Regional Monitoring Program

2014 Detailed Workplan

DRAFT

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Regional Monitoring Program (RMP) for Water Quality in the San Francisco Estuary

2014 Detailed Workplan

Overview

This document is the detailed workplan that describes the major RMP elements and tasks to be completed in 2014. It is the guiding document for planning and allocating funds for 2014. The workplan is divided into topical areas or tasks. For each task, the following information is provided: a description of the task and how it relates to the RMP objectives and management questions; identification of subtasks; a schedule of deliverables; and an estimate of SFEI labor costs. All major tasks and associated costs to complete these tasks are presented in Table 1.

The SFEI labor costs are our best estimate at present as to the level of effort that we anticipate that it will take to complete each of the proposed tasks for 2014. It is likely that as the year progresses, adjustments will be made to the individual labor cost and/or subcontractor and direct cost estimates for each task; however, the total budget for 2014 will remain fixed.

The RMP objectives were revised in 2008 to reflect improved understanding and to respond to new priorities. The overarching goal of the Program is to collect data and communicate information about water quality in the San Francisco Estuary to support management decisions. There are three levels of management questions. The core management questions (level 1) are presented below. Level 2 and 3 questions address specific elements of the level 1 questions (SFEI 2012).

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

This document is divided into four chapters that describe the major task areas within the RMP. Task 1 includes the overall management of the Program and the efforts made to coordinate the Program both internally with SFEI staff and stakeholders and externally with the many agencies and organizations that are responsible for stewardship of the Estuary. Task 2 describes how the results of the RMP studies are reviewed, validated,

synthesized, and disseminated to researchers, regulators, and the public at large. The long-term monitoring component of the Program, Status and Trends monitoring, is presented in Task 3. Task 4 describes special studies that will be performed in 2014.

Task 1 Program Management

The administration and management of the RMP requires a substantial effort from SFEI staff. Costs for this component of the RMP reflect the staff time required to: manage finances and contracts; track deliverables and project status; coordinate SFEI staff; and plan and coordinate activities among external agencies and organizations that have a vested interest in the RMP. This task is divided into four subtasks that are described below: internal coordination; external coordination; contract and financial management; and Program planning.

1.1 Internal Coordination

The purpose of this task is to coordinate and facilitate among Program participants, subcontractors, collaborators, Regional Water Quality Control Board staff, and members of the Steering and Technical Review Committees. This coordination is essential to enhance the exchange of information, to avoid duplication of efforts, to identify and inform members of critical decisions and important issues, and to ensure that RMP activities complement and improve other scientific efforts by RMP participants, the Regional Board, and others. This task also includes the internal coordination of RMP staff (e.g., the coordination and technical oversight of different RMP tasks).

Internal coordination also includes all of the activities associated with the workgroups. Currently, the RMP has five workgroups: Sources Pathways and Loadings; Contaminant Fate; Exposure and Effects; Emerging Contaminants; and Sport Fish. The Sport Fish workgroup meets infrequently (e.g., prior to the year that sport fish sampling will occur). All of these workgroups have advisory panels composed of prominent external experts which provide peer review to assure that the projects developed and implemented are technically sound.

In addition to these five workgroups, select teams from the workgroups and the RMP stakeholders have been formed to implement strategies for priority topics including: mercury, small tributary loading, modeling, dioxins, nutrients and PCBs.

1.2 External Coordination

External coordination promotes comprehensive and coordinated understanding and monitoring of the Estuary through participation in committees outside of the RMP umbrella.

Members of RMP staff participate in the Surface Water Ambient Monitoring Program (SWAMP) and Northern California Society for Environmental Toxicology and Chemistry (NorCal SETAC), and meet with stakeholders including BASMAA, BACWA, LTMS,

IEP, refineries, and various Total Maximum Daily Load (TMDL) work groups and committees. In addition, RMP staff are frequently asked to present guest lectures at universities and at national and international meetings and to serve on advisory boards. RMP staff also provide peer review of documents from other relevant non-RMP programs and projects.

1.3 Contract and Financial Management

Tasks in this category include efforts related to tracking progress and expenditures on all budgeted items, including invoicing of Program Participants, tracking incoming and outgoing funds, accounting and working with the SFEI auditor, working with the Fiscal and Administration Subcommittee of the SFEI Board of Directors, providing financial status updates, and communicating with the Steering Committee on financial matters. It also includes development of contracts after scopes of work have been negotiated, scientific oversight of products, coordination of field and laboratory components, trouble-shooting, scheduling, and implementing course adjustments as necessary, cost-effectiveness/performance evaluations of existing contractors and identifying potential new subcontractors as needed.

1.4 Program Planning

Program planning for the RMP involves several tasks including the development of the Program Plan, the Detailed Workplan, and the Multi-year Plan as well as development of scopes of work, both internally and externally for contracts. The Program Plan and Detailed Workplan provide detailed descriptions of the activities undertaken within a specific year. The Multi-Year Plan articulates longer-term program information needs and program priorities and is updated every year in the fall.

1.5 Schedule, Deliverables, and Budget

Program management activities are implemented year round. Deliverables for these tasks also occur year round and correspond to the RMP activities at hand (e.g., contracts are negotiated at the beginning of the fiscal year, invoicing of stakeholders occurs in the summer, and preparation for the quarterly TRC and SC meetings occurs throughout the year). Both technical and administrative staff are involved with project management as this encompasses a wide variety of activities (e.g., negotiation of contracts, preparation of invoices, coordination with external groups, and coordination internally among staff members).

Estimated labor costs for each subtask are presented below.

Subtask	**Estimated Cost 2014**
Internal Coordination	$361,000
External Coordination	$29,000
Contract and Financial Management	$166,000
Program Planning	$12,000
Total	$568,000

Task 2 Information Management and Dissemination

The overarching goal of the RMP is to collect data and communicate information about water quality in the San Francisco Estuary to support management decisions. It is critical that the important findings from the Program are disseminated to managers and the scientific community. The RMP disseminates information using a variety of means including the Contaminant Data Display and Download (CD3) tool, technical reports, annual reports such as the Pulse and Annual Monitoring Results, workshops, and conferences.

2.1 Data Management

The primary objectives of this task are to manage, maintain, and improve the RMP database, to enable easy access to RMP data, and to share RMP data with the California Environmental Data Exchange Network (CEDEN). In addition to the formatting and reporting of the current year's monitoring data, it is also necessary to periodically update and standardize data from prior years to ensure the comparability of RMP data across all years of the Program. In accordance with these objectives, our information management and dissemination goals for 2014 are as follows (listed in order of priority):

Data Formatting, QA/QC, and Upload

- Upload RMP field and analytical results from laboratories into the RMP database, which is comparable to the State's CEDEN/SWAMP v.2.5 database.
- Perform QA/QC review of the data to verify they meet the RMP's Data Quality Objectives as outlined in the RMP QAPP, which is comparable to the State's SWAMP Quality Assurance Management Plan.

Database Maintenance and Web Access

- Incorporate updates and corrections to data as needed, including reanalyzed results and updates implemented by the SWAMP/CEDEN data management team.
- Add enhancements and updates to the web-based data access tool to make data easier to access by users (e.g., user-defined queries, data download and printing functionality, maps of sampling locations, and visualization tools).

Mapping Assistance (GIS)

- Generate maps of sampling stations to support sample collection and display of results.

Data Management Efficiencies

- Develop and enhance tools to increase the efficiency of data management tasks, including data collection (e.g., develop scripts to upload collection information and generate electronic Chain of Custody (COC) forms for shipping and Electronic Data Deliverable (EDD) templates for the analytical labs), data upload (e.g., web data checker verifies that standard codes are submitted), and QA/QC review (e.g., standard queries for reviewing data quality objectives).

A description of each of these subtasks is presented below.

SUBTASK DESCRIPTIONS

Subtask 1 Data Formatting, QA/QC, and Upload

The data formatting process for the Status and Trends datasets consists of several steps:

1) Verifying accuracy and completeness of each data submission from the sub-contract laboratories;
2) Transferring the electronic data submittals to the SFEI's relational database;
3) Conducting a complete QA/QC review of each data submission to ensure data are appropriately qualified according to RMP data quality objectives and consistent with historic data;
4) Contacting laboratories regarding questionable or missing data and ways to improve data quality; and
5) Tracking the various data management and QA/QC procedures for each dataset.

All results are reviewed according to the data quality requirements outlined in the 1999 QAPP and validated before being publicly released on the Institute's website.

Subtask 2 Database Maintenance and Web Access

In addition to managing data for the current monitoring year, data updates and routine maintenance tasks are performed in order to provide reliable and standardized data for all years of the Program. Data are continually updated to comply with reporting requirements. Inconsistencies are identified, qualifiers are updated, and reanalyzed results are added to the database as they are received from the laboratories. This subtask involves contacting laboratory representatives, updating data records, tracking data management processes and changes, and archiving work files.

Subtask 2.1 Update Web Query Tool

The Contaminant Data Display and Download (CD3) is the RMP's web-based data access tool for disseminating RMP data. This tool will be updated as needed and new enhancements added to more effectively meet the needs of the users.

Subtask 2.2 Update and Maintain RMP Database

The RMP Status and Trends database is comparable to the State's Surface Water Ambient Monitoring Program (SWAMP) database (version 2.5). By using the same standardized data format required by SWAMP and all State-funded grant projects, RMP data are more accessible to regulators, researchers, and the public. SFEI is one of the State's Regional Data Centers and exchanges data with CEDEN on a weekly basis.

The SWAMP database design is extremely detailed and must be updated as the SWAMP/CEDEN data management team continues to develop and update the State's database standards. The RMP will incorporate new changes to the database in order to maintain comparability with the SWAMP/CEDEN database.

Subtask 2.3 Develop and maintain a database of samples archived through the National Institute of Standards and Technology (NIST)

The RMP collaborates with NIST to house RMP biological samples in long-term state of the art facilities. A database has been developed to track these samples. This database will be maintained as samples are added, removed, and updated.

Subtask 3 Data Management Efficiencies

This task will continue to improve the process of developing standards and tools for RMP laboratories to submit their data in standard electronic data deliverable formats (EDDs) and tools for staff to evaluate completeness and accuracy of those data submissions. The tools will allow a preliminary review of the EDDs to ensure that data are submitted in current database formats prior to being parsed into the many relational tables of the RMP

database. Additional review queries will evaluate datasets for completeness and provide preliminary QA/QC review summaries.

Several routine calculations and procedures (e.g., summing of organics totals, QA/QC validation procedures, assignment of QA qualifiers, etc.) could be made more efficient through additional programming. The goal of this subtask is to build additional efficiencies into the RMP QA/QC process and to eventually link these tools to a web-based data submission process as opportunities arise.

Staff Involved

Staff leads for data management are Cristina Grosso, John Ross, Amy Franz, Adam Wong, Michael Weaver, and Donald Yee. Other key staff include: Shira Bezalel and Todd Featherston.

Schedule and Deliverables

Data management tasks are ongoing and updates are made available as soon as they are deemed complete. Data are made available for report production and meeting deadlines.

Budget

The estimated labor budget for data management for 2014 is presented on the table below.

Subtask	**Estimated Labor Cost 2014**
Data Formatting, QA/QC, and Upload	$159,800
Database Maintenance, Data Efficiencies, GIS, and Web Access	$157,700
Total	$317,500

2.2 RMP Web Site

OVERVIEW

The RMP web site has an important role in making data, technical reports, newsletters, bibliographies, Powerpoint presentations, and other documentation available to stakeholders. This task includes: publication of RMP *Annual Monitoring Results* and uploading new documents to the web site (e.g, reports, SC and TRC meeting packages, etc.); maintenance of web directories; updating the RMP program page; and improving the overall design of the RMP web site.

In 2014, SFEI will be updating its website format and layout; RMP staff will be working in collaboration with the Environmental Data, Information and Technology team to improve the RMP web site.

SUBTASK DESCRIPTIONS

Subtask 1 2013 Annual Monitoring Results
The RMP *Annual Monitoring Results* is published only on the RMP website. The graphics group prepares the web layout.

Subtask 2 General Report Formatting for the Web
RMP reports are formatted for access on the RMP web site. Appropriate links are added to the RMP reports page to ensure easy access to the report.

Subtask 3 Maintenance of RMP Data Access Page
Data Access via the Contaminant Data Display and Download Tool

The graphics group is responsible for maintaining the data access homepage and for making sure it effectively provides access to the data associated with RMP reports including the Status and Trends data, Pilot and Special Study data, and QA/QC summary reports. The Data Access Page also has links to associated reports, provides contacts for assistance, and links to additional information.

Subtask 4 Overall RMP Web Site Maintenance
Overall maintenance of the RMP website includes: updating the RMP homepage for calendar items and other "new" elements; maintaining the links on the site; generating new graphics as needed; updating content and adding pages as necessary; and reviewing overall site architecture and maintaining an intuitive hierarchy.

Staff Involved
Key staff involved with this task include: Linda Wanczyk, Joanne Cabling, Meg Sedlak, Cristina Grosso, Adam Wong, and Ellen Willis-Norton.

Schedule and Deliverables
Maintenance of the web site is an on-going activity. The site is updated on a continuous basis as new reports become available and new events are planned.

Budget
The cost for web-site maintenance in 2014 is $10,000.

2.3 Information Dissemination

The primary purpose of this task is to communicate information about water quality in the San Francisco Estuary to scientists and managers. RMP results are synthesized and

disseminated by a variety of means including articles in *Estuary News*, fact sheets, conferences, invited presentations, and journal publications.

The RMP will continue to take advantage of existing venues for information distribution, such as *Estuary News*. As appropriate, press outreach, formal presentations to community groups and other organizations, and scientific conferences will also provide information about the RMP and its findings. This task also includes work related to planning and executing the RMP Annual Meeting.

Subtask 1 Articles and Inserts

Subtask 1.1 Estuary News Articles and Insert

Beginning in 2014, the RMP will assist in funding the *Estuary News* magazine. As a result, *Estuary News* has agreed to increase coverage of RMP priorities and activities (e.g. the RMP could provide a regular column, one or two larger articles, or a "contaminant of the month" profile). *Estuary News's* audience is broader than the RMP mailing list thus providing the Program with an opportunity to reach new readers.

Subtask 1.2 Other Media Opportunities

RMP staff assist other organizations and news services with articles about the RMP and RMP data.

Subtask 2 Record of Publications

The RMP keeps track of all publications that use RMP data. Each publication is assigned an SFEI Contribution number and entered into an EndNote database in full bibliographic format.

Subtask 3 Posters

The RMP produces posters for display at poster sessions at various conferences (e.g., SETAC, State of the Estuary, etc.). Staff members involved include RMP technical staff and the graphic design group.

Subtask 4 Presentations

RMP staff present technical and non-technical talks at various venues (e.g., conferences, lectures, and meetings).

Subtask 5 RMP Annual Meeting

The RMP Annual Meeting is an important means of presenting the Program's latest findings to stakeholders. The Annual Meeting requires preparation by RMP technical, art, and administrative staff. RMP technical staff members are responsible for developing a variety of presentations; the graphics group is responsible for flyers, postcards, photos, and web site announcements; and the administration oversees meeting logistics and mailings.

Subtask 6 Press Outreach

The RMP seeks appropriate opportunities for disseminating RMP information through the media. The RMP Annual Meeting and Pulse of the Bay typically receive coverage on the radio, television, and in numerous newspapers (e.g., San Francisco Chronicle and San Jose Mercury News). In addition, individual staff members frequently serve as technical resources for reporters for stories of both local and national significance.

Staff Involved

Most SFEI staff are involved in some aspect of Information Dissemination. Technical staff write articles for the Pulse and *Estuary News*. Graphics staff are critical for the production of inserts, posters, and presentations. Senior staff and the Executive Director are involved in conducting media outreach.

Schedule and Deliverables

Key deliverables for this task are presented below.

Deliverable	**Target Date**
Estuary News insert	October
RMP Record of Publications	On-going
Posters and Presentations	On-going
Annual Meeting	September
Press Outreach	On-going

Budget

The estimated budget for information dissemination for 2014 is $136,000.

2.4 Annual Reporting

Annual reporting consists of the preparation and production of the *Annual Monitoring Results* and the *Pulse of the Bay* or *RMP Update*. The *Pulse of the Bay* and *RMP Update* are published in hardcopy; the *Annual Monitoring Results* is disseminated via our web site.

Subtask 1 *2013 Annual Monitoring Results*

This report will present 10 years of randomized sampling for water and sediment. It will follow a format similar to the *2012 RMP Annual Monitoring Results*. Data will be presented in the form of maps with bubble plots of contaminant concentrations at each site. Box plots and cumulative distribution frequency plots, by segment, will also be reported. The *Annual Monitoring Results* is a web-based report with downloadable maps and figures.

Subtask 1.1 Preparation of the Annual Monitoring Results
Web-ready graphics and various tables, including analyte lists, will be reviewed and updated. Introduction, water, and QA/QC chapters will be updated to reflect the 2013 data.

Subtask 1.2 2013 Annual Monitoring Results Distribution
The *Annual Monitoring Results* document will be made available through the RMP website *Documents and Reports* link. The 2013 data and QA/QC summaries will be made available on the RMP website through the *Data Access* link.

Subtask 2 *2014 RMP Update*
The RMP issues an annual report that presents the latest results from monitoring and either addresses a theme related to a timely water quality topic (*Pulse of the Bay*) or provides a concise overview of recent RMP activities and a look ahead to significant RMP products and studies (*RMP Update*).

In 2012, the SC/TRC decided to begin publishing the *RMP Update* biennially as a substitute for the *Pulse of the Bay* because it is a shorter publication, reducing the time and cost associated with producing the report. The *Pulse of the Bay* was last published in 2013; therefore, the *RMP Update* will be produced in 2014. The 2014 *RMP Update* will be finished in time for the Annual Meeting (typically the first week in October).

An outline will be developed in consultation with the SC and TRC. First drafts of articles will be sent out for review in March; the articles will then be revised in response to comments. A laid-out version of the report will be distributed to the SC and TRC for a second review in June. The report will be printed by early September, and distributed at the Annual Meeting. An electronic PDF file will be posted on SFEI's web site.

Staff Involved
The production of the *Annual Monitoring Results* will include: Amy Franz, Meg Sedlak, Adam Wong, John Ross, Cristina Grosso, and Ellen Willis-Norton. Leads on the *RMP Update* will include: Jay Davis, Meg Sedlak, and Linda Wanczyk.

Schedule and Deliverables
A detailed schedule of tasks is presented below.

Deliverable	**Target Date**
2013 RMP Annual Monitoring Results – Final on web	December 2014
2014 RMP Update	October 2014

Budget
The estimated SFEI labor budget for the *Annual Monitoring Results* and the *Pulse of the Estuary* for 2014 is presented on the table below.

Subtask	**Estimated Labor Cost 2014**
Annual Monitoring Results 2013	$40,000
RMP Update 2014	$50,000
Total	$90,000

2.5 Quality Assurance

OVERVIEW

Planned tasks for 2014 include:

- completing the update of the Quality Assurance Program Plan (QAPP);
- analyzing data from special QA studies; and
- optimizing metal analyses.

BACKGROUND
The RMP QA program ensures the consistency and reliability of data generated by various subcontractor laboratories and among different facets of RMP estuarine monitoring. The requirements presented in the RMP QAPP are intended to ensure data comparability among different laboratories and different years.

The RMP quality assurance component has been recognized as one of the most thorough and systematic efforts of any ambient monitoring program. The RMP has been involved with method development since its inception in the early 1990s. At that time, the RMP supported trace metal analyses in academic settings; these methods have now become standard methods in commercial laboratories. Similarly, the RMP is working with AXYS Analytical to develop new organic methods for analyzing pharmaceuticals and chemicals of emerging concern (e.g., the development of new methods to analyze for perfluorinated precursors a pro bono exercise). The RMP supports continuous performance evaluation exercises. Most of the RMP contract laboratories participate in NIST intercomparison exercises.

The QA element includes the following tasks:

1. Routine data verification and validation procedures to determine if laboratories are able to meet data quality guidelines specified in the current RMP QAPP and to determine if the data quality meets the expectations of the data users.

2. Updates of the QAPP to meet evolving management priorities and incorporate new components (e.g., new analytes, or new data acceptability criteria).

3. Special QA projects that are limited in scope and that may assist in the evaluation of data accuracy among different laboratories, or in the development of new field collection or analytical methods (e.g., evaluation of samples split among labs or intercalibration exercises).

This section outlines the annual data quality assurance procedures to be conducted in 2014, the periodic review of RMP contract laboratories to ensure high quality performance, and the general evaluation of factors contributing to analytical variation and other causes of measurement uncertainty.

SUBTASK DESCRIPTIONS

Subtask 1 QA Management and Revision of the QAPP

In 2013, we will continue to revise the QAPP. A number of improvements in analytical techniques have occurred since the 1997 QAPP was prepared including a revision of the water and sediment sections.

Subtask 2 Laboratory/Sample Intercomparisons (RMP Status and Trends)

The RMP conducts periodic QA studies such as blind field samples, duplicate field samples collected by different methods, and inter-comparison studies among laboratories to evaluate data quality. These samples are included in the Status and Trends sub-contracts and reported, validated, and reviewed as part of the Status and Trends task. We plan to continue these exercises in 2013.

Staff Involved

The leads on the QA task will include: Don Yee, Meg Sedlak, and Cristina Grosso. Other staff members involved in this task will include: John Ross, Jen Hunt, Amy Franz, and Adam Wong.

SCHEDULE AND DELIVERABLES

The main QA task for 2014 will be finishing the final revisions to the QAPP.

BUDGET

The estimated SFEI labor budget for QA is approximately $28,500.

Task 3 Status and Trends Monitoring

The Status and Trends (S&T) Program is composed of four elements: water, sediment, and bivalve monitoring; sport fish bioaccumulation; bird egg monitoring; and the USGS hydrographic and sediment transport studies. Sampling of these matrices occurs at various frequencies. In addition, the TRC and SC are presently considering modifications to Status and Trends monitoring. In 2014, sediment, bivalve, and sport fish sampling will occur; water sampling will not be conducted in 2014.

The S&T monitoring program switched from a fixed sampling design to a randomized design in 2002. A long-term plan for this design, including a 24-year cycle of rotating panels, is being implemented. The design follows the EMAP example of a randomized design, capable of addressing questions related to a representative characterization of contaminant concentrations in water and sediment. In 2010, the program switched from a five-year rotating panel to a six-year rotating panel to incorporate wet weather sediment sampling which occurs every other year. Five historical water stations and seven historical sediment stations are sampled to maintain time series for long term trend analyses. The bivalve program uses a fixed station, rather than random, sampling design.

The S&T monitoring component of the RMP addresses elements of all of the Level 1 management questions:

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

Randomized sampling provides representative characterization of contamination within each Bay segment to determine whether chemicals are at levels of concern for human health and biota. These data are also used to track trends and to support development of models to forecast future conditions in the Bay.

Beginning in 2002, water, sediment, and bivalve bioaccumulation sampling for the S&T monitoring program were conducted in the summer only. Summer was selected for sampling because inter-annual variation due to natural variables, primarily freshwater inflow, is minimized during this period. However, significant toxicity is observed in the winter in sediments. To better understand the causes of toxicity and the variability that

may be observed in the rainy season, the TRC and SC recommended as part of the 2007 redesign of S&T that biennial sediment sampling should occur in alternating years in the summer and winter. Wet weather sediment sampling commenced in 2010 at a reduced number of sites (i.e., 27 vs. 47 for dry weather sampling), and all samples were analyzed for the full sediment triad of chemistry, toxicity, and benthos. In 2014, sediment sampling will occur during the dry season.

The Annual Monitoring Results reports further describe the scope of work, analytes measured, and the analytical and reporting expectations for the S&T monitoring program.

Much of the S&T monitoring effort consists of sample collection and laboratory analysis that is undertaken by subcontractors (e.g., AXYS Analytical, and Applied Marine Sciences). SFEI provides oversight, coordination with the laboratories, sample collection, and field assistance.

3.1 Status and Trends: Long Term Monitoring of Water, Sediment, Bivalves, Benthos, and Toxicity

In 2005, the RMP began a process to redesign the Status and Trends program element. This was completed in 2007 and a summary report documenting these changes was prepared in 2008 (http://www.sfei.org/sites/default/files/Report555_Power_Analysis_FINAL.pdf). A number of changes were implemented in 2008 and 2009 including the reduction of organic analyses in water and inclusion of benthic community assessments. A much smaller effort was undertaken in 2011 to address the frequency of sediment and water analyses. Based on discussions with stakeholders and a review of the power analyses conducted by Melwani et al. 2008, the TRC and SC recommended that the program switch to biennial sampling of sediment and water. The program is currently undergoing review to determine the needs for Status and Trends data.

Subtask 1 Sediment Chemistry

In 2014, RMP staff will collect sediment samples from 47 sites (eight random stations per segment). In addition to the randomized sites, seven fixed historical stations will be maintained. Samples will be analyzed for organics, inorganics, and conventional water quality parameters.

In 2013, the Exposure and Effects Workgroup (EEWG), TRC, and SC agreed to suspend the toxicity and benthos portion of the 2014 S&T sediment cruise and direct funds to analyzing the cause of moderate toxicity in the Bay. Therefore, only sediment chemistry will be sampled during the 2014 cruise.

Subtask 2 Bivalve Bioaccumulation

The bivalve monitoring component maintains the long-term database started by the State Mussel Watch Program in the early 1980s. Because of logistical complexities, a randomized design is not economically feasible, nor is it technically desirable for this long-term trend monitoring tool. Bivalves are excellent trend indicators particularly for organic contaminants. The redesign workgroup recommended that a biennial plan be implemented. Organics are sampled biennially, while inorganics are analyzed on a longer-term five year cycle and were most recently analyzed in 2008. In 2014, bivalves will be sampled for both inorganics and organics.

STAFF INVOLVED

The S&T staff members will include: Meg Sedlak, Emily Novick, Ellen Willis-Norton, Amy Franz, Rebecca Sutton, Adam Wong, and Don Yee.

SCHEDULE AND DELIVERABLES

The S&T sediment and bivalve sampling cruise will occur in the third quarter of 2014.

BUDGET

The estimated SFEI labor budget for S&T bivalve and sediment monitoring is $44,000.

3.2 Sport Fish Bioaccumulation Monitoring

Sport fish sampling in the RMP began in 1997 and occurs on a five-year cycle. In 2009, sport fish were successfully collected from five popular fishing locations within the Estuary. The trend assessment species included shiner surfperch, white croaker, striped bass, and white sturgeon. Additional species targeted included anchovies, jacksmelt, leopard sharks, and halibut. Samples were analyzed for mercury, dioxins, PCBs, organochlorine pesticides, PBDEs, and perfluorinated compounds.

The next sport fish sampling will be conducted in the summer of 2014. The Sport Fish Workgroup will meet in December of 2013 to select the species and analytes to include in the sampling plan. The collection of fish will be compared to thresholds for protection of human health, representing a key impairment indicator for the Estuary.

SCHEDULE AND DELIVERABLES

The S&T sport fish sampling will occur in the summer of 2014. It is anticipated that the results from this sampling effort will be received in early 2015. After review of the data, a report summarizing these results will be prepared in 2015.

BUDGET

The estimated SFEI labor budget for S&T sport fish monitoring is $50,000.

3.3 RMP-Sponsored United States Geological Survey Studies

The United States Geological Survey (USGS) has been a collaborating agency in the RMP since the beginning of the Program and has contributed in-kind services through Department of Interior funding, IEP funding, and other sources to enhance the RMP financial contributions designed to address basic water quality and sediment transport processes. An understanding of these basic processes is essential to interpreting patterns in data on chemical indicators of water quality condition. The funds contributed by the RMP are generally less than half of the overall USGS costs to conduct both monitoring components outlined below. Because these tasks are undertaken entirely by the USGS, no SFEI labor costs are associated.

Subtask 1 Factors Controlling Suspended Sediment in San Francisco Bay

Since 1993, this element of the RMP has focused on understanding suspended sediment dynamics in the Estuary through the monitoring of suspended sediments at key locations in the Estuary. This work has yielded many insights into sediment and contaminant dynamics in the Estuary, as summarized in articles by Dr. Schoellhamer in the 2003, 2005, and 2010 editions of the *Pulse of the Estuary.*

In 2005, faced with a significant funding shortfall, USGS reduced the number of sites at which it measured suspended sediment concentrations from ten to six (five fixed sites and one temporary site, formerly the aquatic transfer station for Hamilton Air Force base). The fixed sites for 2014 are: Alcatraz, Mallard Island, Benicia, Richmond Bridge, and Dumbarton Bridge. The funding for the remaining temporary site will be allocated to placing a site at the new Exploratorium located in downtown San Francisco.

STAFF INVOLVED

Dr. David Schoellhamer of the USGS in Sacramento, California is the lead investigator for this project. SFEI staff members are not directly involved in this task.

Schedule and Deliverables

Deliverable	Target Date
Progress reports	Quarterly
Annual summary report	December 2014

BUDGET

Because this work is entirely conducted by USGS, no SFEI labor hours are allocated to this task. The total budget for this task is $250,000 (provided by the US Army Corps of Engineers directly to USGS).

Subtask 2 Basic Water Quality

The USGS will continue to conduct monthly water quality sampling of basic water quality parameters along the spine of the entire Bay-Delta system. Measurements will include: salinity, temperature and dissolved oxygen; suspended sediments; and phytoplankton biomass. This information is important for understanding seasonal changes in water quality and estuarine habitats, its influence on biological communities, and the distribution of contaminants.

Highlights from this work were described by Dr. Cloern at the 2013 Annual Meeting as well as an article in the 2006 *Pulse of the Estuary*. In the Pulse article, Dr. Cloern and Dr. Alan Jassby documented the dramatic change that has occurred in the Estuary with the advent of a fall phytoplankton bloom and larger spring blooms.

USGS funding for this monitoring program has decreased in the last several years and it is anticipated that in the upcoming years it will experience even larger decreases. Currently, it is unclear which agency will oversee the monitoring program if the USGS does not maintain the program. The RMP cannot fund the work in its entirety, but future RMP nutrients monitoring will likely overlap with the measurements taken by this study.

STAFF INVOLVED

Dr. Jim Cloern of the USGS in Menlo Park, California is the lead investigator for this project. SFEI staff is not involved in this task.

Deliverables

The USGS posts the data from their monthly cruises on their website (http://sfbay.wr.usgs.gov/access/wqdata/) which is also available from the SFEI RMP web site.

BUDGET

Because this work is entirely conducted by USGS, no SFEI labor hours are allocated to this task. The total subcontract budget for this task is $173,000.

Task 4 Special Studies

Each year, the RMP undertakes special studies to complement Status and Trends monitoring. These studies are developed under the guidance of the workgroups and committees and seek to answer high priority management questions that are articulated in the RMP Multi-Year Plan.

4.1 Monitoring Alternative Flame Retardants in SF Bay Water, Effluent, Stormwater, Sediment, and Biota

OVERVIEW

Reduced use of polybrominated diphenyl ether (PBDE) flame retardants following management actions (bans and phase-outs) has already led to declines in PBDE contamination in Bay biota over the last decade. However, to meet California's strict flammability regulations, product manufacturers must substitute other flame retardant chemicals in place of PBDEs. Contamination with these alternative (non-PBDE) flame retardants may be on the rise in the San Francisco Bay ecosystem, and this potential increase in exposure could pose risks to aquatic life and humans.

Previous RMP studies have identified a number of alternative flame retardants in San Francisco Bay sediment and biota. Non-PBDE flame retardants detected in Bay wildlife were hexabromocyclododecane (HBCD), Dechlorane Plus (DP), pentabromoethylbenzene (PBEB), bis(2,4,6 tribromophenoxy)ethane (BTBPE), tris(1-chloropropyl)phosphate (TCPP), tris(2-chloroethyl)phosphate (TCEP), tris(2 butoxyethyl)phosphate (TBEP), and triphenylphosphate (TPhP). Brominated flame retardants that were analyzed but not detected in Bay samples were EH-TBB and BEH-TEBP (the brominated components of the PentaBDE replacement commercial mixture, Firemaster 550, possibly not detected due to methodological issues), decabromodiphenylethane (DBDPE, a Deca-BDE replacement), and hexabromobenzene (HBB).

The organophosphates TDCPP, TCPP, and TPhP have been detected in Bay sediments at estimated concentrations that are comparable to the PBDE and PCB concentrations in the same samples. Passive water samplers (POCIS) deployed by SFEI as part of the NOAA Mussel Watch Contaminants of Emerging Concern (CECs) Early Warning Network: California Pilot Project also indicated the presence of several organophosphate flame retardants in San Francisco Bay waters: TCPP, TDCPP, TCEP, tributyl phosphate (TBP), and TPhP. A pilot study also detected TCEP, TCPP, and TBEP in cormorant eggs, with a total concentration of up to 200 ng/g lipid weight (Chen unpublished data).

Few alternative flame retardants have been well characterized as to aquatic toxicity, and most are thus assigned to Tier I (Possible Concern) within the San Francisco Bay risk and management action framework, with the exception of HBCD (Tier II: Low Concern).

This task will monitor five to fifteen alternative flame retardants in Bay water, wastewater treatment plant (WWTP) effluent, stormwater, sediment, bivalves and seals. The physical, chemical, and biological properties of each target analyte were used to determine the most appropriate matrix for monitoring. The result is a research plan optimized to detect those widely used flame retardant contaminants entering the Bay and potentially posing risks to wildlife. Measurements made as part of this study will be compared to known threshold effect levels, where possible, and to previous measurements to evaluate variation in contamination with time.

MANAGEMENT QUESTIONS

This study will address the following RMP Objectives and Management Questions:

MQ.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?

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

- A: Do pollutant spatial patterns and long-term trends indicate particular regions of concern?

APPROACH

Evaluation of flame retardant properties led to creation of prioritized lists of flame retardants appropriate to monitor in each Bay matrix. Emphasis was placed on re-examining those flame retardants examined during previous screenings (e.g., Klosterhaus et al. 2012) to allow for initial comparisons of measured levels over time. Additional flame retardants suggested for study include those identified by Howard and Muir as candidates for environmental monitoring due to persistence and bioaccumulative potential (Howard and Muir 2010), as well as those identified by USEPA as replacements for DecaBDE, which is being phased out in 2013 (USEPA 2012).

<u>Flame retardant selection and monitoring approach by matrix:</u>

Bay Water

Organophosphate flame retardant samples were collected in 2013 as part of the Annual Status and Trends (S&T) monitoring effort. Ten flame retardant water samples were collected, three in the Lower South Bay, three in the South Bay, two in the Central Bay (near Oakland and San Francisco), and one each in San Pablo and Suisun Bays. A replicate sample was collected in Lower South Bay site, for a total of eleven samples.

Analysis of water samples will be conducted by Dr. Da Chen of Southern Illinois University using a highly sensitive liquid chromatography–electrospray ionization(+)-triple quadrupole mass spectrometry (LC–ESI(+)-QQQ-MS/MS) based analysis method (Chen et al. 2012a; Chu et al. 2011). Limits of detection are typically in the range of 0.1 ppb. While this method is capable of detecting a wide range of organophosphate flame retardants, those of particular interest to the RMP are: 1) TCPP; 2) TDCPP; 3) TCEP; 4) TBP; 5) TPhP; 6) V6 (a newly identified compound (Fang et al. 2013); and 7) tripropyl phosphate (TPrP, an organophosphate flame retardant with high water solubility).

WWTP Effluent

Grab samples of WWTP effluent voluntarily provided by three Bay Area dischargers will be characterized. A replicate sample will be collected as well, for a total of four WWTP effluent samples. Samples will be analyzed for total suspended solids as well as alternative flame retardants.

Dischargers are not specifically named here, as they will have the option to keep their identities confidential in subsequent reporting of the data. Measurements for each discharger will be reported individually using unique identifiers should dischargers request their identities be withheld. Through cooperative relationships with wastewater dischargers, we can obtain and share data about the extent of alternative flame retardant contamination of effluent without implementing expensive permit requirements.

Initial tests of Bay Area WWTP effluent, as well as ambient samples collected close to discharges, suggest that both hydrophilic and some hydrophobic flame retardants will be detected at quantifiable levels in these samples. Monitoring of WWTP effluent samples collected in southern California has already documented significant concentrations of some hydrophilic flame retardants (TCPP and TCEP; Vidal-Dorsch et al. 2012).

Stormwater

Stormwater will be collected from urban, industrial channels in Richmond and Sunnyvale, both monitored as part of other RMP studies. Two storm events will be characterized at each site, with a preference for storms occurring early in the wet season, when higher levels of alternative flame retardants may be flushed from the watershed. Two samples will be obtained from each storm, during the rising portion of the hydrograph when contaminant levels will likely be higher, particularly for sediment-bound compounds. A replicate sample will be collected as well, for a total of nine stormwater samples. Samples will be analyzed for total suspended solids as well as alternative flame retardants. In addition, they will be filtered to allow analysis of both particulate and dissolved phases.

Sediment

The RMP will collect alternative flame retardant sediment samples in the summer of 2014 as part of the S&T monitoring. Similar to the 2013 water sampling effort, a total of

eleven sediment samples will be collected, the same number of samples per subembayments as the water monitoring effort, and analyzed by Dr. Da Chen.

Organophosphate flame retardants prioritized for analysis include those previously detected in sediment (TDCPP, TCPP, and TPhP) and V6. Sediment will also be examined for halogenated, hydrophobic alternative flame retardants using GC-ECNI-MS (Chen et al. 2012b, c). Limits of detection vary with the compound, ranging from roughly 0.1 to 1 ppb. Hydrophobic flame retardants prioritized for quantification include: EHTBB and BEH-TEBP, DBDPE, BTBPE, PBEB, HBB, Dechlorane Plus, ethylene bistetrabromophthalimide (EBTEBPI), 1,2-dibromo-4-(1,2 dibromoethyl)cyclohexane (DBEDBCH or TBECH) and Dechlorane 602.

Bivalves

The RMP will deploy transplanted bivalves (*Mytilus californianus*) in 2014 at nine locations, with collection and analysis after 90 days of exposure. Deployment at six sites will be selected for alternative flame retardant analysis: one in the Lower South Bay, two in the South Bay, one in the Central Bay (near Oakland), and one each in San Pablo and Suisun Bays. A replicate sample of bivalves will also be deployed at a South or Lower South Bay site, for a total of seven samples. Analysis of the mussel tissue samples will also be conducted by Dr. Da Chen.

Organophosphate flame retardants prioritized for analysis include one previously detected in Bay mussels (TPhP) and V6. Mussel tissue will also be examined for halogenated, hydrophobic alternative flame retardants using GC-ECNI-MS (Chen et al. 2012b, c). Hydrophobic flame retardants prioritized for quantification include those for which metabolism and excretion are expected or suspected, such that they might be less likely to be found in higher trophic level organisms: EH-TBB and BEH-TEBP, DBDPE, and EBTEBPI.

Harbor Seals

A previous RMP investigation of alternative flame retardants generally found seal blubber to contain higher levels of hydrophobic compounds relative to other species studied in the Bay (Klosterhaus et al. 2012). For this reason, seal blubber is an important matrix to monitor to determine which alternative flame retardants may be accumulating in Bay biota. The RMP targeted sampling of adult female seals in the summer of 2014 (goal n=10). One replicate sample will be collected in 2014 as well, for a total of eleven samples. A RMP seal capture and sampling campaign in 2014 may be considered a pilot investigation of the feasibility of incorporating regular characterizations of contaminants in these apex predators into RMP S&T monitoring or other work.

Samples collected in 2014 will be analyzed by Dr. Da Chen, for a broad investigation of potential contaminants, including organophosphate metabolites, Firemaster 550 components, DBE-DBCH or TBECH, and Dechlorane 602. The Chen lab will also be able to screen for and determine any potential degradation products of the priority flame retardants. The degradation products may exhibit different environmental behavior

compared to their parent compounds, which may bring additional environmental and human health concerns.

SCHEDULE AND DELIVERABLES

Results of these proposed study elements will be reported (together) as an RMP Technical Report and/or manuscript in early 2015. Comparisons will be made to past screening efforts in the Bay and in the literature from other locations, as well as to relevant toxicological information on these emerging contaminants available at that time.

BUDGET

The budget for this task is $107,000, $52,300 of which is SFEI labor.

WORKGROUP OVERSIGHT

The Emerging Contaminants Workgroup will review this work.

Literature Cited:

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Klosterhaus SL, Stapleton HM, La Guardia MJ, Greig DJ. 2012. Brominated and chlorinated flame retardants in San Francisco Bay sediments and wildlife. Environ Int 47: 56-65.

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She J, Petreas M, Winkler J, Visita P, McKinney M, Kopec D. 2002. PBDEs in the San Francisco Bay Area: measurements in harbor seal blubber and human breast adipose tissue. Chemosphere 46(5): 697-707.

Tomy GT, Pleskach K, Arsenault G, Potter D, McCrindle R, Marvin CH, et al. 2008. Identification of the novel cycloaliphatic brominated flame retardant 1,2-dibromo-4-(1,2- dibromoethyl)cyclohexane in Canadian Arctic beluga (*Delphinapterus leucas*). Environ Sci Technol 42(2): 543-549.

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4.2 Updating RMP EC Strategy

OVERVIEW

The RMP has completed a synthesis document summarizing the occurrence of contaminants of emerging concern (CECs) in San Francisco Bay and a CEC strategy

document that outlines the priorities for CEC monitoring in the next five years. Given that these are compounds of emerging concern, our understanding of their importance and our ability to monitor them is rapidly evolving. As a result, it is imperative that RMP staff continue to read the literature and actively engage with researchers on this topic.

To date, many of the CECs studies have been the result of pro bono work conducted as a result of collaborations with universities, government agencies, and commercial laboratories. These opportunities were identified by RMP staff through professional contacts and literature reviews. These studies have allowed for prioritization of these CECs using occurrence and toxicity data to determine the level of concern for individual contaminants in the Bay.

The RMP strategy document articulates three approaches for identifying CECs for monitoring. These approaches are based on:

- Existing information (known or suspected use, occurrence or toxicity from other locations, best professional judgment),
- Effects (i.e., bioassays), and
- Occurrence (non-target analyses such as the RMP-funded project with NIST or fate modeling).

This will be an iterative process as new information, new analytical methods, and new collaborations become available. In order to keep the CEC Strategy document relevant and timely, funds are needed to review new results, track relevant work being conducted elsewhere, and develop potential collaborations.

APPROACH

This effort will involve the review of key information sources throughout the year. These sources include:

- Abstracts of newly published articles in key peer-reviewed journals (e.g., Environmental Science and Technology, Environmental Toxicology and Chemistry, Environment International),
- Documents produced by other programs (e.g., USEPA, Environment Canada, European Chemicals Agency, Great Lakes CEC Program),
- Abstracts and proceedings from relevant conferences (e.g., Society of Environmental Toxicology and Chemistry, International Symposium on Halogenated Persistent Organic Pollutants (Dioxin), International Symposium on Brominated Flame Retardants)

The major outcome of this effort will be to provide updates on relevant information to the ECWG each year. More specifically, this information will be used to:

- Propose updates to the tiered risk-management action framework for San Francisco Bay,

- Propose additions or removal of CECs on the 'Unmonitored CEC Candidate List' discussed at the ECWG meetings, and
- Propose special studies for monitoring new CECs.

It is anticipated that this special study will be conducted each year to insure the RMP is incorporating the most recent scientific findings regarding the monitoring of CECs in the Bay.

STAFF INVOLVED
SFEI staff will be Meg Sedlak, Don Yee, and Rebecca Sutton.

SCHEDULE AND DELIVERABLES
This project will be undertaken throughout the year with a memorandum of findings provided to the ECWG in the Spring of 2015.

BUDGET
The budget for the updating of the CEC strategy is $20,000.

WORKGROUP OVERSIGHT
The Emerging Contaminant Workgroup will review this element.

4.3 Developing Bioanalytical Tools (Year 2)

OVERVIEW

A growing number of contaminants of emerging concern (CECs) are found routinely in permitted discharges and their receiving waters. For the few CECs for which analytical methods exist, these methods are still largely in development and only some are routinely performed by commercial services laboratories. As the development and manufacture of chemicals presents an ever changing landscape, those CECs that are produced in high volumes and/or that are capable of being discharged via treated municipal or industrial wastewater effluent or stormwater runoff represent a moving target for environmental quality managers tasked with assessing and/or mitigating their potential for impact.

The CECs of most concern are those which may be potent at trace concentrations (parts per trillion range) and work as endocrine disruptors. Their presence in water bodies may be harmful to aquatic biota inhabiting these locations. Such endocrine disrupting chemicals can interact directly with soluble hormone receptors or can interfere with the natural synthesis or metabolism of endogenous hormones and thereby impede normal function of these processes in exposed organisms. Most attention has been focused on chemicals which act as estrogens or androgens or their antagonists. Estrogens are important in brain development and programming of tissue differentiation at early time points during development.

Previous work by University of Florida researchers has shown that exposure of fathead minnows to concentrations of ethinylestradiol (EE2) at 2 ng/L induced pericardial/yolk sac edema (Johns et al. 2009). The estrogenic mycotoxin zearalenone (exposure range of 2-50 ng/L) also resulted in myocardial edema (Johns et al. 2009). In addition, these researchers have analyzed a limited set of gene expression changes including Vtg, which was up-regulated by the two estrogens, steroidogenic acute regulatory (StAR) protein, insulin-like growth factor 1 (IGF-1) and growth hormone (GH) which were also altered. Thus, these genes in target fish species would be viewed as critically important to include in future studies of responses to estrogenic CECs at the molecular level.

Concurrently, novel in vitro methods based on receptor binding or transactivation have been developed that are extremely sensitive to target chemicals acting with the same mode of action, including the potent endocrine disrupting CECs described above. Work is being performed to adapt these in vitro bioassays for water quality assessment and monitoring purposes. Few studies, however, link results from such in vitro assays with higher order in vivo effects which result in adversity for survival, growth, reproduction, or susceptibility to disease.

This project is the second year of funding to begin to develop quantitative linkages between the in vitro receptor-based assays and traditional endpoints of adversity in a sensitive estuarine fish model, the common silverside (*Menidia beryllina*) which is an established EPA model for estuarine toxicity. During the first year of the study (2013), the focus was on estrogenic responses of selected chemicals of interest first in lab exposures. In 2014, the silverside will be exposed to field-collected wastewater treatment plan (WWTP) effluent and estuarine and marine receiving waters.

MANAGEMENT QUESTIONS

The objective of this effort is to develop a tool that will assist in the identification of chemicals of emerging concern that are adversely affecting biota. This study would address the following RMP management question (MQ):

MQ1. 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?

APPROACH

During the first year of this two-year study (2013), researchers evaluated the effects of four endocrine disrupting compounds (i.e., estrone, bisphenol A, 4-nonylphenol, and galaxolide) on cellular function by identifying molecular biomarkers for silversides and developing *in vitro* bioassays. The presence of biomarkers associated with growth, sexual

differentiation, brain development, and reproduction (e.g., vitellogenin) will be correlated with exposure to endocrine disruptors.

The tasks for 2014 include:

Exposure to WWTP effluent and receiving water samples and in vitro bioassays
Samples of WWTP effluent and receiving waters from two sites, one in southern California and the other in the San Francisco Bay estuary, will be tested. A sufficiently large volume of treated final effluent and receiving water from each site will be filtered through a sorbing phase (e.g. C18 or Oasis HLB cartridge) to capture organic contaminants and subsequently eluted by organic solvents. A portion of each eluent will be set aside for analytical chemistry and the remainder will be shipped to one or the other of the two participating laboratories where the eluent will be reconstituted to the same proportional volume as the original sample and tested with either an early life stage assay or a juvenile assay.

One sorbing cartridge each will be processed and shipped to SCCWRP and the University of Florida. The cartridges will be eluted and then air dried in order to reconstitute test solutions to 1X, 5X and 10X the concentrations equivalent to what they were at the field site. Each solution will be tested in triplicate and will use the 5 ng EE2/L as a positive control. Early life stages and juvenile tests as described above will be performed as well as in vitro nuclear receptor transactivation assays using the concentrates from the field locations.

Chemical analysis of CECs
Estrone (E1) and EE2 will be measured by ELISA following the methods of Huang and Sedlak (2001). Galaxolide (HHCB), BPA and 4-NP will be measured by GC-MS after extraction and derivatization as described in Ligon et al. (2008). Samples of sufficiently large volume will be collected to ensure the appropriate sensitivity of measurement, based on the range of treatments and expected receiving water concentrations. An equivalent amount of chemical as evaluated for the in vivo assays will also be assessed for the in vitro assay.

SCHEDULE AND DELIVERABLES
A final report for year two will be submitted for review and approval from the ECWG and EEWG.

BUDGET
The budget for year two is $56,000, which will be allocated to the two major subcontractors: University of Florida (Nancy Denslow) and SCCWRP (Keith Maruya and Steve Bay).

WORKGROUP OVERSIGHT
The EEWG and ECWG will review this element.

Literature Cited:
Huang CH, Sedlak DL. 2001. Analysis of estrogenic hormones in municipal wastewater effluent and surface water using enzyme-linked immunosorbent assay and gas chromatography/tandem mass spectrometry. Environ Toxicol Chem 20:133-139.
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Ligon AP, Zuehlke S, Spiteller M. 2008. GC-MS analysis of organic compounds in wastewater and sewage sludge. J Sep Sci. 31:143-150.

4.4 Assessing the Impacts of Periodic Dredging on Benthic Habitat Quality

OVERVIEW

The benthic communities of the San Francisco Bay and Estuary are fundamental components of foraging habitat for many fish species. However, there is a lack of scientific information specific to the Bay about the degree of benthic community disruption caused by periodic maintenance dredging, about rates of benthic community recolonization and recovery following dredging, and about effects on fish foraging success or quality. For this reason it is difficult for the regulatory and resource agencies who manage dredging projects and fishery habitat to determine whether and when any actions to enhance or restore benthic communities following dredging may be necessary or warranted. The National Marine Fisheries Service and the LTMS agencies agreed that initial efforts to address this issue via a benthic disturbance study in Central San Francisco Bay was one of the highest priorities under the 2011 Programmatic Essential Fish Habitat Agreement.

This study will try to determine if the quality of benthic habitat for fish foraging is lesser in areas that are dredged at a frequency of annually or once every 2-3 years compared to areas that are undredged, as determined by the structure and function of the benthic invertebrate assemblage.

APPLICABLE RMP MANAGEMENT QUESTIONS

The objective of this effort is to assess the quality of benthic assemblages from a fish forage standpoint, in areas that are periodically dredged in Central San Francisco Bay compared to nondredged areas. This study would address the following RMP management question (MQ):

MQ1. Are chemical concentrations (*or activities*) in the Estuary at levels of potential concern and are associated impacts likely?

- B: What potential for impacts on humans and aquatic life exists due to contaminants (*or activities*) in the Estuary ecosystem??

APPROACH

A phased study approach will be conducted, using a pilot study to inform the full study design. In the first phase, the senior project lead, John Takawa (USGS), will oversee

compilation and evaluation of information regarding fish feeding and benthic invertebrate assemblages in San Francisco from published literature and unpublished data.
The literature review will include a review of existing benthic assessments conducted in the Bay (e.g., RMP SQO and NOAA WEMAP assessments). Benthic assessment results for dredged and undisturbed sites will be reviewed and presented. The focus of the literature review will address the following questions: *What are target fish eating in Central San Francisco Bay? Are there seasonal differences in prey items and invertebrate assemblages? Yearly differences? Can invertebrate species be grouped into functional groups with regards to fish prey resources?*

In the second phase, a field study will be designed to evaluate differences between treatment and control samples in terms of value of habitat for fish foraging (e.g., biomass, functional group). In addition, metrics will be developed for evaluating difference between treatment and control samples in terms of value of habitat for fish foraging (e.g., biomass, functional group). The field study and invertebrate metrics will be designed based on the literature review, and in consultation with a statistician such as Jim Carter (USGS) and benthic experts such as Jan Thompson and Francis Parchaso (USGS). The field study design will include sampling of multiple undredged and dredged sites within shallow (<12 ft MLLW) areas of Central San Francisco Bay. Dredged locations should be chosen based on frequency and last date of dredging. The LTMS agencies will provide guidance on appropriate dredged locations.

In the third phase, a pilot study will be implemented as part of a USGS cruise in 2014. These pilot samples will be collected for initial identification of benthic communities, and to evaluate study design and sample size developed during phase two for a possible larger field study in the future. For example: *Do sample locations adequately characterize dredged and undredged conditions in Central San Francisco Bay? Does the study design include a large enough sample size to account for variability of the invertebrate community and allow for adequate statistical power of analyses?* Samples will be sorted by RMP laboratories (such as Moss Landing Marine Labs) to assure consistency with RMP benthic work. The assemblage assessments from each site will be evaluated using a rigorous statistical analysis. The project lead will write the draft report, which will be circulated among LTMS and NOAA Fisheries staff for review and comment. The project lead will finalize the report.

Agencies and project lead would pursue additional funding to complete a larger field study in the future, based on findings in the project report.

SCHEDULE AND DELIVERABLES
A final report will be submitted for review and approval from the EEWG.

BUDGET
Approximately a third of the funding for this project is requested from the RMP ($50,000); the remaining portion will be leveraged from funds available from Corps (via Port of San Francisco America's cup permit) ($100,000).

WORKGROUP OVERSIGHT

The Exposure and Effects Workgroup will review this element.

4.5 The Effects of Particle Size and Shape and Animal Health on Toxicity Test Results

OVERVIEW

The 10-day whole sediment toxicity test protocol for the amphipod *Eohaustorius estuarius*is one of the principal tests recommended for toxicity monitoring in California. Several studies have shown this species is appropriate for this application, and this is the benchmark test used in regional monitoring programs in southern California and the San Francisco Estuary. Due to concerns about limitations of methods to determine causes of persistent moderate toxicity in field sediments and the relative influence of non-contaminant factors on amphipod survival, two recent workshops sponsored by the RMP identified specific attributes of *E. estuarius* studies that require additional research. Among a list of non-contaminant factors considered, the relative impacts of grain size, particle shape, and test animal condition were identified as possibly important factors affecting amphipod survival.

As part of the initial evaluation of *E. estuarius* as a test species, Dewitt et al. (1989) assessed survival of *E. estuaries* in 42 uncontaminated field sediment samples from Puget Sound, Washington and Oregon. These authors reported that "*E. estuaries* showed little sensitivity to sediments of different grain sizes: mean survival was 92.4% in sediments with >80% silt-clay content and 96.7% for coarser sediments." Tay et al. (unpublished study described in Environment Canada, 1998) found mean survival was 74% in mixtures with 57% clay and 99% fines. Based on these experiments, Environment Canada established tolerance limits of <90% coarse grained sediment, and <70% clay. UC Davis conducted similar experiments using mixtures of sand and field-collected reference mud that was comprised of silt and clay. *E. estuaries* 10d survival was >85% in sediments with <70% fines. Survival was 57% in sediment with 90% fines (Marine Pollution Studies Laboratory-Granite Canyon unpublished data). In addition to these studies, analyses of data from the RMP and elsewhere have shown that survival of *E. estuarius* in field sediments is negatively correlated with percent fine grained sediment, and with percent clay in sediment. Based on the preponderance of evidence, the effect of clay was prioritized for further study by participants of the two RMP workshops.

The toxicity workshops also identified the possible interaction of seasonal differences in amphipod health and their ability to tolerate fine-grained sediments as a high priority topic for investigation. This is based on evidence suggesting sediment toxicity in San Francisco Bay is greater in winter, and the possibility that increased winter toxicity is related to variability of the health of field collected amphipods. Seasonal changes in amphipod fitness related to nutrition, senescence, or reproductive activity have been suggested as the reason for such variations in sensitivity to San Francisco Bay sediments. The workshop participants also recommended measurement of amphipod lipid content as an indicator of animal condition. Prior studies using *E. estuarius* have shown a correspondence between tissue lipid content and changes in sensitivity to toxicants related

to amphipod condition. Measurement of amphipod lipid content may provide a valuable tool for interpreting the results of future sediment toxicity surveys, but information on the seasonal changes in this parameter and its association with changes in amphipod sensitivity to stressors is needed. Combining seasonal measurements of tissue lipid with studies of the sediment particle size effects on *E. estuarius* survival will provide the information needed to evaluate the usefulness of lipid measurements in toxicity testing.

APPLICABLE RMP MANAGEMENT QUESTIONS

The objective of this effort is to determine if non-contaminant factors are influencing the results of 10-day *E. estuarius* toxicity tests in San Francisco Bay. This study would address the following RMP management question (MQ):

MQ1: Are chemical concentrations in the Estuary at levels of potential concern and are associated impacts likely?

- B: What potential for impacts on humans and aquatic life exists due to contaminants in the Estuary ecosystem?

APPROACH

Part One: Establishing a Dose-Response Relationship between Sediment Clay Content and Amphipod (*Eohaustorius estuarius*) Mortality

Laboratory experiments will be used to establish a dose response relationship between *E. estuarius* survival and percent chlorite+kaolinite clay in sediment. Experiments will be conducted using two separate natural reference sediments spiked with clay. The sediment will be collected during the summer of 2014. The lipid content of each batch of test animals will be measured and compared to variations in sensitivity to sediment clay content and season.

Clay-spiked sand: In the first experiments, reference sand will be spiked with increasing concentrations of chlorite+kaolinite clay, the dominant clay found in San Francisco Estuary sediment. Clay purchased from a commercial supplier will be mixed with reference sand at ratios representative of those in the Estuary. After equilibration, 10 day toxicity tests will be conducted with *E. estuarius*. One range-finder test will be conducted to establish the range of percent clay that inhibits amphipod survival. Two definitive experiments will then be conducted to confirm the dose-response relationship. Results of these experiments will be used to establish LC25 and LC50s for percent chlorite+kaolinite clay in sediment. The dose response results will also be used to examine the relationship between percent clay and amphipod survival using regression analysis to calculate of the 95% lower prediction limits of the regression of percent clay and number of survivors for *E. estuarius* (after DeWitt et al., 1989). This may be used for statistically partitioning the effects of percent clay from contamination in sediment toxicity tests with amphipods. Approximately 30 amphipods that are representative of the animals used in the test will be preserved for lipid analysis. If feasible, individuals will be measured in order to determine the variability in animal condition within each test batch.

Clay-spiked reference sediment: In the second experiments, reference sediment from Castro Cove, a site in the northern estuary, will be spiked with increasing concentrations of chlorite+kaolinite clay. The particle distributions in Castro Cove sediment in 2008 were as follows: Sand = 25.36%, Silt = 57.2%, Clay = 17.44%, TOC = 0.9%. Spiking sediment from a San Francisco estuary reference site will allow determination of LC25 and LC50s for percent clay, and confirmation of the regression relationship between sediment clay and amphipod survival determined from experiments with clay-spiked sand. Approximately 30 amphipods that are representative of the animals used in the test will be preserved for lipid analysis. If feasible, individuals will be measured in order to determine the variability in animal condition within each test batch.

All experiments will be replicated three times. The results of these experiments will be used to determine the extent to which clay affects *E. estuarius* survival in 10d toxicity tests. These results may be used to determine how this protocol is implemented in the RMP. One approach may be to establish the range of grain size characteristics in San Francisco estuary sediments appropriate for testing with *E. estuarius*, following the approach used by Environment Canada. A second approach may be to use the regression relationship to establish 95% lower prediction limits which can be used to separate mortality likely due to clay effects from mortality likely due to contaminants. A third approach may be to include lipid concentration as a factor in data interpretation.

Part Two: Investigating the Relationship between Sediment Shape Characteristics and Amphipod (*Eohaustorius estuarius*) Mortality

To investigate whether clay particle shape is correlated with amphipod mortality, particle shape will be analyzed on the experimental sediments spiked with kaolin clay in Part One. In addition, particle shape will be analyzed in field sediments collected as part of RMP S&T monitoring. Particle shape characteristics will follow general methods described in Tucker (1995) using the Powers (1953) grain shape classification. These methods have been adapted by Dr. Ivano Aiello at Moss Landing Marine Laboratories to allow quantification of the relative proportion of each shape category for selected samples. In this classification, particles are categorized as either "high sphericity" or "low sphericity" and within these classifications they are further classified according to their relative angularity (highly angular to well-rounded).

Ten replicate subsample smears of each clay-spiked sand or clay-spiked reference sediment from the experiments described above will be analyzed using light microscopy. The relative proportion of each particle shape category will be quantified and these values will be combined to provide a shape index value for each sample. This value will then be correlated with amphipod mortality to investigate whether there is a significant correlation between particle shape and amphipod mortality in the clay-spiked samples.

A similar approach will be used to establish the dominant shape characteristics of sediments in representative San Francisco estuary samples collected as part of the RMP sampling. Particle shape will be analyzed in the 27 RMP sediments from north, central

and southern estuary reaches collected as part of routine RMP monitoring. Particle shape characteristics will be correlated with amphipod mortality. This information will be used to determine the extent to which clay shape affects amphipod survival, and whether this should be considered as part of the implementation of particle size limits when using *E. estuarius* in sediment monitoring programs.

Part Three: Lipid Assay Method Development and Measurement of Seasonal Variation

Published methods for a micro scale colorimetric assay for tissue lipids will be adapted for use with individual amphipods. The assay is conducted in a 96 well plate format, which provides rapid and cost efficient analyses. Standardized methods for extraction and analysis of amphipods will be developed, and detection limits of the assay will be determined. Monthly samples of *E. estuarius* will be obtained from the collection site in Newport, Oregon. Samples and corresponding environmental data (e.g., water temperature and salinity) will be provided through collaboration with the commercial supplier of the test animals (Northwestern Aquatic Sciences). The weight, length, and percent lipid of up to 30 individuals per sample will be measured. The mean and standard deviation of the percent lipid will be used to document seasonal variation.

STAFF INVOLVED

This task will be conducted by Brian Anderson at UC Davis Marine Pollution Studies Laboratory at Granite Canyon and by Ivano Aiello at Moss Landing Marine Laboratories

SCHEDULE AND DELIVERABLES

A final report will be reviewed by the Exposure and Effects workgroup.

BUDGET

The funding for this study is $80,000 with $30,000 being provided by the RMP and the remaining $50,000 being provided by the State Water Board.

WORKGROUP

This project will be overseen by the Exposure and Effects Workgroup.

Literature Cited:

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4.6 Stormwater Loads Monitoring in Representative Watersheds

OVERVIEW

The San Francisco Bay Hg and PCB TMDLs call for a reduction in loads by 50 and 90% respectively. In response, the Municipal Regional Permit for Stormwater (MRP) (SFRWQCB, 2009) (Provision C.8.e.) calls for better quantification of loads of sediments and trace contaminants on a watershed basis and regionally. This is consistent with a long standing recommendation from the SPLWG where six observation watersheds were recommended, selected on the basis of land use and climate (Davis et al. 2000; 2001). The RMP, through its Sources, Pathways, and Loadings Workgroup (SPLWG) and Small Tributary Loading Strategy (STLS) Team, has been conducting tributary loading studies for 11 years beginning WY2003 in Guadalupe River. The focus has been to provide information on sediment and pollutant transport processes and loads in urban watersheds around the Bay (McKee et al., 2004; 2005; 2006a; 2006b; 2009; 2010; 2012; 2013; Davis et al. 2007; Oram et al. 2008; Gilbreath et al., 2012), and for loads coming into the Bay from the Central Valley via the Sacramento and San Joaquin River Delta (McKee et al., 2001; Leatherbarrow et al., 2005; McKee et al., 2006; David et al. 2009; 2012).

At the March 29, 2011 STLS meeting, draft monitoring methods were outlined that included selection of the first four watersheds for monitoring (Sunnyvale East Channel, Guadalupe River, Lower Marsh Creek, San Leandro Creek), turbidity surrogate methods, the use of manual or ISCO sampling design depending on site logistics, 16 samples over 4 storms for 4 years for MRP category 1 pollutants, annual data management, and a report at the end of 3 years). During water year 2012, two additional sites were selected as POC monitoring locations, bringing the total number of sites monitored to six. Richmond Pump Station and Pulgas Pump Station (sampling location upstream of pump station) went online during WY 2013. The final sampling design for WY2013 load monitoring at the six sites was:

1. Turbidity surrogate at all locations
2. Discrete manual sampling for PCBs, Hg, SSC, nutrients, total organic carbon at all six locations, 4 samples per storm for 4 storms plus quality assurance samples (field blanks, field duplicates) and methylmercury, PBDE and PAH at a lower sampling frequency.
3. Composite sampling for copper, selenium, carbaryl, fiprinil, pyrethroids, and toxicity at all four locations, 1 sample per storm for 4 storms aiming for 16 aliquots per sample based on a prediction of storm duration plus quality assurance samples (field blanks, field duplicates). For Guadalupe River, given site logistics, composite samples were taken by hand also based on a prediction of storm duration
4. Continuous stage and flow data were also collected from each location.
5. Rain gauges were installed at each sampling location.

WY2013 continued the dry weather pattern seen in recent water years, particularly during the period January-April 2013. San Francisco rainfall for the period January-April 2013 was the driest on record in 164 years. Given the previous year was dry also and thus some samples were carried over at some locations, here is a summary of storms completed for each location to-date over the two years:

Richmond Pump Station: 3 of 4
Lower Marsh Creek: 6 of 8
San Leandro Creek: 7 of 8
Pulgas Creek: 1 of 4
Guadalupe River: 6 of 8
Sunnyvale Channel: 4 of 8

It is proposed that additional storms will be carried into the WY2014 sampling plan so that over a 3 year period, representative samples are taken at each site for a total number of 12 storms sampled (8 storm events for the 2 locations added in WY 2013). A lessons-learned document, with suggested recommendations for future monitoring, will be developed during the summer 2013 and taken into account as we set up for monitoring in WY 2014.

APPLICABLE RMP MANAGEMENT QUESTIONS

This study will implement a small tributaries monitoring in 2 watersheds: Richmond Pump Station and Sunnyvale East Channel (the other four locations are being carried out through separate BASMAA funds and contracts).

The following RMP management questions will be addressed in this project:

- Level I RMP, Q3: What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary?
- Level II RMP, Q3C: What is the effect of management actions on loads from the most important sources, pathways, and processes?
- Level III SPL Q2: What is the watershed-specific and regional total water flow, load of sediment, and load contaminants entering the Bay from the urbanized small tributaries and non-urban areas draining to the Bay from the nine-county Bay Area and are there trends through time?
- Level IV STLS Q1: Impairment: Which are the "high-leverage" small tributaries that contribute or potentially contribute most to Bay impairment by pollutants of concern?
- Level IV STLS Q2: Loads: What are the loads or concentrations of pollutants of concern from small tributaries to the Bay?
- Level IV STLS Q4: Support management actions: 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?

APPROACH

POC monitoring will continue at two bottom-of-the-watershed locations in coordination with BASMAA and other project partners according to the Field Manual developed for WY2013 POC monitoring with minor modifications.

STAFF INVOLVED

The project will be led by Lester McKee, with field work, project management, and reporting by Alicia Gilbreath, Jen Hunt, David Gluchowski, and Don Yee.

SCHEDULE AND DELIVERABLES

Sampling will occur of the winter season of 2013-14. We anticipate laboratory analysis and data management/ quality assurance to be complete sometime in the late summer of 2014. The deliverable is a 2014 revision (adding to or updating sections) in the POC loads report. The working title for the report is: "Pollutants of concern (POC) loads monitoring data progress report, water year (WY) 2014".

BUDGET

The budget for this project is $499,500, of which $223,052 is for SFEI labor and $276,448 is for laboratory analyses, equipment and direct costs.

WORKGROUP OVERSIGHT

This project will be overseen by the Small Tributaries Loading Strategy Team, as part of the Sources, Pathways, and Loadings Workgroup (SPLWG).

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4.7 Develop and Update Spreadsheet Model – Year 5

OVERVIEW

To accurately assess total contaminant loads entering San Francisco Bay, it is necessary to estimate loads from local watersheds. Presently mercury loads entering the Bay from urban stormwater described in the San Francisco Bay TMDL have been estimated by the Water Board by combining BASMAA bed sediment data with now outdated estimates of regional suspended sediment loads. In the case of PCBs, the mass loads in the Bay TMDL were derived from scaling loads from the Guadalupe and Coyote Creek watersheds by area up to the region as a whole. Although these methods were arguably appropriate for planning and TMDL development, the implementation plans of these TMDLs call for improvements of regional scale loads estimates and to assess how these loads might be reduced. These needs are now reflected in the municipal stormwater permit (MRP) (SFRWQCB, 2009) and in the 2nd and 4th questions of the RMP Small Tributaries Loading Strategy (STLS).

"Spreadsheet models" of stormwater quality provide a useful and relatively cheap tool for estimating regional scale watershed loads. These models are based on the simplifying factor that unit area runoff for homogeneous sub-catchments have constant concentrations. Spreadsheet models have advantages over models such as HSPF and SWMM because the data for many of the input parameters required by those models do not currently exist, and also require large calibration data sets which take money and time to collect. A spreadsheet model was developed for the Bay Area previously (Davis et al., 2000); however, at that time, there was only local land use specific data on pollutants of concern (POCs) for a drought period during the late 80s and early 90s, and there was no local data on Hg and PCBs. More recently, a spreadsheet model was developed for a watershed in Los Angeles that was able to predict mass emissions to within 8% of measured Zn loads and described options for loads reduction through a focus on "high leverage" areas (Ha and Stenstrom, 2008). Locally Lewicki and McKee (2009) used a combination of methods to make new watershed specific suspended sediment loads estimates, including application of a spreadsheet model for urban areas in which sediment loads were calculated from watershed area and erosion estimates for specific land use classes. In this model, empirical data and regional regression equations were also applied to larger watersheds dominated by non-urban land use. The combination of these methods produced estimates of sediment loading to the Bay that are presently deemed to be the best. An improved version of this sediment model will be integrated in to the regional watershed spreadsheet model (RWSM) described further below.

RMP 2010 Year 1 of model development

- Version 1 of the hydrology component of the regional watershed spreadsheet model (RWSM) was developed.
- The year 1 report also presented a review of land use and source areas in relation to PCBs, Hg, dioxins, Cu, and Se and provided recommendations for steps to

develop event mean concentration (EMC) data to support the input side of the model. The report recommended the model structure for each pollutant, methods to fill data gaps, and priorities (Lent and McKee 2011).

RMP 2011 Year 2 of model development

- Version 2 included several more calibration watersheds to increase the range of watershed characteristics including percent imperviousness character.
- The first versions of the Hg and PCB RWSMs were developed using combinations of SoCal EMC data (Hg only) and world soils data (Hg and PCBs) combined with local SSC EMC data (BASMAA, 1995). The Hg load results were consistent with existing estimates at a regional scale but questionable at the scale of individual watersheds or land uses. For PCBs, the loads were 20x higher than expected on a regional scale but in the right order of magnitude relative to our conceptual models for land uses and source areas.
- In parallel, the BASMAA Monitoring / Pollutants of Concern (POC) Committee has been discussing and prioritizing work products in relation to the MRP. During 2011, project profiles were developed for addressing MRP provisions c8e.vi (sediment delivery estimate / budget) and c.14 (PBDEs and OC pesticides). Subsequently, BASMAA asked SFEI to complete work outlined in these project profiles. The sediment budget estimate is in progress at this time as is the PBDE and OC pesticides profiles.

RMP 2012 Year 3 of model development

- Developed a Copper test case model for RWSM. Copper represents a data rich urban contaminant that follows classical source, build-up, and wash off processes in relation to urban land uses in a similar fashion to PAHs and pesticides and parts of the mercury model process.
- Additionally in 2012, using RMP funds for the EMC development study, we developed improved input datasets that will underlie the refinements to the PCB and Hg models of the RWSM. The outcomes of these efforts are presently about to be used for the next runs of the PCB and Hg RWSM (Year 4 of model development).

RMP 2013 Year 4 of model development

- Refine the RWSM by incorporating spatial data (GIS layers) of PCB and Hg sources (developed with RMP 2012 EMC funding) as input data sets.
- Refine the RWSM by incorporating back calculations of land use-specific EMCs (developed with RMP 2012 EMC funding) as input data sets.
- Revise and complete Hg and PCB RWSM v2 testing and calibration. We will also evaluate model weaknesses through a sensitivity analysis (combinations of more and less source area classes and reasonable ranges of EMCs for each source class, hybrid models) and make any obvious or within budget improvements.

The overall objective for 2014 is to continue to develop and refine mass emissions estimates of Hg and PCBs for the region, using single watersheds for calibration and verification

purposes. The model and documentation will not be packaged for external users and a 10 page technical memorandum will be written.

APPLICABLE RMP MANAGEMENT QUESTIONS

The following RMP management questions will be addressed in this project:

- Level I RMP, Q3: What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary?
- Level II RMP, Q3C: What is the effect of management actions on loads from the most important sources, pathways, and processes?
- Level III SPL Q2: What is the watershed-specific and regional total water flow, load of sediment, and load contaminants entering the Bay from the urbanized small tributaries and non-urban areas draining to the Bay from the nine-county Bay Area and are there trends through time?
- Level IV STLS Q1: Impairment: Which are the "high-leverage" small tributaries that contribute or potentially contribute most to Bay impairment by pollutants of concern?
- Level IV STLS Q2: Loads: What are the loads or concentrations of pollutants of concern from small tributaries to the Bay?
- Level IV STLS Q4: Support management actions: 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?

APPROACH

In 2014, we propose to:

- Refine the RWSM by incorporating any new spatial data (GIS layers) of PCB and Hg sources (developed with RMP 2013 EMC funding) as input data sets.
- Refine the RWSM by incorporating back calculations of land use-specific EMCs (developed with RMP 2013 EMC funding) as input data sets.
- Revise and complete Hg and PCB RWSM v3 testing and calibration. We will also evaluate model weaknesses through a sensitivity analysis (combinations of more and less source area classes and reasonable ranges of EMCs for each source class, hybrid models) and make any obvious or within budget improvements. Assumption: The model and documentation will not be packaged for external users. Such packaging and creation of supporting documentation (i.e., a user manual) may be a prioritized as a further step.
- Deliverable: 10 page technical memo

There are two other project components developed through the STLS that will add value to the RWSM. Pending available non-RMP funding, the tasks are:

- Update the sediment RWSM by developing an erosional rates classification scheme and updating the model with known sediment outputs (model and report due August 2013.

- Begin to develop the RWSM for PBDEs and OC pesticides to estimate regional scale loads.

STAFF INVOLVED

The project will be led by Lester McKee, with support from Alicia Gilbreath, Jen Hunt, and Jing Wu.

SCHEDULE AND DELIVERABLES

Deliverable	Due Date
Task 1. Refine the model for inclusion of any new GIS source layers and new EMC data	5/1/2014
Task 2. Revise and complete mercury and PCB RWSM V3	7/1/2014
Task 3. Model sensitivity analysis and documentation	9/1/2014

The final deliverable is a 2014 revision (adding to or updating sections) in the RWSM Y4 report. The working title for the 2014 Y5 report is: "Development of Regional Suspended Sediment and Pollutant Load Estimates for San Francisco Bay Area Tributaries using the Regional Watershed Spreadsheet Model (RWSM): Year 5 Progress Report".

BUDGET

The budget for this task is $30,000 (all SFEI labor hours).

WORKGROUP

This project will be overseen by the Sources, Pathways, and Loadings Workgroup.

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4.8 Land Use/ Source Area Specific EMC Development

OVERVIEW

The PCB and Hg TMDLs for San Francisco Bay call for improved stormwater loading information and increased application of urban Best Management Practices (BMPs) for reducing pollutant loads and impacts. Since it is impossible to monitor all stormwater inputs to San Francisco Bay (there are more than 450 urban watersheds presently identified), the first report of the SPLWG recommended a combination of monitoring and extrapolation using modeling to develop regional loads estimates (Davis et al., 2001). In addition, Davis et al. identified a need to evaluate the efficacy of local and regional BMPs for influencing stormwater loads trends. These needs are now reflected in the Municipal Regional Stormwater NPDES Permit (MRP) (SFRWQCB, 2009), in the 2009 Small Tributaries Loading Strategy (STLS, 2009), and in the Small Tributaries Loading Strategy Multi-Year Plan (BASMAA, 2012).

To estimate regional loads, the STLS documents the consensus recommendation to develop a regional watershed spreadsheet model (RWSM) using the methods of Ha and Stenstrom (2008). Data inputs for such a model include rainfall, runoff coefficients, and land use based contaminant event mean concentrations (EMCs). Such empirical monitoring studies have been performed in Southern California by Tiefenthaler et al. (2008) who selected eight representative land use classes based on management needs. They found statistical differences between industrial, recreational, and open space land use classes for suspended sediment, copper, lead, and zinc and no statistical difference between commercial and any category of residential urban land use or transportation.

Unfortunately these Southern California data are not directly applicable to the Bay Area, where PCBs and Hg are the pollutants of highest concern. In the Bay Area, older industrial areas are hypothesized to be more polluted with PCBs than other urban landscapes, whereas for mercury, a broader distribution is hypothesized that includes industrial and commercial areas with higher imperviousness, and older urban areas.

In 2010 and 2011 the RMP funded the first, second, and third years of development of that modeling platform (Lent and McKee, 2011; Lent et al., 2012). The outcomes of the first year included the development of two parallel hydrological models, one using land use based runoff coefficients and the other using imperviousness based runoff coefficients. The model outcomes were compared to empirical observations in 18 calibration watersheds. Preliminary loads of PCBs, Hg, and sediment were also generated but confidence was low. In 2011, the RMP provided an additional $20K to further the development of the model to finalize the hydrological component. In parallel, a literature

review was completed as part of the Y1 report (Lent and McKee, 2011). Land use and source specific classes were recommended for RWSM structure, existing EMC data from local sources and literature were reviewed and compiled, and methods for land use/ source area specific EMC estimation were proposed. In addition, recommendations were given for improvement of the GIS data shape and line files that will become the basis of the model structure.

Thus far, the following EMC development work has been completed:

- GIS layer development for the basis of the PCBs and Hg RWSM,
- Estimations of PCB and Hg EMC data for the land use and or source areas developed in the GIS layers,
- Ensured that the STLS EMC spreadsheet model development is developed with strong step wise communication, and with coordination with other BASMAA efforts, in particular the Clean Watersheds for Clean Bay (CW4CB) project and other permit related efforts (status: ongoing).

In 2013, STLS recommended allocating funds to complete the following:

- Further QA of GIS layers,
- Further computations of PCB and Hg EMC data using inverse optimization methodologies for the land use and source areas developed in the GIS layers,
- Completing model runs for mercury and PCBs, develop user interface, and documentation including recommendations from model weaknesses and how those could be addressed with a field monitoring or other methods.

The above 2013 tasks are underway. The STLS Team will evaluate the 2013 work and make a recommendation for tasks to be completed in 2014. At this time, empirical field data collection of EMC data for specific land uses or source areas has not been implemented but the team is aware of large weaknesses in the currently available input data for the first comprehensive PCB and Hg model runs.

APPLICABLE RMP MANAGEMENT QUESTIONS

The objective of this study is to generate event mean concentration data for the input side of the Regional Watershed Spreadsheet model.The following RMP management questions will be addressed in this project:

- Level I RMP, Q3: What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary?
- Level II RMP, Q3C: What is the effect of management actions on loads from the most important sources, pathways, and processes?
- Level III SPL Q2: What is the watershed-specific and regional total water flow, load of sediment, and load contaminants entering the Bay from the urbanized small tributaries and non-urban areas draining to the Bay from the nine-county Bay Area and are there trends through time?

- Level IV STLS Q1: Impairment: Which are the "high-leverage" small tributaries that contribute or potentially contribute most to Bay impairment by pollutants of concern?
- Level IV STLS Q2: Loads: What are the loads or concentrations of pollutants of concern from small tributaries to the Bay?
- Level IV STLS Q4: Support management actions: 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?

APPROACH

Desktop methods

Step 1. Update as needed the 2013 data base on local and international data on soils and water concentrations in relation to land use and source areas for Hg and PCBs,

Step 2. Apply further back-calculation methods using including inverse optimization or other methods,

Step 3. Provide regular updates and feedback opportunities to STLS, including discussion of proposed back-calculation methods,

Step 4 Perform sensitivity analyses, and develop error bars around results (or professional judgment to assign errors or ranges)

Step 5. Prepare a short (<5 page) summary of methods and results for inclusion in the model documentation

Field methods

Task 1: Project management

Task 2: Purchase, prefabricate and install ISCO auto sampling equipment (yet to be determined if triggered by stage or turbidity or a combination) at two EMC sampling locations

Task 3: Carry out fieldwork during 4 wet season storms at these EMC sites.

Task 4: Complete laboratory analysis of water samples

Task 5: Complete data management/quality assurance

Task 6: Complete interpretative report

STAFF INVOLVED

The project will be led by Lester McKee with assistance from Alicia Gilbreath and Jen Hunt.

SCHEDULE AND DELIVERABLES

The STLS workgroup will meet in early 2014 and develop a scope for this task. A final report will be completed by the end of summer of 2014.

BUDGET

The budget for this project is $80,000.

WORKGROUP

This project will be overseen by the Sources Pathways and Loading Workgroup.

4.9 STLS Management Support

APPROACH

The RMP Small Tributaries Loading Strategy (STLS) work group provides the framework for planning and coordinating projects for the improvement of pollutant loads information for S.F. Bay. The STLS has met regularly over the last few years to develop and oversee multiple RMP products including the Regional Watershed Spreadsheet Model and the framework for POC long-term monitoring. These elements together provide assurances that the most cost effective information is generated that directly answers our key loading questions.

This task will include quarterly STLS meetings to collaborate and coordinate WY2014 POC monitoring, provide updates and solicit input on RWSM, and EMC development. Monthly phone conferences calls will be convened to provide brief updates and information sharing.

STAFF INVOLVED
This task will include support from Lester McKee and Jen Hunt.

SCHEDULE AND DELIVERABLES
Quarterly in person meetings and phone conferences as needed.

BUDGET
This element is $25,000, allocated to SFEI labor.

WORKGROUP
This project will be overseen by the Sources Pathways and Loading Workgroup.

4.10 Nutrients Program Management

APPROACH

This task will support science coordination and program management. There are a large number of stakeholders and programs involved in nutrient-related work in San Francisco Bay. RMP nutrient-related activities need to be coordinated with these other efforts to achieve maximum benefit. Additional funding is being sought from BACWA to further support science coordination and program management.

APPLICABLE RMP MANAGEMENT QUESTIONS

1. Is there a nutrient problem or are there signs of a problem in the Bay? What future nutrient-related impairments are predicted for the Bay?

2. Which nutrient sources, pathways, and transformation processes contribute most to concern? What is the relative contribution of each loading pathway (POTW, Delta, nonpoint sources, etc.) to the Bay overall and the Bay's key sub-systems, and how do these loads vary seasonally?

3. What are appropriate guidelines for assessing San Francisco Bay's health with respect to nutrients and eutrophication?

STAFF INVOLVED
This task will be led by David Senn and Emily Novick.

SCHEDULE AND DELIVERABLES
The deliverables for this task include in person meetings and phone conferences as needed.

BUDGET
The budget for this project is $20,000.

WORKGROUP
This project will be overseen by the Nutrient Strategy, the Technical Review Committee (TRC), and the Steering Committee (SC).

4.11 Nutrients Monitoring Program Development

OVERVIEW

The nutrient conceptual model report pointed to the need to develop the scientific framework for a monitoring program, along with the institutional agreements and funding plan to support a regionally-administered and sustainably funded program. Nutrient program management in 2014 will focus primarily on the science program development, but also allow SFEI staff to play a coordinating role to bring key partners to the table and assist in the institutional and funding planning. Additional matching funds for this task are being sought from BACWA.

APPLICABLE RMP MANAGEMENT QUESTIONS

1. Is there a nutrient problem or are there signs of a problem in the Bay? What future nutrient-related impairments are predicted for the Bay?

2. Which nutrient sources, pathways, and transformation processes contribute most to concern? What is the relative contribution of each loading pathway (POTW, Delta, NPS, etc.) to the Bay overall and the Bay's key sub-systems, and how do these loads vary seasonally?

3. What are appropriate guidelines for assessing SF Bay's health with respect to nutrients and eutrophication?

APPROACH

Task 1 Convene monitoring program working group and advisory team

A monitoring program working group will be established to guide development of the monitoring program. This group will consist of regulators, stakeholders, and technical experts. Regulator and stakeholder input will play an essential role in monitoring program development, in particular for identifying monitoring program goals, prioritizing program components to meet those goals, and establishing institutional and funding agreements. A monitoring program technical advisory team will also be established to provide guidance to SFEI staff, technical collaborators, and stakeholders on program development. The technical advisory team will consist of regional and national experts that have experience establishing and maintaining monitoring programs.

Task 2 Draft and implement a program development plan

A major outcome of the meetings with the monitoring program working group and technical advisory team will be a draft monitoring program development plan. This plan will:

- Clearly articulate monitoring program goals
- Lay out an approach for identifying and evaluating different program structures (e.g., specific parameters, spatial and temporal frequency of data collection, balance between ship-based and moored-sensor approaches)
- Identify specific data analysis activities that will be carried out in Task 3
- Recommend pilot studies to test monitoring approaches
- Present goals and an approach for pursuing institutional agreements, exploring funding options, and identifying budgetary constraints.

Task 3 Data analysis to inform future monitoring program structure

The long-term science and monitoring efforts in the Bay/Delta provide a nearly 40-year record of water quality and ecological indicators. This data set provides a tremendous historical record that can be quantitatively probed to inform monitoring program design, and help identify which parameters to measure; the spatial and temporal density of sampling required; and the balance between ship-based and moored sensor applications. Analysis and synthesis of existing data was also recommended in the conceptual model report.

With guidance from the technical advisory team and the monitoring program working group team, the program development plan will identify and prioritize data analysis and

numerical simulation tasks. Results of these tasks will be reported back to the technical advisory team and monitoring program working group in the form of periodic update presentations and sections to be included in the end of year progress report.

STAFF INVOLVED
The study will be led by David Senn with assistance from Emily Novick, and collaborators.

SCHEDULE AND DELIVERABLES
The technical advisory team will meet 2 times in 2014, with electronic exchanges between meetings. The monitoring program working group may meet more frequently (up to quarterly), as needed.

A draft of the monitoring program development plan will be developed at the end Q1 2014, following the first team meeting in 2014. This report will be updated periodically over the course of the year. The report will prioritize work elements for year 1 and beyond. Status updates on work elements will be presented to the working group at meetings, and a year-end progress report will be prepared.

BUDGET
The budget for this project is $50,000.

WORKGROUP
This project will be overseen by the Nutrient Strategy team, TRC and SC, and the newly convened nutrient monitoring program working group.

4.12 Moored Sensor Monitoring Program

OVERVIEW

The nutrient conceptual model report recommended developing a moored sensor sub-program that complements the ship-based monitoring program by providing high temporal resolution data for a range of parameters (e.g., chl-a, dissolved oxygen, nutrients, turbidity) that can be used to: i) identify the onset of events (e.g., large blooms); ii) improve understanding about the processes that influence phytoplankton blooms in order to predict future responses; iii) assess oxygen budgets; and iv) quantify nutrient fate. High temporal resolution data will also be essential for accurately calibrating water quality models.

Continuous monitoring with moored sensor systems is feasible for a wide range of water quality parameters. Techniques for some parameters are becoming increasingly well-established and reliable (e.g., salinity, temperature, turbidity, chl-a, DO, and more recently nitrate), while others are advancing (e.g., phosphate, ammonium, phytoplankton composition using in situ flow cytometry and digital imaging). Moored sensor systems

can telemeter data, allowing for near real-time assessment of conditions, which can be used to trigger field sampling or to identify sensor failure or drift.

Compared to Suisun Bay and the Delta, where there are an abundance of moored sensor stations maintained by DWR/IEP, the moored sensor infrastructure is quite limited in San Pablo Bay, Central Bay, and especially Lower South Bay and South Bay. This is particularly true for parameters like chlorophyll, nutrients, and dissolved oxygen.

The RMP funded a pilot project in 2013 to deploy moored sensors at Dumbarton Bridge; the sensors were successfully deployed in the summer of 2013. In 2014, the moored sensor network in Lower South Bay and South Bay will be expanded.

APPLICABLE RMP MANAGEMENT QUESTIONS

1. Is there a problem or are there signs of a problem in the Bay? What future nutrient-related impairments are predicted for the Bay?

2. Which nutrient sources, pathways, and transformation processes contribute most to concern? What is the relative contribution of each loading pathway (POTW, Delta, NPS, etc.) to the Bay overall and the Bay's key sub-systems, and how do these loads vary seasonally?

3. What are appropriate guidelines for assessing SF Bay's health with respect to nutrients and eutrophication?

APPROACH

In 2014, RMP funding for moored sensor program development will be directed toward:

- purchasing equipment for two additional stations for measuring chl-a, pH, DO, turbidity, fluorescent dissolved organic matter, depth, and nitrate (these stations would be in addition to the current Dumbarton Bridge station);
- field logistics (e.g., ship time) for sensor deployment and maintenance, intensive in situ calibration studies, and pilot field deployments to inform final site selection; and
- data management.

This proposal to the RMP is being augmented by a proposal to BACWA ($150K). The BACWA funding would be directed toward funding moored sensor program development, which will include:

- analysis of existing monitoring data to help optimize placement of moored sensors;
- design and implementation of field experiments for intensive in situ calibration and testing of sensor accuracy and precision (e.g., identifying and developing approaches for correcting for interferences) and pilot field deployments to inform final site selection;

- analysis and interpretation of data from field experiments;
- recommendation of specific program expansion sites in Lower South Bay and South Bay;
- development of beta software for automated data assimilation, initial QA/QC, graphics/visualization, and upload to website for near real-time data viewing on a web-based platform; and
- to the extent possible, data from moored sensors in Suisun Bay and the Delta will also be retrieved in near real-time and uploaded to the beta web platform.

Although the Suisun and Delta sites use similar sensors as those we will use in Lower South Bay and South Bay, there will be differences in the maintenance, calibration, and QA/QC between programs. This is likely to be a non-trivial caveat, and in the long run would need to be addressed by developing common maintenance, calibration, and QA/QC procedures. The near-term goal of the final bullet above is more proof-of-concept, aimed at highlighting the feasibility and advantages of coordination, to develop momentum along the path of establishing institutional agreements with IEP/DWR on monitoring.

STAFF INVOLVED
This project will be led by David Senn and Emily Novick.

SCHEDULE AND DELIVERABLES
Since the majority of RMP funding is being directed toward equipment and logistics, the table below includes a combination of RMP and BACWA deliverables.

Summary of data analysis and field experiment results, and recommended locations for new sites in South Bay and Lower South Bay (Note: dates may shift depending on BACWA project start)	Draft: April 2014 Final: June 2014
Beta website presenting near real-time data for up to three RMP-funded sites in LSB and South Bay, and, if possible, DWR/IEP sites in Suisun Bay and the Delta	Jun 2014

BUDGET
The budget for this project is $215,000; $35,000 of which is SFEI labor.

WORKGROUP
This project will be overseen by the Nutrient Strategy, TRC and SC, and the newly convened nutrient monitoring program working group.

4.13 Nutrients Stormwater Measurements

OVERVIEW

Although nutrients are not the main focus of the STLS and POC, three nutrient analytes (NO3-, total phosphorous, dissolved orthophosphate) are among the current list of required analytes as part of the Municipal Regional Stormwater Permit. However, other important nutrient analytes are not analyzed because the permit does not require them. For this study additional nutrient analytes (NH4+, total Kjeldahl nitrogen (TKN), and NO2-) will be collected and analyzed at the six watersheds being sampled during WY2014 as part of the Small Tributary Loadings Strategy (STLS) and the Pollutants of Concern study.

The combined suite of nutrient analytes matches the type of information being collected in the USGS monthly Bay surveys, and data being collected for POTW effluent characterization. Adding these three analytes, when teams are already mobilizing for the other contaminant sampling allows us to leverage RMP funds. External contractors will be compensated for collecting additional analytes ($2,000 per site).

APPLICABLE RMP MANAGEMENT QUESTIONS

1. Is there a problem or are there signs of a problem in the Bay? What future nutrient-related impairments are predicted for the Bay?

2. Which nutrient sources, pathways, and transformation processes contribute most to concern? What is the relative contribution of each loading pathway (POTW, Delta, NPS, etc.) to the Bay overall and the Bay's key sub-systems, and how do these loads vary seasonally?

3. What are appropriate guidelines for assessing SF Bay's health with respect to nutrients and eutrophication?

APPROACH

The additional analytes will be measured in samples already being collected for other purposes (6 sites, 4 storms/site, 4 samples/storm), so there will be little additional work on the part of field crews, and they will not be responsible for data management.

STAFF INVOLVED

This project will be led by David Senn with support from Emily Novick, Lester McKee, Jen Hunt, and Alicia Gilbreath.

SCHEDULE AND DELIVERABLES

Database of additional analytes	Summer 2014
Brief technical report summarizing results	December 2014

BUDGET
The budget for this project is $35,000.

WORKGROUP
This project will be overseen by the Nutrient Strategy; the Small Tributaries Loading Strategy Team, as part of the Sources, Pathways, and Loadings Workgroup (SPLWG); TRC and SC; and the newly convened nutrient monitoring program working group.

4.14 Hydrodynamic and Water Quality Model Development

OVERVIEW

The Nutrient Strategy calls for the development of models to quantitatively characterize the Bay's response to current nutrient loads; explore ecosystem response under future environmental conditions and identify scenarios under which impairment may occur; and test the effectiveness of load reduction scenarios and other scenarios that mitigate or prevent impairment. Moreover, the recent conceptual model report prepared for the RMP by a team of regional experts recommended development of integrated models of hydrodynamic and water quality to inform nutrient management decisions. That report also identified a set of high priority science questions, many of which will need to be addressed in part through modeling.

The primary goal of this work is to launch the development and refinement of a set of integrated Bay-wide hydrodynamic, nutrient cycling, and ecosystem response models to inform nutrient management decisions. The primary objective of this effort is to develop models that can be applied to inform nutrient management decisions in the Bay. Beyond nutrients, there is the desire to adopt a platform that has sufficient flexibility that it can also be adapted to explore management issues related to other contaminants (e.g. emerging or legacy aqueous or particle-reactive contaminants).

Past and current funding will support this initial, but critical, phase of model development. In subsequent years, funding will be sought from a broad set of stakeholders and funding programs to support continued model refinement and simulation of scenarios.

This task will develop a modeling approach and implement a work plan. Funds set aside for modeling in prior years will be used for planning with 2014 funds being used for model development, refinement, and application.

In 2013, the following modeling planning work was completed:

1) *Completing report for recommendations for modeling platform and approach*
Work began in the second half of 2012 and the first half of 2013 on developing a set of criteria for model selection, recommendations for a model platform, and a recommended approach to model development. SFEI staff worked with RMP stakeholders to define relevant management questions, and held meetings with regional and national modeling experts to solicit input on appropriate model platforms for addressing these management questions. An outline of the report was developed and served as the basis for a meeting with a modeling advisory team held in March 2013. The group consisted of experts in the areas of hydrodynamic modeling (E Gross, RMA; O Fringer, Stanford; L Erikson, USGS; C Jones, Sea Engineering) and phytoplankton modeling (L Lucas, USGS), and water quality modeling (J Fitzpatrick, HDR-Hydroqual). There was broad consensus among the group about model selection criteria, model platforms that meet those criteria, and about general approach for model development and refinement. The group's recommendations were incorporated into a report describing the potential modeling platform and approach.

2) *Model planning meeting*
A focused meeting was held in the Fall of 2013 to solicit additional input on the modeling plan. Meeting participants included the core modeling advisory team, additional technical experts, and stakeholders. Main meeting goals included:
- vetting the selected model platform and draft approach with a broader group of experts and stakeholders; and
- soliciting expert input on the specific approach for model development, which will be incorporated into the detailed work plan.

3) *Finalizing the modeling report and developing the detailed work plan*
Based on input from the modeling plan meeting, the modeling report will be finalized, and a detailed work plan will be developed that identifies the recommended path forward for model development, refinement, and application. The report and work plan will be will be submitted in by December 2013 to the RMP TRC and SC for review and approval. The work plan will lay out an overall long-term plan for model development and application, with near-term (subsequent 2-3 years) goals, approach, and milestones described in substantial detail.

APPLICABLE RMP MANAGEMENT QUESTIONS

1. Is there a problem or are there signs of a problem in the Bay? What future nutrient-related impairments are predicted for the Bay?

2. Which nutrient sources, pathways, and transformation processes contribute most to concern? What is the relative contribution of each loading pathway (POTW, Delta, NPS,

etc.) to the Bay overall and the Bay's key sub-systems, and how do these loads vary seasonally?

3. What are appropriate guidelines for assessing SF Bay's health with respect to nutrients and eutrophication?

APPROACH

Once the recommended modeling approach and work plan have been approved, work on model development will begin. The exact details of model development will depend on the final recommended approach. That said, there are three defined tasks; two of which will proceed simultaneously along two parallel fronts (Task 1 and 2) during the 1-1.5 years, and then iteratively along three fronts (Task 1, 2, and 3) in year 2 and beyond.

Task 1 Develop and refine a Bay-wide hydrodynamic model, building on existing work in the Bay

An initial grid will be adopted and refined, and model calibration and validation will proceed to obtain an acceptable full-Bay hydrodynamic model. Subsequently, the initial hydrodynamic grid and model will be refined to achieve necessary resolution.

Task 2 Develop and test water quality model, and carry out initial modeling experiments

An existing water quality model that has been successfully applied in other estuaries will be used, and refine parameterizations and features as necessary. The initial hydrodynamic output will be used to aggregate the grid; carry out subembayment-scale modeling 'experiments' for sensitivity analysis, uncertainty analysis, hypothesis testing and data synthesis; and to identify high priority data collection or process-level studies.

Task 3 Refine hydrodynamic inputs to water quality model, building toward more highly-spatially-resolved integrated models, and apply these models

This task embodies the ultimate goal of the modeling work. This task will not be completed within the first two years on the available funding. Additional funding will be sought (from other partners, and potentially the RMP) for continued model development in FY/CY2015.

STAFF INVOLVED

The study will be led by David Senn with assistance from Emily Novick, and collaborators.

SCHEDULE AND DELIVERABLES

Progress reports on the model development will be completed every six months from December 2013 to December 2014.

BUDGET
The budget for this task is $200,000.

WORKGROUP
This project will be overseen by the Nutrient Strategy, the TRC and SC, and the newly convened nutrient monitoring program working group.

4.15 Analysis of Dioxin in Sport Fish

OVERVIEW

San Francisco Bay was placed on the State of California's 303(d) list of impaired waters in 1998 as a result of elevated concentrations of dioxins and furans (commonly referred to as 'dioxin') in fish. Every five years the RMP studies contaminants in Bay sport fish; since 1994, dioxin concentrations have remained unchanged, but continue to greatly exceed screening values for human consumption in some sport fish species. Therefore, in 2014 dioxins in sport fish will once again be evaluated.

APPLICABLE RMP MANAGEMENT QUESTIONS

This study would address the following RMP management question (MQ):

MQ1. Are chemical concentrations (*or activities*) in the Estuary at levels of potential concern and are associated impacts likely?

- B: What potential for impacts on humans and aquatic life exists due to contaminants (*or activities*) in the Estuary ecosystem?

MQ4: Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased?

APPROACH
Dioxin concentrations in sport fish are measured as a part of the S&T sport fish monitoring program. The next sport fish sampling is scheduled for the summer of 2014. The Sport Fish Workgroup will meet in December of 2013 to select the species to include in the sampling plan.

SCHEDULE AND DELIVERABLES
The dioxin concentrations and trend analysis will be presented to the SFWG in the fourth quarter of 2014.

BUDGET
The budget for this task is $24,000.

WORKGROUP OVERSIGHT
The Exposure and Effects Workgroup will review this element.

4.16 Develop a Selenium Strategy

OVERVIEW

To support the anticipated North San Francisco Bay Selenium (Se) TMDL and to provide data to more fully understand the food web pathways and uptake/assimilation of Se into sturgeon, the RMP will consider needs for selenium data including analysis of sport fish stomach contents as well as analysis of 2014 mussel tissue in the North Bay for selenium.

APPLICABLE RMP MANAGEMENT QUESTIONS

This study would address the following RMP management question (MQ):

MQ1. Are chemical concentrations (*or activities*) in the Estuary at levels of potential concern and are associated impacts likely?

- B: What potential for impacts on humans and aquatic life exists due to contaminants (*or activities*) in the Estuary ecosystem?

APPROACH

Se and dietary composition analyses of sport fish would be additions to the 2014 S&T sport fish monitoring program. The Sport Fish Workgroup will meet in December of 2013 to select the species to include in the sampling plan. The TRC/SC will discuss information needs and provide guidance on this task.

SCHEDULE AND DELIVERABLES

The schedule and deliverables for this task will be elucidated in early 2014.

BUDGET

The budget for this task is $25,000.

WORKGROUP OVERSIGHT

The SC and TRC will review this element.

Table 1 Projected 2014 Budget

Task	Labor Cost	Subcontracts and Direct Costs
Program management	$568,000	$98,000
Data management	$139,000	
RMP website	$10,000	
Information dissemination	$136,000	$34,500
Annual reporting	$90,000	$27,500
QA/QC	$28,500	
Status & Trends (S&T) Fieldwork&Logistics/Vessel/Data Management	$194,000	$181,000
S&T Chemistry (sediment)		$185,000
S&T Bivalve Bioaccumulation		$46,000
S&T Sport Fish Bioaccumulation	$50,000	$210,700
S&T USGS Monitoring		$423,000
SS: Alternative Flame Retardants	$52,300	$54,700
SS: EC Strategy Update	$20,000	
SS: Developing Bioanalytical Tools		$56,000
SS: Impacts of Dredging on Benthic Habitats		$150,000
SS: Effects of particle size/shape on toxicity		$30,000
SS: Stormwater Loads Monitoring in Representative Watersheds	$223,052	$276,448
SS: Develop and Update Spreadsheet Model - Year 5	$30,000	
SS: Land use/ Source specific EMC	$40,000	$40,000
SS: STLS Management support	$25,000	
SS: Nutrients Program Management	$20,000	
SS: Nutrients Monitoring Program Development	$42,000	$8,000
SS: Moored Sensor Monitoring Program	$35,000	$180,000
SS: Nutrients Stormwater measurements	$10,000	$25,000
SS: Hydrodynamic and Water Quality Model Development	$200,000	
SS: Dioxin Sportfish monitoring	$4,000	$20,000
SS: Develop Selenium Strategy	$25,000	

Set Asides (e.g., sportfish, bird eggs, and bivalves) and Contingency		$211,100
Total Budget (SC Approved)	**$1,942,999**	**$2,255,811**