Sums calculated by SFEI.
Organochlorines in tissue from CDFG analyzed by GC-ECD will be determined using two columns of differing polarity.

Polycyclic Aromatic Hydrocarbons (PAHs)
(Target MDLs: water – 200 pg/L, sediment -- 5 ug/Kg, tissue – 5 ng/g)

[1]Sum of LPAHs and HPAHs
[2]Reported in sediment only
[3]Reported in water only

Low molecular weight PAHs	High molecular weight PAHs	Alkylated PAHs
Acenaphthene	Benz(a)anthracene	Benz(a)anthracenes/Chrysenes, C1[-3]
Acenaphthylene	Benzo(a)pyrene	Benz(a)anthracenes/Chrysenes, C2[-3]
Anthracene	Benzo(b)fluoranthene	Benz(a)anthracenes/Chrysenes, C3[-3]
Biphenyl	Benzo(e)pyrene	Benz(a)anthracenes/Chrysenes, C4[-3]
Dibenzothiophene	Benzo(g,h,i)perylene	Chrysenes, C1[-2]
Dimethylnaphthalene, 2,6-	Benzo(k)fluoranthene	Chrysenes, C2[-2]
Fluorene	Chrysene	Chrysenes, C3[-2]
Methylnaphthalene, 1-	Dibenz(a,h)anthracene	Chrysenes, C4[-2]
Methylnaphthalene, 2-	Fluoranthene	Dibenzothiophenes, C1-
Methylphenanthrene, 1-	Indeno(1,2,3-c,d)pyrene	Dibenzothiophenes, C2-
Naphthalene	Perylene	Dibenzothiophenes, C3-
Phenanthrene	Pyrene	Fluoranthene/Pyrenes, C1-
Trimethylnaphthalene, 2,3,5-	Sum of HPAHs (SFEI)	Fluorenes, C1-
Sum of LPAHs (SFEI)	Sum of PAHs (SFEI)1	Fluorenes, C2-
		Fluorenes, C3-
		Naphthalenes, C1-
		Naphthalenes, C2-
		Naphthalenes, C3-
		Naphthalenes, C4-
		Phenanthrene/Anthracene, C1-
		Phenanthrene/Anthracene, C2-
		Phenanthrene/Anthracene, C3-
		Phenanthrene/Anthracene, C4-

SYNTHETIC BIOCIDES

(Target MDLs: water – 2 pg/L, sediment - 1 ug/Kg, tissue – 1 ng/g)

[1]Parameter reported for water matrix only.
[2]Parameter reported for sediment matrix only.
Sums calculated by SFEI.

Cyclopentadienes	Chlordanes	DDTs	HCH	Other Synthetic Biocides
Aldrin	Chlordane, cis- Chlordane, trans-Heptachlor	DDD(o,p')	HCH, alpha	Chlorpyrifos[1]
Dieldrin	Heptachlor Epoxide	DDD(p,p')	HCH, beta	Dacthal[1]
Endrin	Nonachlor, cis-	DDE(o,p')	HCH, delta	Diazinon[1]
	Nonachlor, trans-	DDE(p,p')	HCH, gamma	Endosulfan I[1]
	Oxychlordane	DDT(o,p')	Sum of HCHs (SFEI)	Endosulfan II[1]
	Sum of Chlordanes (SFEI)	DDT(p,p')		Endosulfan sulfate[1]
		Sum of DDTs (SFEI)		Fipronil desulfinyl[2]
				Fipronil sulfide[2]
				Fipronil sulfone[2]
				Fipronil[2]
				Hexachlorobenzene
				Mirex

OTHER SYNTHETIC COMPOUNDS
Polychlorinated Biphenyls (PCBs)
(Target MDLs: water – 2 pg/L, sediment - 1 ug/Kg , tissue – 1 ng/g)
IUPAC numbers listed. Sums calculated by SFEI.
*Congeners included in the Sum of 40 PCBs (SFEI).
[1]Coplanar PCBs

PCB 001	**PCB 031***	PCB 061	PCB 091	PCB 121	**PCB 151***	PCB 181
PCB 002	PCB 032	PCB 062	PCB 092	PCB 122	PCB 152	PCB 182
PCB 003	**PCB 033***	PCB 063	PCB 093	PCB 123[1]	**PCB 153***	PCB 183*
PCB 004	PCB 034	PCB 064	PCB 094	PCB 124	PCB 154	PCB 184
PCB 005	PCB 035	PCB 065	**PCB 095***	PCB 125	PCB 155	PCB 185
PCB 006	PCB 036	**PCB 066***	PCB 096	PCB 126[1]	**PCB 156*1**	PCB 186
PCB 007	PCB 037	PCB 067	**PCB 097***	PCB 127	PCB 1571	PCB 187*
PCB 008*	PCB 038	PCB 068	PCB 098	**PCB 128***	**PCB 158***	PCB 188
PCB 009	PCB 039	PCB 069	**PCB 099***	PCB 129	PCB 159	PCB 189[1]
PCB 010	PCB 040	**PCB 070***	PCB 100	PCB 130	PCB 160	PCB 190
PCB 011	PCB 041	PCB 071	**PCB 101***	PCB 131	PCB 161	PCB 191
PCB 012	PCB 042	PCB 072	PCB 102	**PCB 132***	PCB 162	PCB 192
PCB 013	PCB 043	PCB 073	PCB 103	PCB 133	PCB 163	PCB 193[1]
PCB 014	**PCB 044***	**PCB 074***	PCB 104	PCB 134	PCB 164	PCB 194*
PCB 015	PCB 045	PCB 075	**PCB 105*1**	PCB 135	PCB 165	PCB 195*
PCB 016	PCB 046	PCB 076	PCB 106	PCB 136	PCB 166	PCB 196
PCB 017	PCB 047	PCB 0771	PCB 107	PCB 137	PCB 167[1]	PCB 197
PCB 018*	PCB 048	PCB 078	PCB 108	**PCB 138***	PCB 168	PCB 198
PCB 019	**PCB 049***	PCB 079	PCB 109	PCB 139	PCB 169[1]	PCB 199
PCB 020	PCB 050	PCB 080	**PCB 110***	PCB 140	**PCB 170*[1]**	PCB 200
PCB 021	PCB 051	PCB 0811	PCB 111	**PCB 141***	PCB 171	PCB 201*
PCB 022	**PCB 052***	PCB 082	PCB 112	PCB 142	PCB 172	PCB 202
PCB 023	PCB 053	PCB 083	PCB 113	PCB 143	PCB 173	PCB 203*
PCB 024	PCB 054	PCB 084	PCB 114[1]	PCB 144	**PCB 174***	PCB 204
PCB 025	PCB 055	PCB 085	PCB 115	PCB 145	PCB 175	PCB 205
PCB 026	**PCB 056***	PCB 086	PCB 116	PCB 146	PCB 176	PCB 206
PCB 027	PCB 057	**PCB 087***	PCB 117	PCB 147	**PCB 177***	PCB 207
PCB 028*	PCB 058	PCB 088	**PCB 118*[1]**	PCB 148	PCB 178	PCB 208
PCB 029	PCB 059	PCB 089	PCB 119	**PCB 149***	PCB 179	PCB 209
PCB 030	**PCB 060***	PCB 090	PCB 120	PCB 150	**PCB 180*[1]**	Sum of 40 PCBs (SFEI)
						Sum of 209 PCBs (SFEI)

Polybrominated Diphenyl Ethers (PBDEs) (Target MDLs: water – 1 pg/L, sediment – 1 ug/Kg, tissue – 1 ng/g) IUPAC number listed. *Only analyzed in sediment.			
PBDE 007	PBDE 035	PBDE 105	PBDE 183
PBDE 008	PBDE 037	PBDE 116	PBDE 190
PBDE 010	PBDE 047	PBDE 119	PBDE 196*
PBDE 011	PBDE 049	PBDE 120	PBDE 197
PBDE 012	PBDE 051	PBDE 126	PBDE 203
PBDE 013	PBDE 066	PBDE 128	PBDE 204
PBDE 015	PBDE 071	PBDE 138	PBDE 205
PBDE 017	PBDE 075	PBDE 140	PBDE 206
PBDE 025	PBDE 077	PBDE 153	PBDE 207
PBDE 028	PBDE 079	PBDE 154	PBDE 208
PBDE 030	PBDE 085	PBDE 155	PBDE 209
PBDE 032	PBDE 099	PBDE 166	
PBDE 033	PBDE 100	PBDE 181	

Pyrethroids (Target RDLs: sediment – 1 to 10 ug/kg) *Sum of individual isomers. Sums calculated by SFEI.		
Allethrin	Deltamethrin	Phenothrin
Bifenthrin	Esfenvalerate/Fenvalerate, total*	Prallethrin
Cyfluthrin, total*	Fenpropathrin	Resmethrin
Cyhalothrin, lambda, total*	Permethrin, cis-	Tetramethrin
Cypermethrin, total*	Permethrin, trans-	Tralomethrin
		Sum of Pyrethroids (SFEI)

Dioxins and Furans (PCDD/F) (sediment and tissue – ug/Kg; water – pg/L)	
Dioxins	**Furans**
HpCDD, 1,2,3,4,6,7,8-	HpCDF, 1,2,3,4,6,7,8-
HxCDD, 1,2,3,4,7,8-	HpCDF, 1,2,3,4,7,8,9-
HxCDD, 1,2,3,6,7,8-	HxCDF, 1,2,3,4,7,8-
HxCDD, 1,2,3,7,8,9-	HxCDF, 1,2,3,6,7,8-
OCDD, 1,2,3,4,6,7,8,9-	HxCDF, 1,2,3,7,8,9-
PeCDD, 1,2,3,7,8-	HxCDF, 2,3,4,6,7,8-
TCDD, 2,3,7,8-	OCDF, 1,2,3,4,6,7,8,9-
Sum of Dioxin-Furan TEQs (WHO 2005;ND=0 SFEI)*	PeCDF, 1,2,3,7,8-
	PeCDF, 2,3,4,7,8-
	TCDF, 2,3,7,8-
* NDs should be set to zero as the default	

Perfluorinated Compounds (PFC) (Target RDLs: water – 1 ng/L or * 2 ng/L; tissue – ng/g; water – ng/L; sediment ug/Kg)	
Carboxylic Acids	**Sulphonic Acids**
Perfluorobutanoate	Perfluorobutanesulfonate*
Perfluorodecanoate	Perfluorohexanesulfonate*
Perfluorododecanoate	Perfluorooctanesulfonamide
Perfluoroheptanoate	Perfluorooctanesulfonate* (PFOS)
Perfluorohexanoate	
Perfluorononanoate	
Perfluorooctanoate (PFOA)	
Perfluoropentanoate	
Perfluoroundecanoate	

Analytes reported in water samples (1993-2011)

Shaded areas indicate that results are available for RMP Status and Trends Sampling.
Parameter Type Codes: ANC = Ancillary Parameters, ORGS = Organic Parameters, PESTs = Pesticide Parameters, SYN = Synthetic Parameters, TE = Trace Metal parameters, WaterTOX = Toxicity Parameters
* Data available upon request

Reportable Water Parameter	Parameter Type	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Ammonium as N	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Chlorophyll a	ANC		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
CTD*	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Dissolved Organic Carbon	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Hardness as CaCO3	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Nitrate as N	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Nitrite as N	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Oxygen, Dissolved	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■
Particulate Organic Carbon	ANC												■	■	■	■	■	■	■	■
pH	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■
Pheophytin a	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Phosphate as P	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Salinity (by salinometer)	ANC	■		■	■	■	■	■	■	■	■	■	■	■	■					
Salinity (by SCT)	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Salinity (by Solomat)	ANC					■														
Silica	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SpecificConductivity	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■
Suspended Sediment Concentration	ANC												■	■	■	■	■	■	■	■
Temperature	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■
Total Suspended Solids	ANC										■	■	■			■	■	■	■	■
Alkanes (C10-C34)	ORGS																			
Dioxins/Furans	ORGS																	■		■
PAHs (biennially beginning 2008)	ORGS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			■
PAHs Alkylated (biennially beginning 2008)	ORGS						■	■	■	■	■	■	■	■	■	■	■			■
PBDEs (annually)	ORGS										■	■	■	■	■	■	■	■	■	■
PCBs 209 (biennially beginning 2008)	ORGS																	■		■

Analytes reported in water samples (1993-2011) (cont.)

Shaded areas indicate that results are available for RMP Status and Trends Sampling.
Parameter Type Codes: ANC = Ancillary Parameters, ORGS = Organic Parameters, PESTs = Pesticide Parameters, SYN = Synthetic Parameters, TE = Trace Metal parameters, WaterTOX = Toxicity Parameters
* Data available upon request

Reportable Water Parameter	Parameter Type	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
PCBs 40 (biennially beginning 2008)	ORGS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■
Pharmaceuticals	ORGS														■					
Phthalates	ORGS										■	■								
Chlordanes	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■
Chlorpyrifos	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■						■
Cyclopentadienes	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■
Dacthal	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■
DDTs	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■
Endosulfan I	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■
Endosulfan II	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■
Endosulfan Sulfate	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■
HCHs	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■
Hexachlorobenzene	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■
Mirex	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■
Oxadiazon	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
p-Nonylphenol	SYN										■	■								
Triphenylphosphate	SYN										■									
Arsenic	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Cadmium	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Chromium	TE	■	■	■	■	■	■	■		■										
Cobalt	TE								■	■	■	■	■	■	■	■	■	■	■	■
Copper	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Cyanide	TE	■	■															■		■
Iron	TE							■	■	■	■	■	■	■	■	■	■	■	■	■
Lead	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Manganese	TE							■	■	■	■	■	■	■	■	■	■	■	■	■
Mercury	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Mercury, Methyl	TE							■	■	■	■	■	■	■	■	■	■	■	■	■
Nickel	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Analytes reported in water samples (1993-2011) (cont.)

Shaded areas indicate that results are available for RMP Status and Trends Sampling.
Parameter Type Codes: ANC = Ancillary Parameters, ORGS = Organic Parameters, PESTs = Pesticide Parameters, SYN = Synthetic Parameters, TE = Trace Metal parameters, WaterTOX = Toxicity Parameters
* Data available upon request

Reportable Water Parameter	Parameter Type	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Selenium	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Silver	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Zinc	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Cell Count	WaterTox	■																		■
Mean % Normal Development	WaterTox	■	■	■	■	■														■
Mean % Survival	WaterTox		■	■	■	■	■	■	■	■	■									■
SWI Mean % Normal Alive	WaterTox							■	■	■										■

Analytes Reported in Sediment Samples (1993-2011)

Shaded areas indicate that results are available for RMP Status and Trends Sampling.
Parameter Type Codes: ANC = Ancillary Parameters, EC=Emerging Contaminants, ORGS = Organic Parameters, PESTs = Pesticide Parameters, SedTOX = Toxicity Parameters, SYN = Synthetic Parameters, TE = Trace Metal parameters
* Data available upon request

Reportable Sediment Parameter	Type	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
% Solids	ANC		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Ammonia	ANC			■	■	■	■	■	■	■									
Clay <0.0039 mm	ANC																■	■	■
Clay <0.005 mm	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			■
CTD*	ANC		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Eh*	ANC											■	■	■	■	■	■	■	
Fine <0.0625 mm	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Granule + Pebble 2.0 to <64 mm	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	
Hydrogen Sulfide	ANC			■	■	■	■	■	■	■									
pH	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Sand 0.0625 to <2.0 mm	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Silt 0.0039 to <0.0625 mm	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Total Nitrogen	ANC	■					■	■	■	■	■	■	■	■	■	■	■	■	■
Total Organic Carbon	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Total Sulfide	ANC			■	■	■	■	■	■	■									
Benthos	Benthos																■	■	■
Dioxins/Furans	ORGS																	■	■
PAHs	ORGS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
PAHs Alkylated	ORGS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
PBDEs	ORGS										■		■	■	■	■	■	■	■
PCBs 209	ORGS																	■	■
PCBs 40	ORGS	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■
Phthalates	ORGS										■	■							
Chlordanes	PESTs	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■
Cyclopentadienes	PESTs	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■
DDTs	PESTs	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■
Fipronil	PESTs																	■	■
HCHs	PESTs	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■

Analytes Reported in Sediment Samples (1993-2011) (cont.)

Shaded areas indicate that results are available for RMP Status and Trends Sampling.
Parameter Type Codes: ANC = Ancillary Parameters, EC=Emerging Contaminants, ORGS = Organic Parameters, PESTs = Pesticide Parameters, SedTOX = Toxicity Parameters, SYN = Synthetic Parameters, TE = Trace Metal parameters
* Data available upon request

Reportable Sediment Parameter	Type	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Hexachlorobenzene	PESTs	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■
Mirex	PESTs	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■
Pyrethroids	PESTs																■	■	■
Mean % Normal Alive	SedTox	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■
Mean % Survival	SedTox	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■
p-Nonylphenol	SYN										■	■							
Aluminum	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Arsenic	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Cadmium	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Copper	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Chromium	TE	■	■	■	■	■	■	■	■	■									
Iron	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Lead	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Manganese	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Mercury	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Mercury, Methyl	TE								■	■	■	■	■	■	■	■	■	■	■
Nickel	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Selenium	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Silver	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Zinc	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Analytes Reported in Bivalve Tissue Samples (1993-2010)

Shaded areas indicate that results are available for RMP Status and Trends Sampling.
Parameter Type Codes: ANC = Ancillary Parameters, ORGS = Organic Parameters, PESTs = Pesticide Parameters, SYN = Synthetic Parameters, TE = Trace Metal parameters
[1]Beginning in 2007, bivalve monitoring occurs biennially for trace organics and every 5 years for trace metal parameters. Bivalves were not deployed in 2007.

Reportable Bivalve Tissue Parameter	Type	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007[1]	2008	2009[1]	2010
% Moisture	ANC		■	■	■	■	■	■	■	■	■	■	■		■		■		■
% Solids	ANC	■	■	■	■	■	■	■	■	■	■	■	■						
% Survival per Species	ANC	■	■	■	■	■	■	■	■	■	■	■	■						
% Survival per Species (caged)	ANC														■		■		
Condition Index Mean	ANC	■	■	■	■	■	■	■	■								■		
CTD	ANC							■	■	■	■	■	■		■		■		■
Dry Weight	ANC	■	■	■	■	■	■	■	■	■	■	■	■		■		■		■
Gonad Index CI Mean	ANC							■	■	■									
Growth Mean	ANC							■	■	■	■	■	■		■		■		■
209 PCBs	ORGS																		■
40 PCBs	ORGS	■	■	■	■	■	■	■	■	■	■	■							
Alkanes (C10-C34)	ORGS	■	■	■															
Musk	ORGS										■	■	■						
PAHs	ORGS	■	■	■	■	■	■	■	■	■	■	■		■	■		■		■
PAHs Alkylated	ORGS	■	■	■	■	■	■	■	■	■	■	■			■		■		■
PBDEs	ORGS										■	■		■	■		■		■
Phthalates	ORGS										■	■	■						
Chlordanes	PESTs	■	■	■	■	■	■	■	■	■	■	■		■	■		■		■
Cyclopentadienes	PESTs	■	■	■	■	■	■	■	■	■	■	■		■	■		■		■
DDTs	PESTs	■	■	■	■	■	■	■	■	■	■	■		■	■		■		■

Analytes Reported in Bivalve Tissue Samples (1993-2010) (cont.)

Shaded areas indicate that results are available for RMP Status and Trends Sampling.
Parameter Type Codes: ANC = Ancillary Parameters, ORGS = Organic Parameters, PESTs = Pesticide Parameters, SYN = Synthetic Parameters, TE = Trace Metal parameters
[1]Beginning in 2007, bivalve monitoring occurs biennially for trace organics and every 5 years for trace metal parameters. Bivalves were not deployed in 2007.

Reportable Bivalve Tissue Parameter	Type	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007[1]	2008	2009[1]	2010
HCHs	PESTs	■	■	■	■	■	■	■	■	■	■	■		■	■		■		■
Hexachlorobenzene	PESTs	■	■	■	■	■	■	■	■	■	■	■		■	■		■		■
Mirex	PESTs	■	■	■	■	■	■	■	■	■	■	■		■	■		■		■
p-Nonylphenol	SYN										■	■	■						
Triphenylphosphate	SYN										■	■	■						
Aluminum	TE		■	■		■	■	■	■	■							■		
Arsenic	TE	■	■	■	■	■	■	■											
Cadmium	TE	■	■	■	■	■	■	■	■	■							■		
Copper	TE	■	■	■	■	■	■	■	■	■							■		
Cromium	TE	■	■	■	■	■	■	■											
DBT (Dibutyltin)	TE	■	■	■	■	■	■	■	■	■									
Iron	TE						■	■									■		
Lead	TE	■	■	■	■	■	■	■									■		
Manganese	TE						■	■	■	■							■		
MBT (Monobutyltin)	TE	■	■	■	■	■	■	■	■	■									
Mercury	TE	■	■	■	■	■	■	■											
Methyl Mercury	TE	■																	
Nickel	TE	■	■	■	■	■	■	■	■	■							■		
Selenium	TE	■	■	■	■	■	■	■	■	■							■		
Silver	TE	■	■	■	■	■	■	■	■	■							■		
TBT (Tributyltin)	TE	■	■	■	■	■	■	■	■	■									
TTBT (Tetrabutyltin)	TE		■	■	■	■	■	■	■	■									
Zinc	TE	■	■	■	■	■	■	■	■	■							■		

Changes to the RMP Program 1993-2011

Action Codes: A= Analyte added or removed from sampling design; D= Data rejected or not available/data comparability issues; L= Change in laboratory conducting analysis or in laboratory methods; P= Change in program/sampling design; S= Station added or removed; T= Trends analysis performed.

Action Code	Year	Action	Detail/Rationale
D	1993-1998	CTD data are not available for tissue	CTD cast was not deployed.
D	1999-2001	CTD data are available for Deployment, maintenance and retrieval tissue cruises	Began deploying CTD casts during tissue cruises.
D	1998-1999	Iron in bivalves is a non-target analyte and not reported via WQT	Iron in bivalves reported by lab, but is not available via WQT.
D	2004-2005	Tissue PAHs analzed by CDFG were rejected due to the method sensitivity	Most PAH measurements in transplant bivalve samples were below detection limits and thus not usable for trends analysis.
A	1993	MeHg in bivalve tissue samples was only analyzed in 1993.	Since this was part of a pilot study, the results are not displayed via the WQT. Total mercury was analyzed each year through 1999.
P	1993	Implemented Regional Monitoring Program for Trace Substances in the San Francisco Estuary (RMP). Samples collected three times per year for conventional water quality parameters and trace analytes.	Samples were collected during the rainy season (March), during declining Delta outflow (May), and during the dry season (Aug - Sept).
P	1993	Implemented Regional Monitoring Program for Trace Substances in the San Francisco Estuary (RMP) samples. Samples collected twice a year for sediment quality parameters and trace analytes.	Samples were collected during the rainy season (March) and during the dry season (Aug-Sept).
P	1993	Implemented Regional Monitoring Program for Trace Substances in the San Francisco Estuary (RMP). Bivalve samples collected twice a year for transplanted, bagged bivalve bioaccumulation and condition.	Samples were deployed during the rainy season (March-May) and during the dry season (Aug-Sept) and retrieved between 90 and 100 days after deployment.
S	1993	Collected samples along the spine of the estuary at 16 set stations for water and sediment; toxicity was measured at 8 of these stations for each matrix. Bivalves were deployed at 11 of the stations.	Original RMP sampling design.
D	1994	Prior to 2003, there are no records for individual fish stored in the database. Therefore, there are no records in the POEFish table.	Only composite information is available.
P	1994	Status and Trends Sport Fish Monitoring	Sport fish monitoring began as a pilot study funded by the Bay Protection and Toxics Cleanup Program. All fish were analyzed as individuals for mercury, PCBs, pesticides, and selenium.
S	1994	Added 2 stations for water and sediment sampling (previously 22) as part of the Local Effects Monitoring Program (LEMP): C-1-3 (Sunnyvale) and C-3-0 (San Jose)	Sites located by water pollution control plants. Added on a trial basis by Water Board. Sites were treated identically as RMP stations. Total water stations =24.
S	1994	Added 4 stations (previously 11) for bivalve tissue sampling	Total bivalve stations = 15.
S	1994	Added 6 stations for water and sediment sampling (previously 16): San Bruno Shoal (BB15), Alameda (BB70), Red Rock (BC60), Honker Bay (BF40), Petaluma River mouth (BD15), Coyote Creek mouth (BA10)	Sites selected to fill large areas in Estuary where no samples were taken and to better monitor areas around tributaries. Total water stations = 22.

Changes to the RMP Program 1993-2011 (cont.)

Action Codes: A= Analyte added or removed from sampling design; D= Data rejected or not available/data comparability issues; L= Change in laboratory conducting analysis or in laboratory methods; P= Change in program/sampling design; S= Station added or removed; T= Trends analysis performed.

Action Code	Year	Action	Detail/Rationale
A	1996	Added trace organics analysis for Southern Slough stations Sunnyvale (C-1-3) and San Jose (C-3-0)	Trace organics were not analyzed for Sunnyvale (C-1-3) during the July 1996 or August 1997 rainy season cruises, however samples were analyzed for trace metals and ancillary parameters.
S	1996	1996-04 Corbicula fluminea (CFLU) clams were collected from Putah Creek.	1996-04 Corbicula fluminea (CFLU) couldn't be retrieved from Lake Isabella so clams were collected from Putah Creek. Due to concerns with contamination, both pre- and post-depuration analysis was performed, but only the post-depurated results were reported. In September 1996, only post-depurated analysis was performed.
S	1996	Added 2 stations for water and sediment sampling (previously 24) as part the Estuary Interface Pilot Study: Standish Dam (BW10) and Guadalupe River (BW15)	Added as part of the Estuary Interface Pilot Study. Total water and sediment stations = 26.
A	1997	Identified 40 target PCB congeners for labs to report: PCB 008, 018, 028, 031, 033, 044, 049, 052, 056, 060, 066, 070, 074, 087, 095, 097, 099, 101, 105, 110, 118, 128, 132, 138, 141, 149, 151, 153, 156, 158, 170, 174, 177, 180, 183, 187, 194, 195, 201, 203	Analysis of RMP data collected from 1993-1995 showed 40 congeners consistently quantified in Bay samples. It was found that 40 congeners would be a good representation (~80% representative) of the total mass of PCBs in the bay.
D	1997	Prior to 2003, there are no records for individual fish stored in the database. Therefore, there are no records in the POEFish table.	Only composite information is available.
D	1997	Total salinity measurements taken in the field are not available for the April cruise.	Measurements not available.
L	1997	Changed analytical lab for analysis of PCBs and PAHs in bivalve tissue samples	Central Contra Costa Sanitary District began analysis of PCBs and PAHs in bivalve tissue.
P	1997	Implemented Sport Fish Contaminant Study - Sport Fish will be collected on a three year cycle and analyzed for mercury, PCBs, legacy pesticides (DDT, dieldrin, chlordane), and Se	Study implemented as a follow up to a 1994 study conducted by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB).
P	1997	Status and Trends Sport Fish Monitoring	• A special study was done to compare skin-on versus skin-off organics concentrations in white croaker. • Analytes measured: mercury, PCBs, DDT's, chlordanes, dieldrin, dioxin and dioxin-like compounds, and selenium. • Most samples were analyzed as composites except for mercury in striped bass and California halibut, and selenium in white sturgeon. • EWG analyzed some archive 1997 RMP samples for PBDEs in 2002. These data are not available on the WQT.
A	1998	T-1 samples analyzed for trace organics and trace elements	While T-0 samples have been consistently analyzed throughout the years, T-1 samples were analyzed for only two cruises: 1998-04 and 2001-09. The decision to analyze was because a lot of the transplants died during deployment.

Changes to the RMP Program 1993-2011 (cont.)

Action Codes: A= Analyte added or removed from sampling design; D= Data rejected or not available/data comparability issues; L= Change in laboratory conducting analysis or in laboratory methods; P= Change in program/sampling design; S= Station added or removed; T= Trends analysis performed.

Action Code	Year	Action	Detail/Rationale
D	1998	Status and Trends Sport Fish Monitoring	• Bivalves and crustaceans were analyzed as part of the sport fish study.
D	1998	Tissue results are not available for Sept. 1998 for BF20 (Grizzly Bay)	• The bivalves *Corbicula fluminea* (CFLU) could not be found at the reference site Lake Chabot
D	1999	Status and Trends Sport Fish Monitoring	• Bivalves and crustaceans were analyzed as part of the sport fish study.
L	1999	Changed analytical lab for analysis of mercury in water samples	University of Maryland, Center of Environmental Studies began analysis of Hg in water.
S	1999	Removed 1 station (previously 15) for bivalve tissue sampling BF20 (Grizzly Bay)	A bivalve reference site could not be found for *Corbicula fluminea* (CFLU). Total bivalve tissue stations = 14.
A	2000	Added Cobalt (Co) analysis in water and sediment samples	Co is a useful marker of geochemical processes in the Estuary, particularly as an indicator of metal fluxes from suboxic sediments. Added as part of the Fe/Mn/Co group
A	2000	Added gonadal index and growth analysis in bivalve tissue samples	Growth analysis calculated by SFEI in 2000 and 2001. AMS started calculating growth analysis in 2002.
A	2000	Added Methyl Mercury analysis in water and sediment samples	Ratios of Methyl Mercury to Total Mercury can be used to determine environments that methylation is most likely to occur in.
A	2000	Removed Mercury (Hg) and Arsenic (As) analysis in bivalve tissue samples	RMP results (1993-99) indicated that there was very little bioaccumulation of Hg beyond background concentrations and there was an absence of serious As contamination.
D	2000	Prior to 2003, there are no records for individual fish stored in the database. Therefore, there are no records in the POEFish table.	Only composite information is available.
L	2000	Changed analytical lab for analysis of PCBs and PAHs in bivalve tissue samples	Texas A&M Geochemical and Environmental Research began analysis of PCBs and PAHs in bivalve tissue.
P	2000	Changed frequency of water sampling to twice a year for ancillary and trace metal analytes	Discontinued sampling during declining Delta outflow (May). Samples were collected during the rainy season (March) and during the dry season (Aug-Sept). It was determined that samples collected during the dry season were most indicative of ambient concentrations.
P	2000	Changed frequency of sediment sampling to once a year for ancillary, trace metal and organic analytes	Samples collected during the dry season (Aug-Sept).
P	2000	Changed frequency of water sampling to once a year for organic analytes	Samples collected during the dry season were analyzed for organic contaminants. Most organic contaminants are legacy pollutants which degrade slowly so analyzing more that once a year for these analytes was found to be unnecessary.
P	2000	Status and Trends Sport Fish Monitoring	• A special study was done to compare organics concentrations across time during one year in the Oakland Inner Harbor. This study was to look at the seasonal variation of organic contaminants pre- and post-spawning. • Analytes measured: mercury, PCBs, DDTs, chlordanes, dieldrin, PBDEs (qualitative), dioxin and dioxin-like compounds, and selenium. • The 1998 crab data and 1999 clam data were reported in the 2000 report. • Most samples were analyzed as composites except for mercury (California halibut, white sturgeon, leopard shark and striped bass) and selenium in white sturgeon.

Changes to the RMP Program 1993-2011 (cont.)

Action Codes: A= Analyte added or removed from sampling design; D= Data rejected or not available/data comparability issues; L= Change in laboratory conducting analysis or in laboratory methods; P= Change in program/sampling design; S= Station added or removed; T= Trends analysis performed.

Action Code	Year	Action	Detail/Rationale
A	2001	Removed Gonadal Index analysis in bivalve tissue samples	Unable to obtain sufficient level of precision in separating somatic and gonadal tissue.
A	2001	T-1 samples analyzed	While T-0 samples have been consistently analyzed throughout the years, T-1 samples were analyzed for only two cruises: 1998-04 and 2001-09. No rational was found for analyzing these samples.
D	2001	PBDE Tissue Data not reported	A minimum amount of QA/QC was conducted. Dataset was missing replicates and SRMs. Data was treated as a special study and not added to S&T db.
D	2001	Status and Trends Sport Fish Monitoring	• Bivalves and crustaceans were analyzed as part of the sport fish study.
A	2002	Added PBDEs, phthalates, and p-nonylphenol analysis in water and sediment samples	Added potential persistent pollutants with the ability to bioaccumulate and cause toxicity.
A	2002	Added PBDEs, phthalates, p-nonylphenol, triphenylphosphate and nitro and polycyclic musks analysis in bivalve tissue samples	Added potential persistent pollutants with the ability to bioaccumulate and cause toxicity.
A	2002	Changed health indicator from Condition Index Mean to Growth Mean in bivalve tissue samples	Condition index is the ratio of tissue mass to shell volume and may be affected by factors other than health. Growth compares the pre- and post- deployment weight of each mussel and is a more direct measurement of health.
A	2002	Reduced bivalve Trace Metals (Ag, Al, Cd, Cu, Ni, Pb, Se, Zn) analysis in bivalve tissue samples to 5 year cycle and removed tributyltin analysis in bivalve tissue samples	RMP results indicated that Trace Metals and tributyltin do not appreciably accumulate in bivalve tissue.
A	2002	Removed chromium analysis in water, sediment and bivalve tissue samples	Technical Review Committee made decision based on findings by Khalil Abu-Saba that stated that the chromium found in the estuary was mostly of the trivalent form and none of the hexavalent form was detected. The concentrations in water and sediment were found to be essentially the same as those from the soils in the watersheds draining into the estuary.
D	2002	CTD casts were not taken during 2002 bivalve tissue maintenance cruise	The water and bivalve maintenance cruise occurred concurrently and it was decided that it was more important to take casts on the water cruise.
D	2002	Data unavailable/rejected for BDEs 82, 128, 203, 204, 205, 206, 207, and 209 for bivalve tissue samples	BDEs 82, 128, and 209 not part of standard mix reported by lab. BDEs 203, 204, 205, 206, 207 and 209 do not elute off of the GC-ECD columns.
D	2002	Data unavailable/rejected for PCB 132 analyzed in bivalve tissue samples	PCB 132 not analyzed in the lab due to co-elution problems.
L	2002	Changed analytical lab for analysis of mercury and methyl mercury in water	• University of California, Santa Cruz Dept. of Environmental Toxicology began water Hg and MeHg analysis (formerly conducted by University of Maryland).
L	2002	Changed analytical lab for analysis of trace organics in bivalve samples	California Dept. of Fish and Game, Marine Pollution Control Laboratory began analysis of trace organics in bivalve tissue (including pesticides, PAHs, and PCBs).

Changes to the RMP Program 1993-2011 (cont.)

Action Codes: A= Analyte added or removed from sampling design; D= Data rejected or not available/data comparability issues; L= Change in laboratory conducting analysis or in laboratory methods; P= Change in program/sampling design; S= Station added or removed; T= Trends analysis performed.

Action Code	Year	Action	Detail/Rationale
L	2002	Changed analytical lab for water trace organics to AXYS	Analysis formerly conducted by University of Utah Energy and Geoscience Institute (UUEGI)
L	2002	Changed method for analysis of Total Suspended Solids (TSS) in water to Suspended Solid Content (SSC) in water	The SSC method analyzes the whole sample while TSS is a subsetting method. SSC poses less variability by human interference and attains better precision because heavier sand and sticky clay particles are not lost during analysis.
P	2002	Changed Aquatic Toxicity Testing from yearly to a five year cycle	From 1993 to 2002, a noticeable decline in aquatic toxicity to organisms was observed, especially during the dry season.
P	2002	Implemented new random sampling design. Random sampling design based on spatially balanced probabilistic sampling design. The bay was divided into 5 hydrographic regions plus the Rivers segments. 7 Historic RMP sites were maintained in the program for sediment trends analysis and 3 (now 5) historic sites were maintained for water analysis	Sampling design will provide better statistical basis to answer regulatory questions. Will provide unbiased estimate of ambient conditions.
p	2002	Status and Trends Sport Fish Monitoring	The Environmental Working Group collected fish in 2002 from fishing piers around the Bay and analyzed fish for PBDE levels. SFEI reviewed this data set and added it to our sport fish database. The data are not currently being included in the WQT due to some issues with the data. EWG also analyzed some archive RMP samples (1997) for PBDEs. These data are also not being displayed externally.
P	2002	Stopped Bivalve Maintenance Cruise	Cruise was found to be unnecessary.
A	2003	Added PBDE analysis in sport fish samples collected for the Sport Fish Contaminant Study	Increasing PBDE concentrations in the bay area coupled with concern about the health effects on humans and wildlife led to adding PDBEs.
A	2003	CTD casts were not taken during 2003 bivalve tissue maintenance cruise	The water and bivalve maintenance cruise occurred concurrently and it was decided that it was more important to take casts on the water cruise.
D	2003	Data rejected for PAHs in bivalve tissue	Data was rejected by SFEI QA Officer due to many samples being qualified as Non Detect.
D	2003	Data unavailable/rejected for pesticide, PCB, and PBDE sediment samples	Samples are to be reanalyzed using HRGC/MS since there has been a change in analytical method.

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Action Code	Year	Action	Detail/Rationale
P	2003	Changed container for bivalves deployed from bags to cages. Some of the cages were maintained and some were un-maintained at each site	Findings from side by side deployment of bivalves in cages and in bags indicated that cages reduced the effects of bivalve predation.
P	2003	Status and Trends Sport Fish Monitoring	• A special study to do preliminary screening of additional species began in 2003. Additional species were analyzed for mercury and PCBs. Species included anchovy, barred surfperch, black surfperch, brown rockfish, herring, Chinook salmon, diamond turbot, sardine, smooth hound shark, starry flounder, and walleye surfperch. • Analytes measured: mercury, PCBs, DDT, chlordane, dieldrin, PBDEs. • Most samples were analyzed as composites except for mercury (California halibut, striped bass, leopard shark, white sturgeon) and selenium in white sturgeon
P	2003	Stopped deployment of bivalves *Corbicula fluminea* (CFLU) in the estuary. CFLU collection was continued in the delta by trawling at the Rivers sites BG20 (Sacramento River) and BG30 (San Joaquin River)	Findings from 2000-2002 special studies concluded that bioaccumulation of contaminants in the estuary could be monitored using only one species *Mytilus californianus* (MCAL).
S	2003	Removed three stations (previously 14) BD50 (Napa River), BD15 (Petaluma River in San Pablo Bay), and BC21 (Horseshoe Bay in Central Bay) for bivalve tissue monitoring	Findings indicated that only 2-3 stations were required to track long term changes in contaminant concentrations in bivalves. Stations = 11.
S	2003	Removed two water and sediment stations (previously 24) C-1-3 (Sunnyvale) and C-3-0 (San Jose), part of the Local Effects Monitoring Program (LEMP)	Funding ended for monitoring of trace organics in water and sediment which began in 1996 at these stations as part of the NPDES. Stations = 24.
S	2003	Removed water sampling from one random site in the South Bay segment and one random site in the Lower South Bay segment in order to add water sampling at historic sites BA30 (Dumbarton Bridge) in the South Bay and BC10 (Yerba Buena Island) in the Central Bay	Dropping these two random sites enabled the two historic sites to be added back into the sampling design at no additional cost to the program. These sites, along with BG20 (Sacramento River) are used by the Water Board for NPDES permit processing
A	2004	Added Particulate Organic Carbon (POC) analysis in water samples	Began analyzing for POC in order to be able to calculate Total Organic Carbon values (DOC+POC).
A	2004	Data unavailable for pesticides, PAHs, PCBs, and PBDEs in bivalve tissue samples	Poor recovery and high detection limits created "too many holes in the dataset". Samples will be archived but not re-analyzed.
A	2004	Removed PBDEs, phthalates, p-nonylphenol, triphenylphosphate and nitro and polycyclic musks analysis in bivalve tissue samples	These analytes posed low levels of concern for the San Francisco Bay Region based on current literature.
A	2004	Removed phthalates and p-nonylphenol analysis in water and sediment samples	These analytes posed low levels of concern for the San Francisco Bay Region based on current literature.
D	2004	Bivalve Organics data are not available for pesticides, PAHs, PCBs, and PBDEs	Poor recovery and high detection limits created "too many holes in the dataset". Samples will be archived but not re-analyzed.

Changes to the RMP Program 1993-2011 (cont.)

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A	2005	Expanded target BDE analyte list for sediment and water samples	Based on results from BDEs sampled in previous years and capabilities of the RMP laboratories, increased number of analytes.
A	2005	Removed Toxicity Identification Evaluations (TIEs) from sediment toxicity analysis	Method development is needed to aid in understanding the toxicity found in the bay sediments. Toxicity Identification Evaluations (TIEs) will be conducted using contingency funds when sufficient toxicity is observed.
D	2005	2005 Bivalve samples were analyzed for orgaincs by CDFG. PAHs were rejected. PBDEs, PCBs and PESTS were approved.	About half the analytes in each group were NDs.
D	2005	7 archived bivalve samples (T-0,BA10,BA40,BC10,BD 20,BD30,BG30) were reanalyzed in 2007 by AXYS for PBDES, PCBs, Pests and PAHs. 3 samples (BA40, BD20, BD30) were reanalyzed for PAHs using Base Extraction Method as a demonstration of appropriate lab method. Results were approved. Samples not reanalyzed included BB71, BC61, BG20, BD40, BA30. Due to lack of archived material not all samples were re-analyzed.	Reanalyzed in 2007 by AXYS as part of Intercomparison study with CDFG. The data available on the WQT include the 7 reanalyzed samples from AXYS and 5 samples analyzed in 2005 by CDFG.
D	2005	Mallard Island PBDE Data for study year 2005 – 2006 should not be used in load calculations due to blank contamination and missing samples (especially 209).	Data should not be used in load calculations. Flagged during internal ratio review due to blank contamination and missing samples (especially 209).
L	2005	2005-09 archived bivalve tissue samples reanalyzed for organics by AXYS and CDFG in 2007	Data analyzed by two different labs: 5 samples were analyzed by CDFG and 7 samples reanalyzed by AXYS.
L	2005	Changed method for extraction of organic analytes in water samples	High blank contamination in 2003 PAH samples led to a change from the Soxhlet extraction method to an ambient temperature extraction method.
A	2006	Began collecting hardness data for all water stations where salinity <5ppt	Previously hardness data was collected at riverine stations where salinity <1ppt and estimated for estuarine sites.
A	2006	Removed BDE 82 from target analyte list	BDE 082 is not in any commercial mixtures and its rationale for reporting it was unclear as it is not a major congener.
D	2006	Analyses of 2006 bivalves for trace organics data were delayed until 2008.	Analysis was delayed pending a decision regarding a demonstration of lab capabilities.
D	2006	Tissue data are unavailable for Coyote Creek (BA10)	Nearly full mortality (1% survival) due to heavy biofouling and sedimentation
D	2006	Tissue data are unavailable for San Pablo Bay (BD20)	Mooring was removed during deployment period
D	2006	Water diazinon and chlorpyrifos data are not available	Initially, samples were not analyzed due to analytical issues. These issues were resolved. In 2010, the TRC decided to cancel the analysis due to the high cost and the lack of a pressing need for the data
L	2006	Changed lab for the water diazinon and chlorpyrifos analysis from CDFG to AXYS	Changed labs based on new method development for this analysis and difficulties with prior method for analyzing these compounds.

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L	2006	Changed method for analysis of arsenic in water samples	Method changed from HGAA to ICP-MS as a cost saving measure for method development.
P	2006	Annual Bivalve Maintenance Cruise discontinued and biannual cruise implemented	TRC approved dropping the maintenance cruise after a study conducted from 2002-2005 showed no significant difference in survival of bivalves in maintained and non-maintained cages
P	2006	Changed program name to Regional Monitoring Program for Water Quality in the San Francisco Estuary	Previous name was the Regional Monitoring Program for Trace Substances in the San Francisco Estuary. This change is intended to more adequately express the objectives of the RMP.
P	2006	Status and Trends Sport Fish Monitoring	• The special study to look at contaminants in other species continued in 2006. Barred surfperch, brown rockfish, black surfperch, Chinook salmon, rubber lip surfperch, walleye surfperch, and northern anchovy were analyzed for PCBs, PBDEs and mercury. • Analytes measured: mercury, PCBs, PBDEs, dioxins, DDTs, dieldrin, chlordane, dioxin, and selenium. • Archived 2003 white croaker samples were analyzed and reported with 2006 white croaker data in the 2006 report. • Jacksmelt, leopard shark, and California halibut were discontinued as status and trends species. • Most samples were analyzed as composites except for mercury in striped bass and selenium in white sturgeon.
P	2006	Stopped analyzing the dissolved water fraction for organics in water	California Toxics Rule (CTR) has only been established for the total fractions of organic contaminants. The dissolved fraction was removed as a cost saving measure. At three stations, the RMP will report our dissolved and particulate fractions separately for comparative purposes.
S	2006	Changed bivalve tissue site BD20 (San Pablo Bay) by a nautical mile. BD20 will be renamed.	USGS replaced the channel marker where bivalve mooring BD20 was attached. The site was moved from Petaluma Light 1 to Petaluma Light 4. A new mooring will be installed at that site.
A	2007	Added BDE 197 to target analyte list for water and sediment and BDE 196 for sediment only.	This will provide a more accurate estimate of total PBDEs since these congeners constitute a relatively high percentage of the Deca-BDE mix.
A	2007	Nitrogen results will be reported as "Nitrogen, Total Kjeldahl" in sediment. This is different from the historical RMP data.	Lab changed from UCSCDET to AMS-Texas.
D	2007	No bivalves data for 2007	Bivalves were not deployed in 2007. Sampling was changed to every other year.
D	2007	Water diazinon and chlorpyrifos data are not available	Initially, samples were not analyzed due to analytical issues. These issues were resolved. In 2010, the TRC decided to cancel the analysis due to the high cost and the lack of a pressing need for the data.

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L	2007	Changed lab for the bivalve tissue analysis from CDFG to AXYS	2006 tissue analyses were conducted by AXYS. A subset of 2005 archive bivalves were reanalyzed by AXYS in 2007 and results much improved.
L	2007	Changed lab from UCSCDET to AMS-Texas for analysis of sediment quality samples	Changed labs based on an evaluation of turnaround time, cost, and analytical capabilities.
L	2007	Intercomparison study with UCSC (POC only) and AMS-Texas (POC/DOC) for ancillary analytes in water	UCSC sampled 9 of the 22 sites, AMS-Texas sampled all 22 sites. UCSC sampled 9 of the 22 sites, AMS-Texas sampled all 22 sites.
L	2007	Intercomparison study with UCSC and AMS-Texas for grainsize, Total Organic Carbon and Total Nitrogen in sediment	UCSC sampled 9 of the 47 sites; AMS-Texas sampled all 47 sites.
L	2007	Intercomparison study with UCSC and BR for trace metals in water samples.	UCSC sampled 9 of the 22 sites, BR sampled all 22 sites.
L	2007	Intercomparison study with UCSC and EBMUD for analysis of SSC, Pigments Nutrients, salinity, and hardness in water	UCSC sampled 9 of the 22 sites, EBMUD sampled all 22 sites. (Pigments (Chlorophyll & phaeophytin) & Nutrients (ammonia, phosphate, nitrate/nitrite, silica)
L	2007	SFEI begins taking shipboard total salinity measurements.	Switched labs for water ancillary data; new lab does not participate in cruises. UCSC used to also report salinity by SCT along with their analytical measurements.
P	2007	Modified sediment toxicity sampling design.	During 2002-2006, every other sediment sample was analyzed for toxicity, which spatially biased the samples to the Lower South Bay
P	2007	The number of water sites was changed from 31 to 22. Sampling will occur at 3 sites in each of the upper 4 segments and 5 sites in the Lower South Bay segment. The 5 historic sites will continue to be sampled.	The power analysis from San Jose suggests that this change will be able to detect about a 1 ug/L change (give or take) in dissolved copper in every segment at a very high 99% power. The TRC approved this change in December 2006.
P	2007	The S&T monitoring program was expanded to triennial bird egg monitoring (cormorant and tern).	Part of the redesign process implemented in 2006.
P	2007	Water toxicity sampling occurred in 2007. Toxicity sampling has been changed to a screening effort approximately every five years.	RMP S&T aquatic toxicity monitoring in the Estuary has shown no toxicity over the past several years. Next scheduled sampling will occur in 2012.
A	2008	Added benthos analysis (CCSF) and (MLML)	The addition of benthos collection will enable sediment assessments in accordance with the SQOs which use three lines of evidence, benthos, sediment chemistry and sediment toxicity.
A	2008	Added pyrethroids analysis in sediment (CDFG)	To investigate the potential toxicity of pyrethroids in the Bay.
A	2008	Added selenium analysis in tissue (BR)	Added to provide information for the Selenium TMDL
A	2008	PCBs were not analyzed in water. PAHs and Pesticides in water were not scheduled to be analyzed but were added into the sampling plan.	PCBs, PESTS, PAHs will be sampled every other year in water (on a biennial basis) based on recommendations from the redesign process. PAHs were analyzed because of the Cosco Busan oil spill, and PESTS were analyzed to validate the detection level for AXYS Analytical's MRES method using both whole water samples and 100L High volume extracts. Pesticide results were not reported because they were part of the Intercomparison study.

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D	2008	2008 grainsize granule fraction is not available	Granule fraction was not analyzed. In 2008, RMP switched labs from UCSC-DET to MLML-Aiello. MLML did not analyze larger grainsize fractions, and only fractions <2mm are available.
D	2008	Grainsize determination changed to an optical method.	In 2008, RMP switched grainsize labs from UCSC-DET to MLML-Aiello where they employ a different method.
D	2008	Grainsize for 2008 are not comparable to previous years.	Grainsize in 2008 and later is reported for fractions 2mm and smaller, as a percentage of total volume determined by an optical (laser) method, as opposed to gravimetric measurement (as a percentage of mass) for mechanically separated samples used prior. Additionally, split samples analyzed mechanically in 2009 showed poor comparability to the optical method due to possible artifacts of handling in the mechanical separation method, usually yielding higher apparent coarse material due to aggregation of smaller particles during the drying of samples. The lab is currently testing a wet seiving method to resolve these artifacts.
D	2008	Manganese and iron in bivalves are non-target analytes and not reported via WQT	Manganese and iron are not reported as target analytes via WQT.
D	2008	Missing % Lipids for the trace metals bivalve analysis	Lab could not analyze for this.
D	2008	MRS Pesticide Results should not be combined with prior years for Trends Analysis.	Axys switched to a multiple residue (MRES) method for pesticides. Whole water MRES samples typically showed higher concentrations than in solid phase (XAD) extracted samples, due to only partial retention of pesticides by the XAD. Interannual trends should therefore be evaluated only within any given collection type (i.e. whole water 2008 and later or XAD 2007 and before).
D	2008	Oxadiazon was not reported	The MRES method cannot analyze for Oxadiazon and because the 2008 demonstration project used only the MRES method, it was not possible to collect this data.
D	2008	Pyrethroid tralomethrin not analyzed in sediment samples	Tralomethrin was not analyzed in 2008 by CDFG, but will be in the future.
D	2008	Water MRES pesticide data	The 2008 samples were part of a demonstration project for the MRES method and were conducted on a subset of stations using whole water grabs (7 samples). These results were then compared to the extracts from the 100-liter infiltrex samples at the same location. These results will not be reported on the web.
L	2008	Added sediment-water interface cores exposure (SWIC) toxicity testing method for bivalve larval (Mytilus galloprovincialis) SWIC will be analyzed for toxicity by UCD-GC.	The Sediment Quality Objectives recommend using sediment–water interface core exposure (SWIC) for bivalve larva toxicity instead of elutriate testing for toxicity. Toxicity testing for amphipods will continue to be conducted using the elutriate method. TIEs will be conducted in samples that show significant toxicity.
L	2008	Changed lab for analysis of Total Organic Carbon and Total Nitrogen in sediment from UCSC to MLML – Hunter	Changed labs based on an evaluation of turn around time, cost, and analytical capabilities.
L	2008	Changed lab for analysis of grainsize in sediment from UCSC to MLML - Aiello	Changed labs based on an evaluation of turn around time, cost, and analytical capabilities.

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Action Code	Year	Action	Detail/Rationale
L	2008	Changed lab for analysis of SSC, Pigments, Nutrients, salinity, and hardness in water from UCSC to EBMUD	Changed labs based on an evaluation of turn around time, cost, and analytical capabilities.
L	2008	Changed lab for POC and DOC analysis from UCSC and AMS-Texas to Columbia Analytical Services	Changed labs based on an evaluation of turn around time, cost, and analytical capabilities/ AMS-Texas went out of business.
L	2008	Changed principle lab for trace metals in water from UCSC to BR and changed principle lab for trace metals in tissue from UCSC to BR (Se) and CCSF (other metals)	Changed labs based on an evaluation of turn around time, cost, and analytical capabilities such as elevated methyl mercury quantitation limits. Due to BR's method, metals (Al, Cd, Cu, Fe, Pb, Mn, Ni, Ag, and Zn) are no longer reported as near-total concentrations. UCSC extracted with a weak acid (pH < 2) for a minimum of one month, resulting in measurements that approximate bioavailability of these metals to Estuary organisms. BR used reductive precipitation according to EPA Method 1640.
L	2008	Intercomparison study with BR and City and County of San Jose for Copper and Nickel in water	Samples were analyzed by both labs at all 22 sites.
L	2008	Pesticide water analysis conducted by AXYS was performed using MRES method on samples collected on 100L infiltrix system. In previous years pesticides were analyzed using GC/LRMS which could not detect chlorpyrifos/diazinon.	The MRES method is able to detect the standard suite of RMP pesticides including chlorpyrifos/diazinon (oxadiazon is not tested for using MRES).
P	2008	Began reporting water particulate trace organic results.	New design of web query tool makes it easier to post particulate results.
P	2008	Benthos sampling was added as part of the sediment sampling cruise.	With all three lines of evidence (i.e., benthos, sediment chemistry and sediment toxicity), it will be possible to conduct sediment assessments in accordance with the Sediment Quality Objectives (SQOs), which are scheduled to be promulgated in 2008.
T	2008	Bivalve Trends	These are available in the AMR beginning in 2008 for years bivalves are collected, biennially for trace organic contaminants and every five years for trace metal contaminants.
A	2009	Cyanide was analyzed in water.	New site specific objective was developed for cyanide in water in San Francisco Bay.
A	2009	Dioxins were added as part of the Small Tributary Loading Study.	Data will fill the dearth of information that currently exists for dioxin. This is a special study.
A	2009	Dioxins were analyzed for all 22 water stations, all 47 sediment stations, and in sport fish.	Data will fill the dearth of information that currently exists for dioxin. This is a 5 year special study that is not a part of the Status and Trends Component.
A	2009	Oxadiazon was dropped from the RMP target analyte list.	The different MRES method for analyzing pesticides in water adopted by the RMP doesn't include oxadiazon. Since concentrations of oxadiazon have remained relatively constant over time, the TRC approved removing it from the target list in July 2009.
A	2009	PFC analysis was added to bird samples.	Part of Exposure and Effects Pilot Study.
A	2009	PFC analysis was added to sport fish samples.	Part of Emerging Contaminants Special Study.
A	2009	PFC samples were collected at a subset of water stations.	Special Study - Added because of concern over elevated concentrations found in Bay Area tissue samples as compared to reference samples from Tomales Bay.

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A	2009	The RMP PCB list was expanded from 40 congeners to 209 congeners for all matrices.	The non-Aroclor PCB, PCB 11, was unexpectedly observed in air and effluent samples outside the Bay Area in significant concentrations, prompting the expansion of the RMP PCB congener list to include all possible congeners.
A	2009	Water PAHs were not analyzed.	Due to the Cosco Busan oil spill, PAHs were analyzed in 2008. Because no significant changes in the water column were identified, PAH sampling was skipped in 2009 and 2010. Water PAHs are scheduled to be sampled again in 2011.
A	2009	Whole water samples were collected at 22 sites for analysis of pesticides.	Whole water samples are collected for the analysis of pesticides using MRES methods. Beginning in 2009, pesticides analyzed using the MRES method are considered the RMP's target analytes.
D	2009	2009 total cyanide water results are not reported.	The RMP's previous California Toxics Rule (CTR) work was based on the Weak Acid Dissociable (WAD) fraction. Total cyanide will most likely give an over-estimation of the bio-available fraction. Several of the 2009 total cyanide water results were above the cyanide trigger level (1.0 ug/L) for ambient monitoring as stated in the Basin Plan Amendment, which is based on the WAD fraction. Hence, at the request of the Water Board these samples were not reported to avoid confusion.
D	2009	Water PBDEs 196, 201, and 202 are not available.	AXYS has not developed a method for detecting these PBDEs in water.
L	2009	Contra Costa County Sanitation District will analyze water for cyanide.	New analyte for analysis in water only.
P	2009	Added Pesticides Fipronil, Fipronil desulfinyl, Fipronil sulfide, and Fipronil sulfone for sediment analysis	These pesticides are highly used in the Bay Area and are of emerging concern. Fipronil is widely-used in flea/tick applications. It is exceedingly toxic to insects/crustaceans. There is relatively little Bay Area data so it would be very helpful to report these data when available.
P	2009	Changed the statistical design for sediment sampling from five-year panels to six-year panels	Changed to incorporate rainy season sediment sampling which will occur every other year starting in 2010. Rainy season sediment sampling will occur at 20 random sites and 7 historic sites. Dry season sediment sampling will continue to occur at 40 random sites and 7 historic sites.
P	2009	Dioxins were analyzed in water, sediment, sediment core, bird egg, small tributary loading, and sport fish samples.	The Dioxin Pilot Study is not part of the Status and Trends component, but samples were collected during regular RMP sampling events.

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Action Code	Year	Action	Detail/Rationale
P	2009	Status and Trends Sport Fish Monitoring	• The 2009 monitoring effort was combined with the BOG coast year 1 sampling effort. This resulted in adding one additional species to the RMP list: Jacksmelt. • Most samples were analyzed as composites except for mercury in striped bass and selenium in white sturgeon. • Analytes measured: mercury, PCBs, DDTs, dieldrin, chlordanes, PBDEs, dioxins, PFCs, and selenium. • There were two side-by-side studies in 2009: ◊ Comparison of selenium concentrations in filet, muscle plug, and liver of white sturgeon. This was done for the development of the North Bay selenium TMDL. The comparison was also to determine if we could use muscle plugs (nonlethal) instead of filet (lethal) to determine selenium levels in white sturgeon. ◊ Comparison of skin-on and skin-off PCBs, legacy pesticides, PBDEs, and dioxin concentrations in white croaker. Starting in 2009, white croaker will be analyzed skin-off.
T	2009	Sport Fish	SWAMP/RMP/Bight Program Report on Contaminants in Fish from the California Coast. 2011.
A	2010	Began reporting Sum of PCBs 208 (SFEI)	This sum provides an index of the PCBs present in Aroclor mixtures. PCB-11 is excluded from the sum because it is a by-product of dye manufacturing and is not related to Aroclors. PCB 11 does not have dioxin-like potency and has different sources than Aroclors.
A	2010	Pyrethroids Tetramethrin and piperonyl butoxide moved to a status of "Information only" by analytical lab	Compounds have a history of persisting high variability in Ongoing Precision and Recovery (OPR) and linearity data. Results are estimated to be accurate only within an order of magnitude.
D	2010	Added new PrepPreservation Code: FieldFiltered,FieldSolventPres,FieldFrozen	This code is used for Chlorophyll-a and Pheophytin samples beginning in 2010. We will not update previous years' sample records which have codes "FieldFiltered, LabAcidified" and "FieldFiltered, FieldFrozen" because it was determined that the benefit does not justify the time and effort at this time.
D	2010	Bivalve data not available for BD40 Davis Point Station because it was not sampled.	BD40 was not sampled due to terminal construction and weather issues.
D	2010	TRC cancelled scheduled analysis of archived 2006 and 2007 water samples for Diazinon and Chlorpyrifos	Initially, water samples were stored during method development for analysis once analytical issues were resolved. These issues have since been resolved. In 2010, TRC decided to cancel the analysis due to the high cost ($60,000) and the lack of a pressing need for the data.
D	2010	Whole water PBDE sample results are not available through the Web Query Tool.	In 2010, 4L whole water samples were analyzed for PBDEs as part of an intercomparison study. The Web Query Tool Does note report data from Intercomparison studies.

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D	2010	YSI data collected by SFEI on water cruise are not available for 2010	Data were inadvertently deleted from YSI machine by staff working on another project before it was downloaded.
L	2010	Began adding LabPoisoned to the PrepPreservation code for organic water samples when samples tested positive for residual chlorine.	It was decided that we will not update the PrepPreservation code for samples prepped with poison from 2002-2009 because the benefit does not justify the time and effort at this time.
P	2010	Sediment samples will be collected in alternate seasons starting with a rainy season (winter) sampling event in February 2010.	There appears to be a seasonal element to sediment toxicity with winter sampling exhibiting higher toxicity. 27 samples will be collected during the dry season and 47 samples will be collected during the rainy season. February of 2010 was the first rainy season collection. The next sampling event is August 2011.
A	2011	Range dropped from grainsize parameter names and is now stored in fraction field.	Changed as part of effort to incorporate SWAMP comparability to SFEI data reporting.
A	2011	Sediment toxicity test organisms changed.	The TWG and EEWG recently decided to change the test organisms at the river sites to Hyalella and Ceriodaphnia for 2011. Prior years used Eohaustorius and Mytilus.
A	2011	Three sum of PCBs: 40, 208, 209 will be reported through the Web Query Tool.	Three sum of PCBs: 40, 208, 209 for all matrices and all studies. Sum of 209 PCBs is provided solely for comparison to other studies that use this statistic. SFEI does not recommend using this sum for comparison to any Aroclor-based thresholds (the TMDL target, OEHHA thresholds, etc.) - the Sum of 208 PCBs is better for that purpose.
D	2011	SWAMP has changed the definition of LCS Sample Type. The new definition says that LCS samples have gone through the entire QA process.	SWAMP has provided a new definition for samples that have not gone through the entire QA process. The new sample type code is 'UnkAcc' – Control Sample used to assess accuracy, unknown whether or not taken through the full analytical process. We will not go back and update the database for samples previously called LCS since we do not always know whether the samples have gone through the entire analytical process but in future data sets we will use the code 'UnkAcc'.
D	2011	Updated coelution flag for PCB 156(Surrogate) to DO156L. In previous years, the flag DO156 was reported.	The L indicates that it is a labeled compound. Including the 'L' in the coelution flag increases accuracy.
L	2011	Beginning in 2011, the MDLs from EBMUD for sediment trace organics are all 40CFRs.	EBMUD wanted to provide consistent MDLs between analytes.
P	2011	The name of the Web Query Tool (WQT) changed to Contaminant Data Download and Display (CD3).	This name is more descriptive and is more representative of what the SFEI data query tool does.
T	2011	Small fish Trends Report.	Report by Ben Greenfield will be published in 2011.
D	2011	Cyanide results are not available for SB061W	The sample was not analyzed due to hold time violations.