PCB Workgroup 2020 Proposal #2: PCB Loading and Distribution in the Steinberger Slough/Redwood Creek Complex

Summary: This study would assess the loading and spatial distribution of PCBs in the Steinberger Slough/Redwood Creek (SS/RC) Priority Margin Unit (PMU) to address information gaps in the conceptual model for this area and establish baseline data for evaluating the response of these receiving waters to load reduction efforts in the watershed. In this first phase of work in 2020, passive sampling devices (PSDs) will be deployed at eight locations to assess spatial patterns in dissolved PCBs in porewater and surface water, providing information on spatial patterns in current biotic exposure. In addition, analysis of depth profiles of porewater with PSDs, accompanied by bulk sediment chemistry in cores from two locations, will provide information on the chronology of loading and exposure over the past 50 years.

Proposed Funding: $91,000 from RMP ($60,000 in-kind from Stanford)

Oversight group: PCB Workgroup

Proposed by: Diana Lin and Don Yee, SFEI
Yeo-Myoung Cho and Dick Luthy, Stanford University

Time Sensitive: Yes. Planning is underway for management actions in the watershed, so there is urgency to establishing baseline conditions in this multi-phase study. Also, the match from Stanford is available now, but may not be in the future.

Proposed Deliverables and Timeline

Deliverable	Due Date
Draft technical report	May 2021
Final technical report	August 2021

Introduction and Background

The objective of this study is to assess the loading and spatial distribution of PCBs in the Steinberger Slough/Redwood Creek (SS/RC) Priority Margin Unit (PMU) to address information gaps in the conceptual model for this area (Davis et al., 2017). The overarching goal of RMP PCB studies in PMUs is to establish a conceptual foundation and baseline data to evaluate the response of these nearshore environments to reductions in PCB loading from adjoining watersheds. SS/RC is of particular interest due to active management of PCB source areas in the Pulgas Pump Station South watershed and at the Delta Star property. Passive sampling device (PSD) measurements will complement sediment measurements to evaluate the spatial pattern of PCB concentrations in the surface and subsurface sediment. The study would provide information on current spatial patterns in

PCB availability (which may provide insights on present patterns of loading) and long-term trends in loading from the tributaries to SS/RC. A secondary goal of this study is to demonstrate the logistical and technical advantages of PSD field sampling and analysis compared to sediment sampling and analysis. This study will also directly compare PSD measurements with sediment measurements. Additionally, PSD measurements will be correlated with fish tissue measurements planned for the following year.

PSDs have been developed to measure the freely dissolved water concentration (C_{free}) of nonpolar organic compounds (Log K_{ow} > 4). While C_{free} has been demonstrated to be a better scientific basis for risk assessment compared to conventional sampling and monitoring procedures, use of PSDs for regulatory monitoring has been limited (Booij et al., 2015). One main obstacle is that water quality standards and discharge permits are established on the basis of total water or sediment concentrations or biota tissue concentrations, which are different from C_{free} measured by PSDs. Another obstacle is real and perceived uncertainty in measurements. The greatest source of uncertainty in C_{free} measurements is uncertainties in the sampler-water partition coefficients and kinetic uptake rates measured in the field. All of these are challenges that are currently being addressed by the scientific and regulatory communities. This study will represent a practical application of the use of PSDs for San Francisco Bay monitoring and measure site-specific parameters that may be relevant for the region.

Study Objective and Applicable RMP Management Questions

The objective of this study is to examine PCB loading and spatial patterns in the SS/RC PMU through the use of PSDs and sediment cores. This study would address, or contribute to addressing, the following management questions articulated in the PCB Strategy.

1. What are the rates of recovery of the Bay, its segments, and in-Bay contaminated sites from PCB contamination?
2. What are the present PCB loads and long-term trends in loading from each of the major pathways?
4. Which small tributaries and contaminated margin sites are the highest priorities for cleanup?
5. What management actions have the greatest potential for accelerating recovery or reducing exposure?
6. What are the near-term effects of management actions on the potential for adverse impacts on humans and aquatic life due to Bay contamination?

The study would also address the overarching RMP management questions that are related to these PCB management questions.

Approach

Eight passive sampling devices, equipped with low density polyethylene film (LDPE), will be deployed along the intertidal shoreline and shallow subtidal areas of SS/RC to measure the porewater concentration profile at depth (Figure 1). The goal is to evaluate:

1) PCB concentration profiles along the shoreline to evaluate contaminant transport (relative loadings from two stormwater discharge areas, and/or additional unidentified discharges, sediment deposition zones, and sediment resuspension and mixing);
2) Changes in historical loadings from the local watersheds;
3) Evaluate potential PCB sources at depth, such as historical deposits or groundwater leaching.
4) Estimate surface water PCB concentrations (for locations which are subtidal)
5) Compare measured C_{free} concentrations with planned subsequent fish study measurements at co-located sites to evaluate the use of PSD measurements to measure the bioavailability of PCBs as a surrogate for fish measurements.

PSDs will be deployed at the first five locations listed below; additionally, two sediment cores co-located with PSDs will be collected at the first two of these sites (Figure 1). Additionally, Stanford will deploy PSDs at the last three locations as in-kind support for the project. Sampling sites are listed in order of priority.

1) Steinberger Slough near the entry of Pulgas Creek
2) Steinberger Slough near the entry of SMC_unk15 (urban watershed around Holly Street/Industrial Road, San Carlos)
3) Steinberger Slough approximately midway between #2 and South Bay shoreline
4) Redwood City marina
5) Redwood Creek backwater near Seaport Blvd/Highway 101
6) Detention pond SMC_unk15
7) Redwood Creek midway to South Bay shoreline
8) Westpoint

Location #7 may not be accessible from a shore approach, as much of the southeast bank of Redwood Creek is developed commercial parcels, with armored shorelines and industrial loading piers. The shoreline is developed and armored in many areas along the southeast shore of Redwood Creek, and many locations in the area are periodically dredged to allow vessel navigation, so locations with predictable long term sedimentation may be difficult to locate. Nonetheless, PSDs in these latter locations may still be useful for their estimates of water and near-surface sediment PCBs, even if their deeper layers are of unknown age and origin.

PSD depth profiles offer a few advantages relative to sediment cores. As thin plastic films, the film can be sectioned at smaller intervals more precisely than sediment cores, and can be analyzed to consistent 1 cm intervals. Also, with PSDs attached to steel plates, samplers are often easier to deploy and more robust compared to an intact sediment core. Contaminant extraction is also simpler with the LDPE film compared to sediment. A limited set of sediment core sections will be analyzed to correlate sediment measurements

with porewater measurements. Five sediment sections from each core will be analyzed to correlate porewater measurements with sediment chemistry. Sediment concentrations are expected to correlate well with porewater measurements if sediment organic carbon and black carbon content are consistent at depth. Sediment core samples will also be analyzed for grain size distribution, total organic carbon (TOC), total solids since these factors are important to the partitioning behavior of contaminants in water and sediment.

Each porewater profile will be analyzed in sections, and to a depth of 30-60 cm. The surface sections will be analyzed at finer resolution of 1-2 cm, with coarser sections at lower depths. A 2 cm section is estimated to represent approximately 10-years resolution based on assuming 2 mm/year deposition rate. PSDs will be deployed with performance reference compounds to measure kinetic uptake rate of PCB contaminants. Co-located sediment cores will be extracted to a depth of 30-60 cm, depending on feasibility. The budgeted analytical cost is based on an analyzing 50 PSD sections, for approximately 10 sections per PSD.

This study is envisioned as part of a larger overall effort to address data gaps for the SS/RC area. Studies proposed for implementation in 2021 include a survey of surface sediment and a survey of prey fish. Locations of all proposed sampling stations are shown in Figure 2. Measured C_{free} concentration in the overlying water and porewater will be compared to fish tissue concentrations measured in subsequent survey of prey fish. Additionally, C_{free} measurements from this study may be useful as a baseline comparison to subsequent studies designed to evaluate trends from management actions in the vicinity.

Budget

Sample Collection

Field sampling will be led by Stanford University, who will provide PSD equipment, and deploy and retrieve PSDs. Sediment cores will also be collected by Stanford University. Estimated sub-contract costs for field sampling activity including use of equipment and labor is estimated to be $12,000. SFEI staff hours are estimated to obtain necessary permits from agencies and to assist with field sampling ($12,000). Additionally $1,000 of direct costs are estimated for shipping sediment samples to SGS AXYS for analysis.

Laboratory

Analytical cost for analysis of LDPE samplers is $46,000, which is based on an estimated $920/sample for fifty LDPE samplers (Stanford University). Analytical cost for analysis of sediment samples is estimated to be $965/sediment sample (PCBs by AXYS SGS; grain size, TOC, and total solids by ALS). Ten sediment core sections are expected to cost $10,000 (10 sediment samples x $1,000) – this could potentially be covered under the 2021 budget to keep the overall amount needed from RMP in 2020 to the $80,000 guidance level from the Steering Committee.

Reporting

Yeo-Myoung Cho of Stanford will be the lead author for the report. Drs. Cho and Luthy's time spent on report writing will be an in-kind contribution from Stanford. SFEI staff will be coauthors (50 hours, $10,000).

Matching Funds from Stanford

In addition to the in-kind contribution from Stanford for report preparation ($20,000), other in-kind contribution items include: 1) field equipment and samplers (~1K), 2) sediment core processing (~2K), and 3) Stanford's additional PSD sampling (minimum 3 additional PSD devices) and sediment sampling and analysis ($37,000). The overall amount of matching funds is estimated to be at least $60,000.

Amount from RMP:	**$91,000**
In-kind from Stanford:	**$60,000**
Total Budget	**$151,000**

Figure 1. Proposed locations of PSDs (white cylinders) and sediment cores (yellow cylinders). Numbered sampling sites are as follows: 1) Steinberger Slough near the entry of Pulgas Creek; 2) Steinberger Slough near the entry of SMC_unk15 (urban watershed around Holly Street/Industrial Road, San Carlos); 3) Steinberger Slough approximately midway between #2 and South Bay shoreline; 4) Redwood City marina; 5) Redwood Creek backwater near Seaport Blvd/Highway 101; 6) Detention pond SMC_unk15; 7) Redwood Creek midway to South Bay shoreline; 8) Westpoint. Orange cylinders represent surface grab samples planned for subsequent sampling effort. Fish sampling is planned for locations 1, 3, 4, 5, and 7 during subsequent sampling effort along with surface grab samples. Yellow open circles are proportional to PCB concentrations in sediment from previous analysis. Red line represents generalized split in water flow to the east (Steinberger Slough) and west (Redwood Creek).