

Special Study Proposal: Characterization of Sediment Contamination in Central Bay Margin Areas

Summary: Bay margins (i.e., mud flats and adjacent shallow areas of the Bay) are more productive and highly utilized by biota of interest (humans or wildlife) than the open Bay areas. This study will provide a spatially distributed unbiased characterization of surface sediment contamination and ancillary characteristics within shallow Central Bay margin areas. The data will be used to investigate spatial distributions of pollutants, watershed influences, and regional trends. This study will complement targeted studies to link watersheds, known contaminated margins, and the open Bay, much of which will be focused in Central Bay.

Estimated Cost: \$257,470 over two years (\$226,370 in 2015, \$31,100 in 2016)

Oversight Group: TRC. On 3/11/15, the TRC recommended that the SC approve this study.

Proposed by: Don Yee, Phil Trowbridge (SFEI)

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	Due Date
Task 1. Project Management (write and manage sub-contracts, track budgets)	March-May 2015
Task 2. Finalized detailed sampling plan	April 2015
Task 3. Field Sampling	Summer 2015
Task 4. Lab analysis	Fall/winter 2015-2016
Task 5. QA/QC and data management	March 2016
Task 6. Data web upload	Apr 2016
Task 7. Draft & final report	Mar 2016 (preliminary), Dec 2016 (final)

Background

The Bay margins (i.e., mud flats and adjacent shallow areas of the Bay) are important habitats where contaminant exposure is high in some known locations, but that have been largely unsampled by the RMP, due to logistical considerations; the RMP historically focused on deep water locations, limited even after the 2002 redesign to areas accessible by a moderately large boat (~3 foot draft). Aside from the margins' importance as habitats in themselves, contamination in margins may contribute to the lack of decreasing trends in biota (e.g., fish tissue) concentrations of PCBs (and other persistent bioaccumulative contaminants), despite long-term changes in sediments in some parts of the open Bay. Locations on the margins often may have a closer linkage with terrestrial sources and therefore a higher potential for showing a positive response to management actions aimed at reducing loads and impairment. Analysis of margins contaminant concentrations in the RMP Margins

Conceptual Model Report (Jones et al., 2012) suggested higher and more variable concentrations in margins, but much of the previous sampling was spatially biased to include known polluted areas in the margins associated with Superfund sites and other legacy sources, while the characteristics of contamination of other sites in the Bay margins are less known.

Study Objectives and Applicable RMP Management Questions

This study will provide an unbiased spatially distributed characterization of surface sediment contamination and ancillary characteristics (grain size, TOC, etc.) in shallow Central Bay margin areas. According to the RMP Margins Conceptual Model Report (Jones et al., 2012), such data are needed to characterize and model contaminant risk, fate, and trends in the Bay margins. Otherwise, assessments of exposure and risks to margins biota would rely on extrapolation from data from deeper, subtidal, open water areas of the Bay, and/or biased margin cleanup target areas, neither likely representative of most locations the margins. Collection of representative margin data is the only real solution for obtaining such data. Ideally ambient margins sampling should recur regularly, as it is characterizing a relevant, evolving, and critical portion of the ecosystem. Deterministic sampling related to identifying sources, or to management in specific locations should be addressed by monitoring schemes specifically designed for those needs and are complementary.

Although there are broader questions and needs for ambient margins data (paralleling those for the Bay S&T), this study has evolved from a periodic synoptic Baywide survey of margins to a single pilot effort focused on Central Bay. The power to make some comparisons (e.g., with other Bay segments, if those segments are later sampled) has been reduced, in favor of obtaining information more quickly on Central Bay, with likely the most areas surrounding potential management actions. This plan accelerates characterization of ambient Central Bay margins to be able to compare to and complement deterministic sampling at priority managed margin areas and watersheds, to evaluate the effectiveness of management actions, especially with regards to PCBs.

Information needs addressed by these data include:

1. Ambient concentrations of PCBs and other contaminants in sediment in the margin areas. This information will facilitate setting achievable targets for restoration and/or load reductions.
2. Mass balance calculations for PCBs and other contaminants in margin areas to show the relative importance of watershed loads in maintaining elevated concentrations in the sediments. This information will show whether taking management actions in the watersheds has the ability to change the margin concentrations.
3. Effectiveness of on-the-ground watershed management projects at reducing loads. This information will show whether the installed technology is meeting its design specifications.
4. Screening for the existence of additional hotspots in areas that have not been sampled to date

Probabilistic vs Targeted Sampling Designs

Spatially distributed probabilistic sampling is the best design for Information Need #1, and would also be valuable for Information Need #4. However, the probabilistic design will take into account current knowledge, by not sampling areas with nearby comparable recent or impending/planned data (criteria for “comparable” and “nearby” described below in the section on Approach).

Targeted sampling is the best design for Information Needs #2 and #3. The RMP has a special study planned to monitor PCBs in priority margin units with separate funding. That targeted study will be directly relevant to Information Need #2. In the future, when on-the-ground watershed management projects start, targeted performance monitoring should be required to address Information Need #3. However, even for these targeted sampling needs, ambient data are needed to provide important complementary information, e.g., for #2, to estimate mass exchanges with adjacent less contaminated areas, or for #3 to identify which locations among targeted locations are showing mostly ambient rather than site or watershed specific influences.

Recommended (Modified) Probabilistic Design

- Concentrating all 40 margins sites into Central Bay (see Figure 1) in order to better characterize this segment since it is of primary interest for management.

Due to the expected high variability in margins, especially in Central Bay, an effort that spread the sampling effort across the whole Bay was assumed to reduce uncertainty too slowly to address immediate Central Bay information needs. It should be noted that here the Central Bay sampling frame is delimited using the RMP rather than SFBRWQCB definition. Both definitions share a common northern limit running between Point San Pablo in Richmond and Point San Pedro in San Rafael. For the SFBRWQCB, the southern limit of Central Bay ends at the San Francisco-Oakland Bay Bridge, whereas the RMP definition includes a portion south of the Bay Bridge, extending approximately from San Francisco Airport to Oakland Airport. These margins adjoin some older industrialized areas and thus might be expected to be of interest for legacy pollutants such as PCBs and Hg.

Advantages

- Central Bay is of high interest for management actions.
- Would be better able to characterize ambient concentrations in Central Bay and allow meaningful comparisons to “open bay” sediment concentrations within 1-2 years.
- The 40 probabilistic sites can be post stratified into a few “sub populations” to characterize ambient concentrations in different categories or areas of Central Bay.
- Rapid characterization of margin areas in Central Bay would be helpful to:
 - illustrate the spatial patterns of margin contamination in this segment, providing context for managing contaminated areas;
 - understand the high PCB concentrations in fish found there;
 - evaluate the influence of known hot spots or the prevalence of unknown ones; and
 - identify candidate areas for the PCB Priority Margin Unit Study.

- A focused pilot effort will provide the best chance of a study that is successful in generating the information of interest, and management success can potentially be evaluated in a short time-frame.

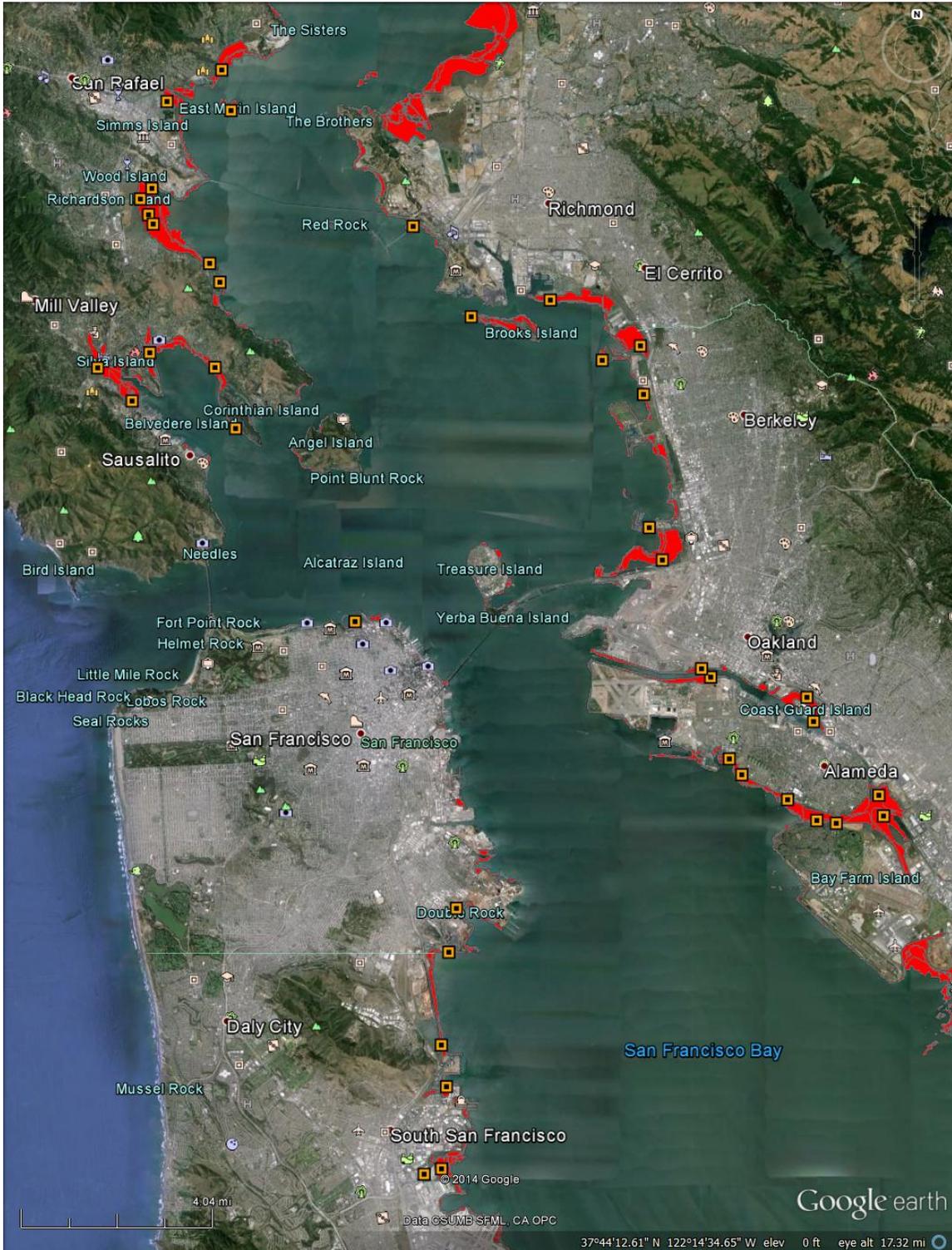


Figure 1. First 40 margin sites in Central Bay (orange symbols). Red areas are margins frame sampled.

Disadvantages

- There is uncertainty about whether even 40 samples can adequately characterize such a diverse, fragmented, and likely heterogeneous area as the margins of Central Bay.
- The sampling design will not collect data from any other Bay segments in the same years. This approach will make it more difficult to compare margin areas between segments due to possible conflation of temporal and spatial differences
- Collection of information on margins in other segments will be delayed. Information to support margin management decisions in other segments will continue to be lacking.

Approach

Study Area and Sampling Locations

The proposed margins sampling monitoring would include areas previously excluded from the sampling frame in the RMP S&T redesign process: areas shallower than 1 foot at MLLW, up to the unvegetated shoreline (roughly MHW). In most areas this is approximately synonymous with mudflat (if we include shallow subtidal areas in that definition). A margin sampling frame was defined in consultation with Josh Collins and the SFEI GIS team, minimizing overlap with other monitoring such as CRAM assessed wetland areas (by excluding vegetated areas) and the open water areas already in the RMP Bay S&T (areas below 1 foot below MLLW).

A GRTS method was used to draw sampling locations (up to 128 per segment) from this frame for the whole Bay in an unbiased manner through consultation with Don Stevens, the environmental statistician who helped design the RMP open Bay GRTS sample draw. Although it was investigated whether or not to include areas previously skipped in the Bay S&T sampling (due to water being too shallow for the vessel to access), Don Stevens recommended that they not be added, as oversample sites already have been sampled and should be adequate for characterizing the open Bay stratum. Figure 1 shows a map of Central Bay with the first 40 margins sampling locations marked.

The TRC Margins Planning Subcommittee held a teleconference to discuss criteria for rejecting sites and replacing them with oversample locations. If any of the following logistical criteria occur at the planned site coordinates:

- Access/safety: The site cannot be accessed safely; OR
- Substrate: The substrate at the site is too coarse to collect a cohesive sample, is rocky shoreline, is covered with dense aquatic vegetation, or is shell hash; OR
- Upland area: The planned site is in a salt marsh or upland area.

If the logistical criteria are not met at the planned coordinates, the field team will be able to navigate within 50 meters of the planned site to find a suitable location with target habitat nearby. For sites that need to be relocated within the 50 meter allowable radius, to avoid biasing (e.g., always going to the deepest allowed depth) an attempt will be made to sample

at the expected original depth for the site; sites that are not at their expected depth range but are still within acceptable habitat at their planned coordinates will not be relocated. If no suitable locations are found within 50 meters, the site will be rejected as not possible to sample. To the extent possible, unsampleable sites will be pre-identified through a desktop exercise from aerial imagery, and the next site in the overdraw list will be added in its place.

The subcommittee also discussed criteria for using other programs/projects data to substitute for collecting and analyzing samples from a site. Currently the USGS is collecting samples in the near field of POTW discharges in South Bay, which may overlap with RMP ambient margins sites, if this study is extended to other Bay segments. Remediation action sites may also have recent or ongoing sampling of margins sites; where sites are effectively co-located with those for other studies, the RMP will try to minimize duplication of sampling and analytical effort where possible.

The following criteria were chosen to determine if existing data are sufficiently near and comparable to the desired analyses to be used in substitution to characterize a planned site:

- Spatial: Existing data <50 meters from the planned site (co-located); AND
- Temporal: Existing data <10 years old (since 1/1/06 for the 2015 season); AND
- Depth: Existing data 10 cm sediment depth or shallower; AND
- Parameters: Existing data are for at least PCBs and ancillary characteristics (grain size, TOC).

Note, data planned for imminent collection (i.e., less than a year in the future) may be considered to be equivalent to existing data on hand. Plans more than a year in the future should be evaluated on a case-by-case basis, but risks of studies not proceeding or being significantly delayed increase the further into the future we consider. If all criteria are met, then staff will review the field and laboratory methods to determine if the existing data can be used to characterize the planned site without collecting more data. If the existing data can be used, the next site in the overdraw list will be used in the sampling plan to increase the overall sample coverage. Similar principles apply to planned sample collections at co-located (or just nearby) sites; even when the planned analyses do not overlap, requests can be made with these other studies/projects to collect additional sample material. Aside from not wasting money, the other purpose of this effort is to be coordinated with other margins monitoring efforts.

Sample Size

Don Stevens noted that assuming compared strata have similar variance, equal numbers of samples in each stratum would provide the greatest power to detect differences among strata. Although the Central Bay shoreline is already more urbanized than most of the rest of the Bay, a teleconference of a TRC Margins Planning Subcommittee considered the possibility of pre-stratifying within Central Bay to allocate even more sites to areas adjoining urbanized industrial areas. However, given the already small number of samples in the (presumed less variable) less urbanized areas it was decided that a pre-stratification effort could at most re-allocate around 5 sites. Discussions suggested the limited benefit of redistributing these sites was outweighed by the statistical challenges and complications it would create (e.g., if variance is not as small as expected, if we wish to explore/test different

post-stratification classification schemes). Therefore, it was decided to not pre-stratify the points for this first round of sampling but to reconsider this option after the new data are evaluated.

Sampling Frequency

This study plan represents a single effort in Central Bay to get a broad representative characterization of Bay margins. Results from this study may point to future possibilities or needs for site investigations, or further ambient characterization to get a better understanding/statistical certainty of patterns found. Studies of margins in other segments of the Bay may be planned as well for future years using this study as a pilot of the logistics and methods for margin sampling. However, there is not yet a plan for systematic regularly scheduled sampling of the margins akin to the Bay S&T at this time.

Target Analytes

Sediment samples will be analyzed for grain size and ancillary parameters, mercury, methylmercury, trace metals, and PCBs (209 congeners). Extra archive samples will be collected so that additional parameters can be analyzed in the future.

Budget

The proposed budget for the study is shown in Table 1. The study will be completed over two years. In 2015, all 40 sediment samples will be collected in order to lower field costs and to reduce temporal variability. In 2016, the data analysis and reporting will be completed. The annual costs for 2015 and 2016 will be \$226,370 and \$31,100, respectively. The total cost for the two-year program will be \$257,470.

The approved 2015 RMP budget contains \$140,000 for this effort. Another \$120,000 for the margins study is expected to be in the 2016 RMP budget. Therefore, between the 2015 and 2016 funds, there will be sufficient funds for the study. However, because most of the expenses will be in 2015, the Steering Committee will need to authorize adding \$86,370 of Undesignated Funds to the 2015 budget. This amount will be returned to Undesignated Funds from the 2016 budget.

Efforts and costs can be scaled up or down by changing the types of analyses run, number of samples per segment in a given year, or number of segments per event. For this proposal, it was necessary to drop sediment analyses for PAHs in order to balance the budget. These analyses would add \$36,000 to the cost of the study.

Budget Justification

Labor Costs

SFEI labor costs for the planning task are for developing this proposal and a detailed cruise plan for the study. For the field work task, SFEI labor is mostly devoted to data

management, managing field and lab contractors, and auditing field work. The reporting task assumes 4 weeks of work for SFEI senior scientists to prepare a report.

Subcontract Costs

Subcontract costs are based on quotes received from contractors. Field cost estimates were based on an estimate provided by Moss Landing Marine Labs, assuming all sampling would occur in summer 2015, concurrent with their efforts to sample for the National Coastal Condition Assessment.

It will be necessary to change laboratories for the PCB analyses. EBMUD has performed the sediment analyses for PCBs in recent years but is not planning to continue this type of work. Therefore, an extra \$7,200 has been allocated to complete a small interlaboratory comparison study to ensure for consistency with past results.

Direct Costs

The budget estimates the cost for supplies, travel, and shipping of samples to laboratories and the RMP archive.

Reporting

After the completion of the scheduled first round of samples (all 40 in Central Bay) these results will be formalized in an RMP technical report. The report will address two of the four high priority information needs:

- Ambient concentrations of PCBs and other contaminants in sediment in the margin areas. This information will facilitate setting achievable targets for restoration and/or load reductions.
- Screening for the existence of additional hotspots in areas that have not been sampled to date

A preliminary review of the data and lessons learned will be presented to the TRC in March 2016. A draft report on the study will be produced in October 2016, with December 2016 as the target due date for final report.

Information for addressing the other two priority needs (mass balance, and tracking of watershed management impacts) will be provided through other (generally more deterministically sited) studies and will not likely be ready at the time of reporting for this study. However, data from this study may help guide ongoing and future efforts in deterministically focused studies. Raw data from this sampling effort will also be reported via RMP web tools (cd3.sfei.org) and can be used for other purposes.

References

Jones C, Yee D, Davis JA, McKee LJ, Greenfield BK, Melwani AR, Lent MA. 2012. Conceptual Model of Contaminant Fate on the Margins of San Francisco Bay. SFEI Contribution 663. San Francisco Estuary Institute, Richmond, CA.
http://www.sfei.org/sites/default/files/663%20Complete_Margins%20Conceptual%20Model.pdf

Table 1: Budget for Bay Margins Sediment Study

Note: Field costs assume that all 40 stations in Central Bay are visited in 2015.

	Tasks		
	Planning (2015)	Field Work (2015)	Reporting (2016)
Labor			
Project Staff	\$15,600	\$13,000	\$26,500
Senior Management Review	\$3,300	\$1,550	\$3,300
Project Management	\$0	\$0	\$0
Contract Management	\$0	\$0	\$0
Data Technical Services	\$0	\$25,000	\$0
GIS Services	\$1,100	\$620	\$1,300
Creative Services	\$0	\$0	\$0
IT Services	\$0	\$0	\$0
Communications	\$0	\$0	\$0
Operations	\$0	\$0	\$0
Subcontracts			
Contractor for field sampling		\$74,000	
Lab for grain size and ancillary		\$11,000	
Lab for Hg/MeHg and TE		\$30,000	
Lab for PCBs		\$37,000	
Lab for PAHs		\$0	
Interlab Comparison for PCBs		\$7,200	
Direct Costs			
Supplies		\$4,000	
Equipment		\$0	
Travel		\$500	
Printing		\$0	
Shipping		\$2,500	
Other		\$0	
Total for Task	\$20,000	\$206,370	\$31,100
GRAND TOTAL			\$257,470
Budget			\$260,000
Budget consists of:	\$20,000 planning task in 2015 (approved)		
	\$120,000 sampling task in 2015 (approved)		
	\$120,000 sampling task in 2016 (requested)		