



## RMP Sources, Pathways and Loadings Workgroup Meeting

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## Dr. Barbara June Mahler

January 26, 1959 - April 29, 2023



Barbara joined the San Francisco Bay Regional Monitoring Program Sources Pathways and Loading Workgroup as an expert advisor on urban runoff contamination and loads in 2006 and gave us reliable and sound advice and review for 15 years until a terrible car accident in April 2021 left her critically injured and her husband, Peter Van Metre, deceased. Sadly her fight for recovery ended a few weeks ago at the age of 64 when she passed away from illnesses associated with the car accident. We will fondly remember you, Barb. Thanks for your support, enthusiasm, insightful critique, and goodhearted nature. We have enjoyed every moment of it all.

Barbara began working at the USGS in 1997 and since then had published over 170 USGS reports and journal articles. She has been cited 5500 times, with 16 articles cited over 100 times, with one article published back in 2000 "[Urban sprawl leaves its PAH signature](#)" being cited 600 times. Her favorite part of her job was "the process of detecting a pattern in data and figuring out how to convey that, of crafting a journal article to make the scientific findings come alive." Barbara presented at two Congressional briefings, was repeatedly featured in media outlets, and consequently was recognized in 2017 with a DOI Meritorious Service Award.

What a gem - the San Francisco Bay science and management community will miss you, Barb, and hold you in our memories always.



## RMP Sources, Pathways and Loadings Workgroup Meeting

May 23, 2023 09:00 AM – 3:00 PM

### HYBRID MEETING

#### In Person

In-person: First floor conference room at SFEI

#### Remote Access

Join Zoom Meeting <https://us06web.zoom.us/j/86843748002>

Meeting ID: 868 4374 8002

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### AGENDA

1.	<p><b>Introductions and Goals for This Meeting</b></p> <p>The goals for this meeting:</p> <ul style="list-style-type: none"> <li>• Provide the Water Board and Permittee perspectives on the SPLWG management questions</li> <li>• Provide updates on recent and ongoing SPLWG activities</li> <li>• Inform group of project proposals in other workgroups that relate to SPLWG</li> <li>• Discuss SPLWG proposals for the next fiscal year</li> <li>• Recommend which special study proposals should be funded in 2023 and provide advice to enhance those proposals</li> </ul> <p>Meeting materials: 2022 SPLWG Meeting Notes pages 45-84</p>	<p>09:00 Jay Davis</p>
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<b>2.</b>	<b>Information: SPLWG Stakeholder Perspectives (Placeholder)</b>  Water Board briefing on its schedule, plans and data needs for the upcoming TMDL reviews for PCBs and Mercury. Water Board and Municipalities briefing on the management and support needs from SPLWG.  Desired Outcome: Informed Workgroup	09:15 Richard Looker, Chris Sommers
<b>3.</b>	<b>Information: Strategy and Management Questions Review and Upcoming Update</b>  The SPLWG is currently undergoing a transition from a focus on monitoring and modeling legacy pollutants towards a greater focus on a more integrated monitoring and modeling approach. In light of this transition and the release of the new Municipal Regional Permit, it is an important time to revisit the guiding strategy and management questions for the workgroup. This revision process was funded in 2023 and the workgroup will hear the progress for revision.  Meeting material: Proposed management questions update Desired Outcome: Informed Workgroup, consensus on updated management questions	09:35 Alicia Gilbreath
	10 minute break	10:50-11:00
<b>4.</b>	<b>Scientific Update: Watershed Dynamic Model (WDM) Development to Support Watershed Loads</b>  The workgroup will hear the progress of the multi-year WDM modeling project. The WDM update is mainly about the phase three POC (PCBs and Hg as pilots) modeling progress and the linkage of the WDM development to the integrated watershed-Bay modeling strategy.  Desired Outcome: Informed Workgroup; feedback on modeling design and modeling strategy.	11:00 David Peterson, Kyle Stark, Tan Zi
<b>5.</b>	<b>Scientific Update: Stormwater Monitoring Activities</b>  RMP stormwater monitoring activities in Water Year 2023 included monitoring for legacy pollutants (PCBs and Hg) at flow gauges to support modeling, monitoring for PCBs in watersheds that discharge to priority margin units, and monitoring for suspended sediment at four gauging stations to support sediment loads modeling for the region. WY 2023 was a very wet year and the RMP team successfully sampled at several sites during several storm events. Midway through the season the stormwater team requested additional funds to be used contingent on additional large storms. Using this funding, one additional storm was sampled at one of the flow-gauged sites. Another major stormwater monitoring activity included the development and pilot testing of a remote sampler. Based on an original design by the EPA, the SFEI RMP stormwater team modified and field-tested a remote sampler suitable for use in tidal areas.  In this presentation, the SPLWG will hear about the stormwater monitoring accomplished over the season as well as about the development of the remote sampler, the test deployments, the challenges encountered and solutions developed, as well as recommended improvements for the future.  Meeting material: Links of pre-recorded presentations and slides Desired Outcome: Informed Workgroup, feedback on next steps of tidal remote sampler	11:40 Alicia Gilbreath, Don Yee
	Lunch (45 minutes)	12:00-12:45

<b>6.</b>	<b>Summary of Proposed SPLWG Studies for 2024</b>  The SPLWG science leads will present the proposed special studies. Clarifying questions may be posed, however, the workgroup is encouraged to hold substantive comments for the next agenda item.  2024 RMP SPLWG Special Study proposals include: <ul style="list-style-type: none"> <li>• Tidal area remote sampler development</li> <li>• PCB/Hg monitoring and modeling</li> <li>• Canine PCBs detection</li> </ul> 2024 general RMP proposals: <ul style="list-style-type: none"> <li>• Remote sampler purchase</li> <li>• WDM model maintenance</li> </ul> Meeting materials: 2024 Special Studies Proposals, pages 6-44	12:45 Alicia Gilbreath, Kelly Moran, Tan Zi
<b>7.</b>	<b>Discussion of Recommended Studies for 2024 - General Q&amp;A, Prioritization</b>  The workgroup will discuss and ask questions about the proposals presented. The goal is to gather feedback on the merits of each proposal and how they can be improved. The workgroup will then consider the studies as a group, ask questions of the Principal Investigators, and begin the process of prioritization by stakeholders.  Desired Outcome: Clarify questions answered by scientific leads.	1:30 Jay Davis
	10 minute break	2:10 - 2:20
<b>8.</b>	<b>Closed Session - Decision: Recommendations for 2024 Special Studies Funding</b>  RMP Special Studies are identified and funded through a three-step process. Workgroups recommend studies for funding to the Technical Review Committee (TRC). The TRC weighs input from all the workgroups and then recommends a slate of studies to the Steering Committee (SC). The SC makes the final funding decision. For this agenda item, the SPLWG is expected to decide (by consensus) on a prioritized list of studies to recommend to the TRC. To avoid an actual or perceived conflict of interest, the Principal Investigators for proposed special studies are expected to leave the meeting during this agenda item.  Desired Outcome: Recommendations from the SPLWG to the TRC regarding which special studies should be funded in 2024 and their order of priority.	2:20 Chris Sommers
<b>9.</b>	<b>Report Out on Recommendations</b>	2:50 Chris Sommers
	<b>Adjourn</b>	3:00

## 2024 SPLWG Proposals

For 2024 funding, we are requesting your consideration of five proposals summarized in the table below and detailed more fully in the following pages of this agenda package. The first proposal is the continuation of the work group's primary efforts to monitor and model PCB and Hg loads to the Bay. The second and third studies both propose testing novel methods for PCB source area identification through the use of remote samplers that are suitable for deployment in tidal areas as well as by using dogs for scent detection. Recognizing the many challenges and limitations, and expense associated with mobilizing field crews for manual stormwater sampling, the fourth proposal requests funds to build a set of automated remote samplers for RMP stormwater monitoring work primarily intended to support the growing CECs stormwater monitoring program. And finally, we request your consideration for funding the ongoing maintenance of the Watershed Dynamic Model. Funding for these last two proposals is being requested from the RMP but not as a special study. At the end of the SPLWG meeting on May 23rd, attendees will have the opportunity to discuss the merits of these proposals and rank them without the principal investigators in the room.

Proposal Title	Funding Request	Description	Pgs
1) Integrated Monitoring and Modeling to Support PCBs and Mercury Watershed Loads Uncertainties Assessment and Monitoring Design	\$261k - \$382k	Continue integrated monitoring and modeling efforts on PCBs and Hg by conducting stormwater monitoring to support loads estimation, estimating model uncertainty, evaluating model sensitivities to parameters and data gaps, and providing PCBs and Hg monitoring design recommendations. There are two phases proposed. Addresses all five Management Questions (MQs).	7 - 14
2) Pilot Study Using a Detection Dog Team for Source Tracing of PCBs in Old Industrial Areas of the San Leandro Bay Watershed	\$77k	Assess the feasibility of working with a detection dog to identify areas of high PCB concentrations in old industrial areas of the San Leandro Bay watershed. During a 2-week pilot deployment, SFEI will collect soil/caulking samples where the detection dog indicates elevated PCBs. Will provide insights into the validity of using this approach. Directly addresses MQ4 by identifying areas and properties with elevated PCBs for management action.	15 - 25
3) Tidal Area Remote Sampler Pilot - Year 2	\$62k	Deploy the SFEI Mayfly - a remote sampler that addresses the challenges of sampling in tidal areas - at eight sites to capture water samples for PCB and Hg analysis. Will solidify our experience in field deployment of these samplers and an SOP will be developed to transfer to the municipalities. Primarily addresses MQ1.	26 - 31
4) Remote Sampler Purchase	\$180k	Funds the purchase of remote samplers for RMP stormwater work to support CECs monitoring in Bay Area watersheds and urban runoff monitoring in tidal zones. This proposal is a placeholder until this summer, when the Stormwater CECs Stakeholder-Science Advisor Team (SST) will decide on whether to use the SFEI Mayfly, the ISCO, or neither. Sampler purchase/construction will be done under the oversight of the SST.	31 - 37
5) Watershed Dynamic Model (WDM) Maintenance	\$50k/yr	Funds maintenance of the Watershed Dynamic Model (WDM). Provides a list of tasks that can be done with the maintenance fund and proposes a process to decide on which of the maintenance activities and documentation are needed each year.	38 - 44

# SPLWG Special Study Proposal: Integrated Monitoring and Modeling to Support PCBs and Mercury Watershed Loads Uncertainties Assessment and Monitoring Design

**Summary:** The Sources, Pathways, and Loadings Workgroup (SPLWG) has done extensive work on the design and implementation of modeling and monitoring techniques to support estimates of stormwater flows, suspended sediment (SS), and contaminant concentrations and loads in the local tributaries that ring the Bay. The RMP has monitored stormwater throughout the region over the last 20+ years, providing the foundational data to support watershed model development. With the recent development of the Watershed Dynamic Model (WDM), flow, suspended sediment, and PCBs and Hg loads from local tributaries can be estimated at an hourly scale. The SPLWG is now building an integrated modeling and monitoring framework to further address the PCBs and Hg management questions, such as the PCB TMDL reconsideration planned for 2028. This proposal is for funding in 2024 and 2025 for the integrated monitoring and modeling activities for PCBs and Hg. In this study, we propose to: continue the second year of a two-year monitoring study to support the PCBs and Hg loads estimation, estimate model uncertainties, determine model sensitivities to parameter and data weaknesses, and provide PCBs and Hg monitoring design recommendations. The outcomes are envisioned to also provide an improved structure as a starting point for monitoring and modeling any future contaminant of interest.

**Estimated Cost:** \$261K for Phase 1 (2024); \$121K for Phase 2 (2025); \$382K for Phase 1 + Phase 2

**Oversight Group:** SPLWG

**Proposed by:** Pedro Avellaneda, Alicia Gilbreath, Tan Zi, and Lester McKee (SFEI)

**Time Sensitive:** No

## Proposed Deliverables and Timeline

Deliverable	Completion Season (Phase 1)	Completion Season (Phase 1 + Phase 2)
Wet season 2024 samples collected and sent for lab analysis	04/2024	04/2024
Laboratory analysis, QA, & Data Management	09/2024	09/2024
Draft integrated monitoring and modeling Phase 1 report	12/2024	12/2024
Final Phase 1 report	03/2025	03/2025
Draft Phase 2 report	-	12/2025
Final Phase 2 report	-	03/2026

## Background

The San Francisco Bay TMDLs call for a 50% reduction in Hg loads by 2028 and a 90% reduction in PCB loads by 2030, respectively. To implement these TMDLs, the Municipal Regional Permit for Stormwater (MRP) (SFRWQCB, 2009; 2015; 2022) called for the implementation of control measures to reduce PCB and Hg loads from urbanized tributaries. The MRP has also identified additional information needs associated with improving understanding of sources, pathways, loads, trends, and management opportunities for contaminants. In response to the MRP requirements and information needs, a set of management questions (MQs; see Table 1) have been used to guide RMP and regional stormwater-related monitoring and modeling activities.

Over the past two decades, the SPLWG and Bay Area Municipal Stormwater Collaborative (BAMSC) have focused on answering MQs 1, 2, and 4 in relation to PCBs and Hg, mainly based on an intensive field-based monitoring approach, and identifying watersheds exhibiting high relative concentrations to help prioritize areas for greater management focus. In recognition of the need to answer MQ3 (How are loads or concentrations of POCs from small tributaries changing on a decadal scale?), starting in 2019, the regional Watershed Dynamic Model (WDM) has so far been developed for hydrology (Phase 1) and sediment (Phase 2) simulation with load modeling of PCBs and Hg (Phase 3) being completed presently. Future applications of the WDM could also be developed to provide a mechanism for evaluating the potential for management actions and management impact on future pollutant loads or concentrations in support of MQ5.

Whereas in the past we have relied on collecting empirical data to estimate loads to the Bay margins and Bay food web, going forward we plan to use an integrated modeling-monitoring approach to address management questions more effectively. Monitoring design driven by modeling needs can lead to more accurate, efficient, and effective modeling, thus improving decision-making. However, the datasets to support a robust model calibration of PCBs and Hg for the Bay Area need improvement. To help verify the WDM load estimation to the Bay from local watersheds over time, a two-year monitoring study was proposed and funded in 2022 to collect load monitoring data (data with both concentration and flow rate) from three watersheds. The monitoring data from these three watersheds will help to fill the data gaps in two ways: PCB samples at Guadalupe River will extend the time series at that location, which will be used to support the temporal aspect of model calibration and explore temporal trends, and samples collected at Arroyo Corte Madera del Presidio and Walnut Creek will fill the spatial calibration weaknesses in the present model. The first year of the monitoring study was approved in summer 2022 and sampling was conducted at the three watersheds during water year (WY) 2023. We propose to continue the second year of load monitoring in WY 2024.

The WDM Phase 3 work - estimating PCBs and Hg loads from local tributaries - will be completed in 2023. However, the WDM is currently calibrated against the loading data of PCBs and Hg from only seven sampled watersheds, representing less than 5% of the modeling domain for PCBs, and less than 0.5% for Hg. Improving the spatial representation with additional data collected in this proposed monitoring task will improve the calibration and decrease the degree of uncertainty. Even with this additional data, however, uncertainty in the

PCBs and Hg load estimation will remain. In the case of PCBs, with a reconsideration of the PCBs TMDL planned for 2028, a new robust estimate of PCB load and quantified model uncertainties are needed to link management effort with load reduction progress and to link to the enhanced in-Bay fate modeling that is also being conducted under guidance from the PCB Workgroup. To better assess the uncertainty of PCB load estimation and provide recommendations for monitoring design to reduce uncertainty, a Monte Carlo simulation-based uncertainty study is proposed for 2024. The WDM will also be used to evaluate different monitoring designs. The integrated effort proposed here is a pilot study to use the WDM to guide monitoring design in order to reduce uncertainties of load estimation. The workflow, method and tools we hope to develop in this study for PCBs and Hg, can be modified and refined for a broader use in the future.

## Study Objectives and Applicable RMP Management Questions

The proposed monitoring effort will provide load monitoring data to fill spatial gaps and to extend existing load monitoring time series. The pilot uncertainty analysis study will quantify the prediction uncertainty associated with PCB and Hg loads estimated by the WDM and evaluate different monitoring designs and parameter sensitivities to answer following questions:

1. What model parameters contribute greatest to model uncertainties?
2. What is the uncertainty of WDM load estimation?
3. What is a suggested monitoring design to reduce uncertainties and support load estimation?

This proposed work is a pilot study to support an integrated monitoring and modeling strategy. The WDM can be used to assess monitoring strategies and quantify how informative they are for load estimation. We anticipate that the workflow, methods, and tools developed in this study can be applied to other contaminants in the future.

The objectives of the project and how the information will be used are shown in Table 1 relative to the SPLWG high-level management questions.

**Table 1.** Study objectives and questions relevant to SPLWG management questions.

Management Question	Study Objective	Example Information Application
Q1: What are the loads or concentrations of Pollutants of Concern (POCs) from small tributaries to the Bay?	Use paired load sampling to support load estimation. Modeling analysis provides uncertainty estimates of the load predictions from WDM.	The model will produce an estimate of PCBs concentrations and loads at selected watersheds with uncertainty ranges.
Q2: Which are the “high-leverage” small tributaries that contribute or potentially contribute most to Bay impairment by POCs?	Provide modeled load from different tributaries to in-Bay transport and fate model to evaluate the contribution from different tributaries	The model can provide tributary loadings to priority margin units for the in-Bay model to simulate the contaminant transport and fate at those regions.
Q3: How are loads or concentrations of POCs from small tributaries changing on a decadal scale?	Uncertainty analysis of the load estimation will help quantify the possible ranges of load estimation.	Model outputs of PCBs (load and uncertainties) can help us understand the uncertainty of trend estimation.

Management Question	Study Objective	Example Information Application
Q4: Which sources or watershed source areas provide the greatest opportunities for reductions of POCs in urban stormwater runoff?	Understanding uncertainties caused by land-use relevant parameters can help with the source area identification.	The model uncertainty caused by land use relevant parameters can be used to assess the uncertainties of yield simulation from source areas.
Q5: What are the measured and projected impacts of management action(s) on loads or concentrations of POCs from small tributaries, and what management action(s) should be implemented in the region to have the greatest impact?	Understanding uncertainties caused by land-use relevant parameters can help with the management action effectiveness evaluation.	The model uncertainty caused by land use and control measure relevant parameters can be used to assess the uncertainties of management effectiveness simulations.

## Approach

### Load Monitoring

Site selection and monitoring design were completed in the first year (WY 2023) of this two-year load monitoring study. Using our standard mobilization criteria and discrete sampling methods for load evaluation (collecting one or two samples on the rising limb, one at the peak, and one or two samples on the recession limb of the hydrograph for a total of four samples) (Gilbreath et al., 2015), during WY 2023 we collected samples over two storms on Guadalupe River and Walnut Creek, and during three storms on Arroyo Corte Madera del Presidio. WY 2023 was very wet and we were able to sample sizable storms at each location. Arroyo Corte Madera del Presidio was also sampled during the first of the season flush. We propose to continue load monitoring at the three selected watersheds (Guadalupe River, Walnut Creek, and Arroyo Corte Madera del Presidio) in WY 2024. Data with this level of detail can be used to explain the physics of local rainfall-runoff based sediment transport and contaminant buildup and washoff processes, and verify the representations of those processes in the WDM.

Water samples will be analyzed for PCBs, Hg, and SSC. SGS AXYS Analytical will analyze for PCBs, Brooks Applied Laboratories will analyze for Hg, and SFEI will analyze the water samples for SSC. We have long experience working with these laboratories and expect the data to be high quality.

### Load Modeling Uncertainty Analysis

The Watershed Dynamic Model (WDM) has been calibrated using monitoring data at several locations around the region; however, uncertainties of model predictions such as streamflow and suspended sediment load (SSL) are unavoidable. This uncertainty is due to lack of process representation, poor initial boundary conditions, measurement errors, uncertainties in parameter choices, and, as mentioned above, the limited nature of the calibration data. Estimating uncertainty in the WDM is an important step in assessing the reliability of model predictions and making informed decisions based on model results. There are three key stakeholder questions that need to be resolved. We will perform the analysis in two phases.

1. What model parameters contribute greatest to model uncertainties?

As a first step in the overall uncertainty analysis, we will conduct a sensitivity analysis to identify key model parameters that influence the variation of pollutant loads. For example, a model parameter can be allowed to change within a predetermined range (e.g.,  $\pm 10\%$  of a default value) and the predicted model output summarized by keeping the other parameters fixed. By repeating the process with other model parameters, we will identify the influence of individual parameters on model output and create a prioritized parameter list for uncertainty quantification.

2. What is the uncertainty of WDM load estimation? Having a quantitative understanding of uncertainty ( $\pm A\%$ ) and a qualitative understanding of potential biases (high, low) will improve confidence in the load estimates for decision-making.

We propose to quantify the uncertainty of WDM load estimation by using a Monte Carlo (MC) based method. Two widely applied methods are the Generalized Likelihood Uncertainty Estimation (GLUE; Baven and Binley, 2014) and the Approximate Bayesian Computation (Sadegh and Vrugt, 2014). With the key model parameter list that was developed in Step 1, the Monte Carlo method will deliver a subset of model simulations (e.g., time series for SSL, PCBs, and Hg) that are deemed to be consistent with the observed data. The WDM currently has seven sub-regions. We propose to apply the Monte Carlo simulation method to test one sub-region of the WDM with the best water quality data availability (Phase 1). The subset of model simulations will allow us to estimate pollutant loads and provide an estimate of load uncertainty ( $\pm A\%$ ). Data weaknesses and how they might contribute to low or high bias will be discussed qualitatively.

3. What is a suggested monitoring design to reduce uncertainties and support load estimation? A key outcome of an integrated modeling-monitoring approach to answering management questions is cost efficiency. How does this coupled approach lead to lower longer term costs and more nimble answers to pressing management questions?

There are three sub-questions that will help us answer this key stakeholder question: 1) Did adding additional monitoring on Guadalupe in 2023 and 2024 improve the model calibration for trends through time? 2) Did adding two additional watersheds improve the spatial calibration? 3) In hindsight, even if uncertainties are greater, would similar loads be predicted using fewer watersheds for calibration with fewer water years of data? In the second phase (Phase 2), we will produce two model outputs: 1) estimated pollutant loads considering *only* hydrologic forcing (e.g., rainfall, evapotranspiration) for the WYs 2023 and 2024, and 2) estimated pollutant loads considering the hydrology and water samples collected during WYs 2023 and 2024 which were intended to help improve the temporal and spatial aspects of the model. These two model outputs will allow us to detect differences in estimated pollutant loads (and their range of variation) with and without the additional two-year load monitoring effort. Based on these numerical experiments, we will make recommendations for future monitoring design.

The tasks for the uncertainty analysis include:

### **Phase 1:**

#### 1. WDM modification

Currently, a user of the WDM populates model parameters via its graphical user interface. The source code of the WDM will need to be adapted to facilitate integration with a Monte Carlo based calibration technique. We propose to modify the source code to allow automation of the Monte Carlo simulation process.

#### 2. Uncertainty method and tool development

We propose to identify an appropriate method for uncertainty quantification and develop a tool to integrate the WDM and the uncertainty quantification method.

#### 3. Parameter sensitivity analysis

A sensitivity analysis will be conducted on key modeling parameters to help us identify priority parameters as major contributors to model uncertainties.

### **Phase 2:**

#### 4. Pilot uncertainty quantification

The uncertainty quantification will be applied to a test sub-region of the WDM using a priority parameter list identified in task 3.

#### 5. Model performance evaluation using data from the two year (2023 and 2024) load monitoring campaign

The WDM will produce output (e.g., time series for SSL, PCBs, and Hg) with and without considering monitoring data from the two year load monitoring activities. We will test for any changes in the estimated pollutant loads, and range of variation, due to the newly available dataset.

#### 6. Regional uncertainty quantification

We will apply the uncertainty quantification method to regions not considered in Phase 1.

## **Budget**

The following budget represents estimated costs for this special study (Table 2).

**Table 2.** Proposed budget cost estimates.

	Phase 1 (2024)		Phase 2 (2025)		Phase 1 + Phase 2	
Expense	Hours	Cost (\$)	Hours	Cost (\$)	Hours	Cost (\$)
Uncertainty analysis	480	\$73,200	660	\$92,400	1140	\$165,600
Stormwater monitoring and data management	484	\$71,820			484	\$71,820
Report and scientific communication	279	\$43,870	98	\$15,190	377	\$59,060
Project management and science overview	157	\$26,720	72	\$13,120	229	\$39,840
<b>Subcontracts</b>						
SGS AXYS Analytical, Brooks Applied Laboratories		\$37,000				\$37,000
<b>Direct Costs</b>						
Equipment		\$2,050				\$2,050
Travel		\$2,100				\$2,100
Shipping		\$4,500				\$4,500
<b>Total</b>	<b>1400</b>	<b>\$261,260</b>	<b>830</b>	<b>\$120,710</b>	<b>2230</b>	<b>\$381,970</b>

### Budget Justification

**Labor Costs:** Labor costs include staff time for monitoring and modeling efforts. It will support staff time to conduct fieldwork and data management, develop WDM uncertainty analysis tool, perform calibration/verification, process model results, and write up technical reports; and get technical support from related other parties; and senior staff contributions and review.

**Laboratory Costs:** Up to 30 independent samples will be analyzed each year, including field duplicates and field blanks. Analyses will be conducted for PCBs, mercury, and suspended sediment concentration.

**Data Management Costs:** Data services will include quality assurance and upload to CEDEN.

**Reporting Costs:** Preparation of draft and final reports on the results will be completed.

## **Reporting**

- Presentations at SPLWG meeting
- Draft integrated monitoring and modeling reports for peer review (Phase 1 report for 2024 and Phase 2 report for 2025).
- Final reports (Phase 1 report and Phase 2 report)
- Monitoring data will be made available for the public via CEDEN.
- Model simulation results will be archived in the SFEI server and available upon request.

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# SPLWG Special Study Proposal: Pilot Study Using a Detection Dog Team for Source Tracing of PCBs in Old Industrial Areas of the San Leandro Bay Watershed

## Summary

This pilot study will assess the feasibility of working with a detection dog to identify areas of high PCB concentrations. FieldLab LLC has already proven its PCB detection capabilities in Seattle and Spokane. In this proposed study, RMP staff will support the FieldLab LLC team (Julianne Ubigau and her trained detection dog, Jasper) to survey old industrial areas of the San Leandro Bay watershed. Prior to the survey, we will first analyze available spatial data layers combined with stormwater monitoring data and sediment/soil data for the watershed, and then collaborate with the Water Board and BAMSC to chart a 2-week pilot deployment. During the 2-week field deployment, a RMP field staff will accompany the dog team and when Jasper detects elevated PCBs in street dirt, drop inlets, along properties, or in caulking, SFEI will collect a sample and submit it for PCB analysis. Comparison of detailed field notes of Jasper's positive identifications to sample results will provide insights into the validity of using this approach in the San Francisco Bay region. Based on the prior development, testing, and real-world applications, we anticipate that a number of PCB sources and source areas could be accurately identified.

**Estimated Cost:** \$77k

**Oversight Group:** SPLWG, PCBWG

**Proposed by:** A Gilbreath, J Dougherty (SFEI)

**Time Sensitive:** Yes, because this will provide the pilot test case as proof of concept from which to consider applying for other funding sources next year.

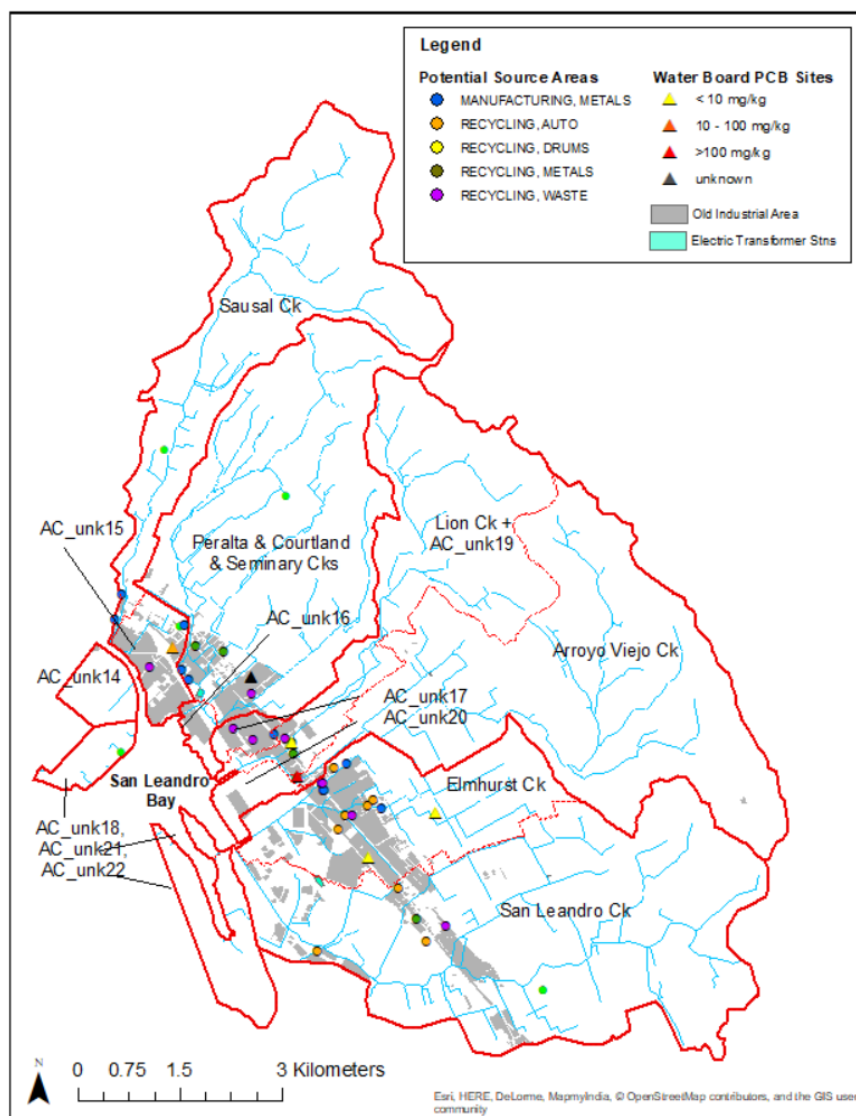
## Proposed Deliverables and Timeline

Deliverable	Due Date
Project mapping and planning in consultation with project collaborators	8/31/2023
Pilot deployment of PCB detection dog team and soil sampling by SFEI	10/31/2023
Presentations to Water Board, BAMSC, and at SPLWG	2/28/2024
Data upload to CEDEN and Draft Report	3/31/2024
Final Report	5/31/2024

## Background

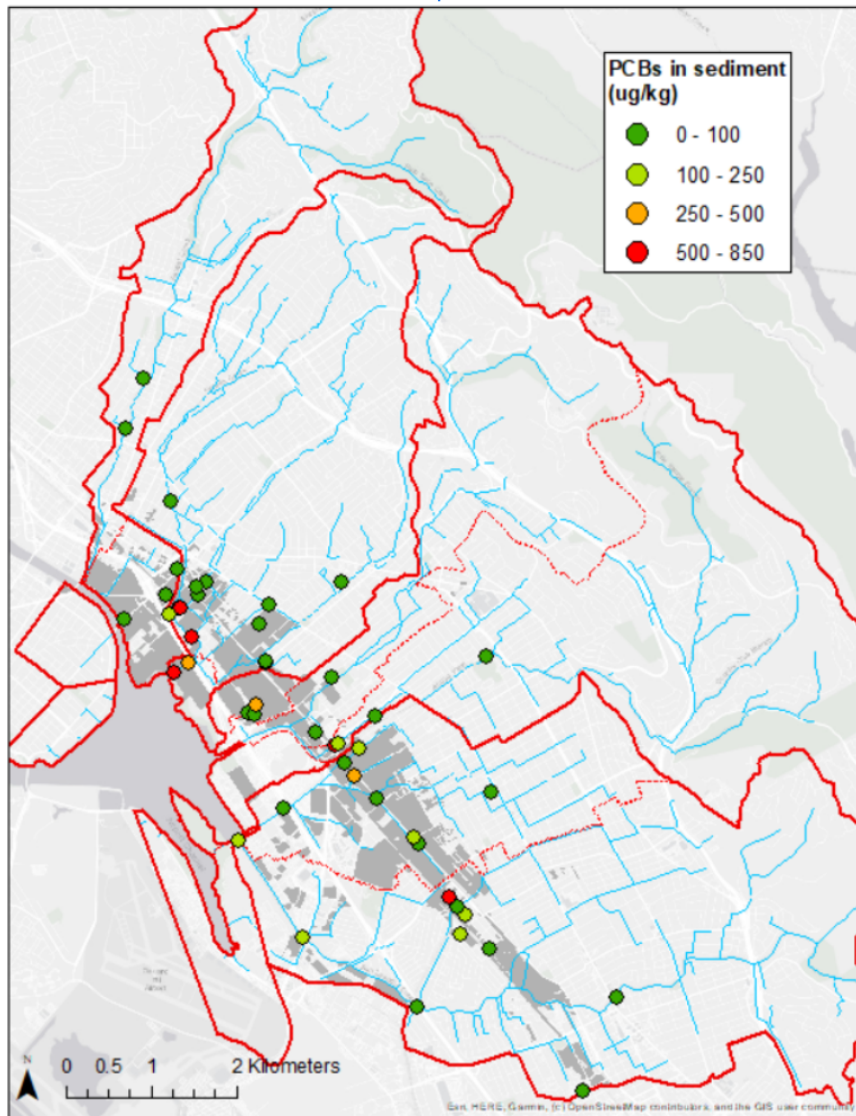
The partially-enclosed San Leandro Bay (SLB) and its margins have been identified as a high priority for management and monitoring based on observations of high concentrations of PCBs in water, sediment, and biota and the potential for interventions to reduce loads in the adjoining watersheds. Since its selection as one of the key Priority Margin Units (PMUs) as part of the RMP PCB multi-year work plan, the RMP has developed conceptual and simple numerical modeling of the SLB PMU to assess how changes in PCB loads from the 83 sq km SLB watershed would affect recovery of the SLB PMU (Yee et al. 2019). It was determined through this process that significant recovery appears to be possible if loads of PCBs were significantly reduced.

Although two major sources of PCBs have been identified in the SLB PMU watershed (including a former General Electric (GE) property and a former Union Pacific Railroad (UPRR) site), finding more properties and areas for clean up remains challenging. Typically in the Bay Area, when we find high concentrations of PCBs, e.g. in street dirt or drop inlets or on properties, it is within an older industrial area. Whereas the region has approximately 3% old industrial area, the SLB watershed has 8.5%, or 7 sq km of old industrial area. Figure 1 shows the watershed area (outlined in red) draining to the SLB and the significant area of old industrial land use (shaded in darker gray and located primarily closer to the Bay).



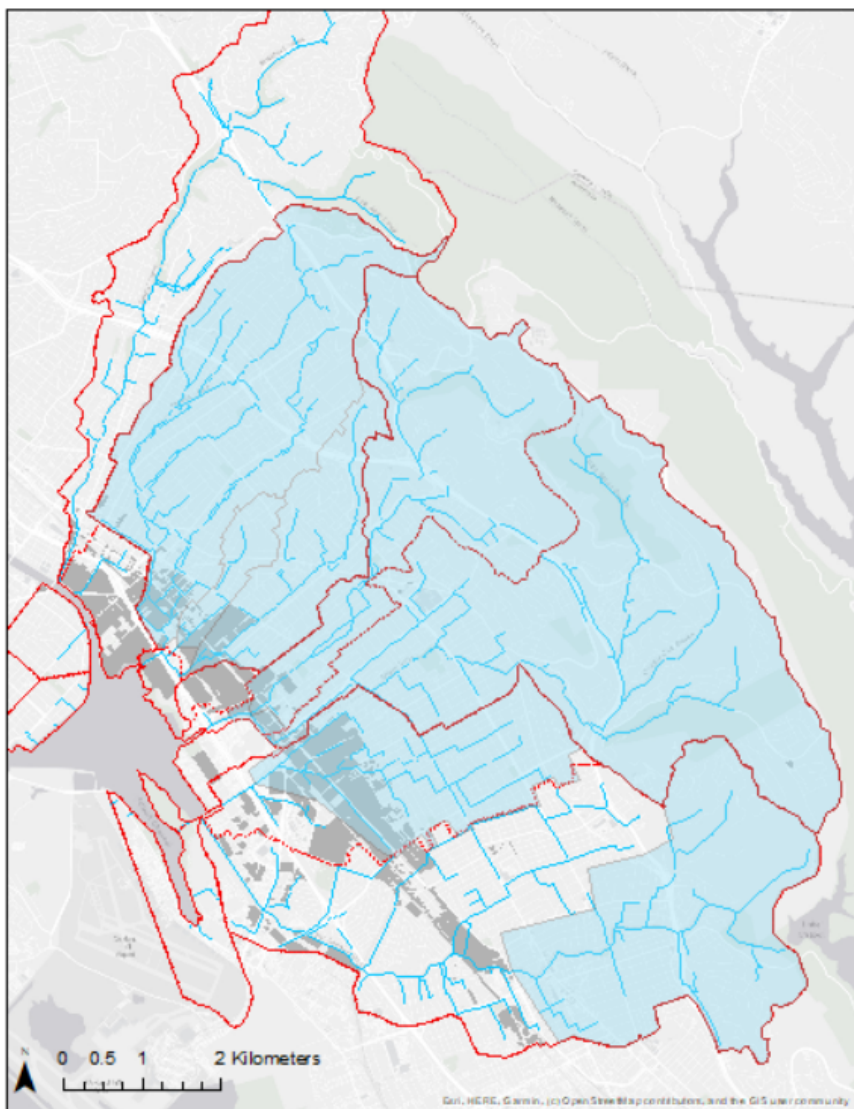
**Figure 1.** San Leandro Bay (SLB) and its watershed (outlined in red). The old industrial area, potential source areas, and properties identified by the Water Board as having high PCBs are included.

Not all old industrial areas have high concentrations of PCBs and it takes significant resources to find locations for management action. As an example of this, 55 PCB soil and sediment samples have been collected previously from creeks, streets, and drop inlets in the watershed (Figure 2). Most of these sampling locations were selected specifically because it was believed that they may have higher concentrations of PCBs. Of the 55 samples, approximately half had concentrations that were below 50 ug/kg and two-thirds had concentrations below 100 ug/kg. A substantial amount of resources went into identifying these sampling locations, collecting the samples, paying for lab analysis, and then analyzing the data, yet many of these samples measured only low or moderate concentrations of PCBs.



**Figure 2.** Sediment and soil sample data collected in the SLB watershed.

As an alternative tool for identifying contaminated areas, we can use stormwater monitoring to try to identify subwatersheds that are elevated in PCBs, and then use that information to go upstream in the watershed to try to find sources. The stormwater monitoring data also may help to identify large areas that are not of particular interest. While this is an important tool, it is extremely challenging to sample downstream of much of the old industrial area because it lies within areas that are tidally influenced from the Bay. This is evident in Figure 3, where the subwatersheds (shaded light blue) have been sampled for stormwater at locations as far down in the watershed as feasible. Much effort went into collecting these samples that were primarily slightly below the tidal interface, and still we were unable to sample below approximately half of the old industrial area in the SLB watershed.



**Figure 3.** Blue shaded areas represent the subwatersheds of the SLB watershed where storm sampling has occurred. As in previous figures, the old industrial area is shown in darker gray.

RMP stakeholders have recently identified a new method to more efficiently hone in on locations with elevated PCB concentrations in the watershed, and improve on both challenges of being able to search below the tidal interface as well as improve the rate at which we measure high concentrations in soil and caulk samples. Although PCBs are generally considered to be odorless, scent detection dogs from FieldLab LLC (Spokane, WA) are able to smell PCBs. The PCB detection method was pioneered in 2016 by Julianne Ubogau and her canine cohort, Sampson, as part of a collaborative project between the University of Washington (UW), Seattle Public Utilities (SPU) and Washington Department of Ecology. Sampson has been trained on more than 20 targets including PCBs.

During the pilot project, dog training was phased. In phase one the dog was exposed to various materials spiked with Aroclor 1254 or 1260 using three different types of placement; in

benches, under screens, and within walls. In phase two, these spiked materials as well as archived samples from SPU were placed in field sites in natural and industrial areas that were free of PCBs to allow the dog to locate placed samples in more realistic scenarios and in varying conditions. Controlled testing was performed to determine if Sampson was able to consistently detect PCBs in various placed media, and to move forward with more realistic training and testing. Sampson correctly alerted in 98% of bench tests, with no false alerts (Windward Environmental LLC, 2017). During testing for phase two which included six trials with 14 total placed samples, Sampson alerted 92% of PCB samples and did not alert for the blanks (Windward Environmental LLC, 2017). Materials for training and testing included; caulk, paint chips, catch basin solids, street dirt, forest soil, clean sand, milk crate, electronics recycler, transformer fluid, coolers, cotton, and wood. Phase three was carried out at sites known to have PCB contamination, so the dog was detecting PCBs in the field. Testing of phase three occurred at 17 industrial sites. In this phase, the dog responses were categorized into none, low, low-moderate, moderate, and strong. These tests provided a sense of Sampson's ability to detect various concentrations of PCBs in field testing environments. Strong responses ranged from 1.17 to 164,100 mg/kg, while moderate ranged 0.023 to 2.65 mg/kg (Windward Environmental LLC, 2017).

Although Sampson was the only detection dog trained for PCB detection as part of the 2016 pilot study, the handlers learned lessons from the study that improved their ability to more quickly train future dogs for PCB detection. The project determined the ability for dogs to reliably detect PCBs at levels as low as 0.1 mg/kg. More importantly, the pilot project demonstrated a clear potential for canines to become a powerful new tool that can streamline PCB source tracing efforts. For example, at one site, Sampson quickly identified a hotspot in soil (63.81 mg/kg) that would have not have been found by SPU investigators without extensive investigation and sampling (Windward Environmental LLC, 2017). Additionally, Sampson allowed for a 57% decrease in sample collection, when compared with 2014 source tracing efforts (Bidwell et al., 2021). They concluded that using the dog PCB-detection team resulted in highly efficient search ability. The team was able to quickly and effectively screen large areas on industrial sites for PCBs, and was successful at both finding sources of PCBs and showing a lack of interest in their absence. Therefore, dog detection can be helpful in three key scenarios; suspected PCB property area search, broad area search, or drainage system mapping. Additional considerations include: ensuring temperatures are between 45°F and 80°F, winds less than 10 miles per hour, and awareness of potential distractions to the canine (*Use of Detection Dog Team for Source Tracing and Source Verification of PCBs: Standard Operating Guideline*, 2023). Today, FieldLab, UW, and SPU continue to work together with a shared mission to optimize pollution source control efforts and help others learn about how they can integrate this new tool into their current management practices.

Jasper is the current detection dog that works with Julianne for identifying PCBs. Jasper and Julianne completed a field survey for SPU in August 2021 in which Jasper identified PCB sites in Spokane including; building exteriors, dry wells, doorways, stormwater drains, gravel banks, water, cinder blocks, and perimeters (Ubigau, 2021). In total over three survey days, Jasper identified 19 sites of interest, including 9 of high interest, six of medium interest and four

of low interest. The team concluded that the source of PCBs was likely from buildings and contaminated soil within the stormwater drainage discharging to a particular outfall and that field testing at those sites should be the next step in the process.

In this proposed RMP study, we will work with Julianne and Jasper to pilot PCB detection in the SLB PMU watershed.

## Study Objectives and Applicable RMP Management Questions

The goal of this project is to pilot the use of scent detection dogs for identification of locations with elevated PCB concentrations. The near-term objectives will be to collaborate with RMP stakeholders to determine the area for investigation by the dog team, and survey that area with the dog team over a 2-week deployment, and collect soil or caulking samples where elevated concentrations are indicated. Based on the prior development, testing, and real-world applications, we anticipate that a number of PCB sources and source areas in the pilot study area will be accurately identified thus providing immediate support for PCB management and load reduction.

**Table 1.** Study objectives and questions relevant to SPLWG management questions.

Management Question	Study Objective	Example Information Application
Q1: What are the loads or concentrations of Pollutants of Concern (POCs) from small tributaries to the Bay?	N/A	N/A
Q2: Which are the “high-leverage” small tributaries that contribute or potentially contribute most to Bay impairment by POCs?	N/A	N/A
Q3: How are loads or concentrations of POCs from small tributaries changing on a decadal scale?	N/A	N/A
Q4: Which sources or watershed source areas provide the greatest opportunities for reductions of POCs in urban stormwater runoff?	Pilot the use of scent detection dogs for identification of locations with elevated PCB concentrations.	Identify areas and properties with elevated PCBs for management action.

Management Question	Study Objective	Example Information Application
Q5: What are the measured and projected impacts of management action(s) on loads or concentrations of POCs from small tributaries, and what management action(s) should be implemented in the region to have the greatest impact?	Indirect, via answering Q4	By identifying locations/areas with high PCBs, we can start to formulate the most effective management action plans to treat or intercept those PCBs from getting to the Bay.

## Approach

A PCB identification and testing approach was developed by FieldLab LLC in a pilot study in Seattle, WA from 2016-2022. This proposed project is an application of the methods developed in that pilot study to locate PCB sources in the SLB watershed. Our goal will be to determine if detection dogs can be incorporated into routine practice to help facilitate PCB source tracing efforts in the Bay Area. This determination will be made by following the approach described in the five tasks below.

Task 1: Conduct a spatial analysis of stormwater and soil samples data within the old industrial areas of the SLB PMU watershed. Using this analysis, SFEI will collaborate with the Water Board and Alameda County Clean Water Program to select priority areas (higher and lower priority) for investigation by the FieldLab team.

Task 2: Develop a project strategy plan with FieldLab based on the priority areas identified in Task 1. The strategy would make a preliminary map of the most efficient sampling site order to maximize coverage.

Task 3: Verify dog and handler readiness and best survey design by conducting field trials at “control site” areas. FieldLab will provide a variety of PCB source materials for controlled testing and refresher-training activities for the dog. For controlled field-site investigations, the RMP team will provide access to areas with known PCB sources. This will occur over 3 to 5 days.

Task 4: Carry out PCB source tracing investigations in the SLB PMU watershed with FieldLab. Over 5 to 7 days, the dog team and RMP staff will complete surveys first in the higher priority areas, followed by the lower priority areas. The team will complete as many of the lower priority areas as possible based on funding and logistical constraints. When Jasper detects elevated PCBs in street dirt, sediment in drop inlets, along properties or in caulking, the RMP staff

member will collect a sample and submit it for PCB analysis for verification. A set of two soil samples will be collected at each dog-identified location for PCB analysis to quantitatively complement the canine insights provided. One sample of the pair collected at each site will be sent to the lab for Aroclor method analysis (EPA Method 8082). The second sample will be archived for potential further analysis using the more robust congener method analysis (EPA method 1668) to allow for source tracing as needed.

Task 5: Compare the analyzed PCB concentrations with information collected from the dog team field surveys from Task 4 and determine if canine detection can streamline the source tracing efforts, making it possible to more effectively identify sources of PCBs in the Bay Area. We will address areas of uncertainty including: the dog handler's assessment of the dog's performance in public areas where distractions may be present, the amount of area that the dog team can cover daily, and the cost effectiveness relative to random sampling methods and/or sampling studies in the past at targeted locations. FieldLab will provide a narrative summary of the detection dog investigations and provide technical reviews for all other reports and protocols regarding this project. In addition to a RMP technical report (draft and final), SFEI will present the findings to the Water Board, BAMSC, SPLWG, and PCBWG in Spring 2024.

## Budget

The following budget represents estimated costs for this special study (Table 2). This study is scalable e.g. instead of deploying the detection dog team for 2 weeks, we could deploy for 1 week only (saves \$6k) or decrease the number of samples collected (saves \$100 per sample). We can also scale up by increasing sample numbers, adding the congener method analysis for a subset of samples out of the archives, or add deployment days.

**Table 2.** Proposed budget.

Expense	Estimated hours	Estimated Cost
<b>Labor</b>		
Project Management, Planning & Collaboration	84	\$12,600
Field Work (field prep, sampling, shipping)	108	\$16,000
Data Management	90	\$12,000
Reporting and Presentations	100	\$15,000
<b>Subcontracts</b>		
Laboratory Analysis; estimated 70 samples		\$7,000
Field Lab LLC (dog detection team)		\$13,600
<b>Direct Costs</b>		
Equipment		\$200
Travel		\$300
Shipping		\$300
<b>Grand Total</b>	382	<b>\$77,000</b>

#### Budget Justification

*Labor Costs:* 382 hours of staff time to manage the project, collaborate on defining the project area, accompany the dog team to collect soil/caulk samples, analyze the data, present to interested parties including the SPLWG in spring of 2024, and to finalize a report.

#### Early Funds Release Request

If this project is approved, we request early release of funds for use in late summer/fall of 2023. The scent detection process is best done in dry conditions so we prefer to start the project prior to the wet season. Additionally, the results and lessons learned from this pilot project will directly serve from which to base future grant proposals, which we hope to be positioned to do in early spring 2024.

## Reporting

Details of the pilot project including methods and results of dog detections versus analyzed samples will be documented in a RMP technical report. All chemical analysis data will be uploaded to CEDEN. Presentations of the method and results will be provided to the Water Board, BAMSC, SPLWG, and PCBWG.

## References

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# SPLWG Special Study Proposal: Tidal Area Remote Sampler Pilot - Year 2

## Summary

Old industrial land use disproportionately supplies PCB and Hg mass loads to the Bay. The Municipal Regional Stormwater Permit (MRP) calls for controlling these discharges and a lot of effort has already occurred in non-tidal industrial watersheds, but knowledge about sources and source areas in tidally-influenced areas remains limited due to the challenges associated with sampling in tidal areas. Last year a new remote sampler that addressed these challenges was developed to sample the tidally-influenced industrial landscape. Two samplers were built that automatically collect stormwater samples when freshwater storm runoff is detected. The samplers were deployed at three tidally influenced sites to assess for performance and test alternative methods for physically securing the sampler, but no sampling for lab analysis was completed. In the proposed study, field staff will deploy the equipment at eight sites to capture water samples for PCB and Hg analysis. This study will solidify our experience and understanding on the field deployment of these samplers. The outcome will be a completed and proven sampler design and characterization of stormwater from eight old industrial areas influenced by tides. The deliverable of this project will be quality-assured PCB and Hg data made available through the CD3 web tool, and a report detailing the methods and results of the pilot study.

**Estimated Cost: \$107k; Carry over from 2023: \$45k; Total Requested for 2024: \$62k**

**Oversight Group:** STLS/SPLWG

**Proposed by:** A Gilbreath, D Yee, and L McKee (SFEI)

**Time Sensitive:** No

## Proposed Deliverables and Timeline

Deliverable	Due Date
Pilot testing during rainy season	04/2024
Update presentation at SPLWG on the results to date	05/2024
Data upload to CEDEN	12/2024
Draft Report	1/2025
Final Report	3/2025

## Background

Old industrial land use is the main source of the greatest yields and total mass of PCB loads in the region (Wu et al., 2017), but at this time due to sampling logistics, only the non-tidal portions have been well-sampled (Gilbreath and McKee, 2022). Most of the Bay Area's heavy industrial areas, historically serviced by rail and ship-based transport, are located in close proximity to the shoreline. To date, the RMP has sampled stormwater from nearly 100 watersheds and drainages in the region. However, sampling for PCBs and HgT since WY 2003 has included just 34% of the old industrial land use in the region. Of the *remaining* older industrial land use yet to be sampled across all the counties, 48% of it lies within 1 km and 74% within 2 km of the Bay. These areas are more likely to be tidally influenced, and are often not well serviced by public roads.

Tidal areas are very difficult to sample because of a lack of public right-of-ways and a range of tidal-related constraints near the Bay such as bidirectional flow, the timing of tides with storms, the need for boat access to outfalls to install equipment and take samples, complex mixing, and water column stratification. With great patience and effort, some sampling in tidally influenced areas has occurred during the last seven years. To be able to sample these areas, tides that are sufficiently low (site-dependent) must align with storms of sufficient intensity. Additionally, to warrant mobilization for these events to the exclusion of other sampling in the region, these conditions need to be met for some minimum time period (e.g. minimally 2-3 hours) to account for potentially shifting storm timing. Tidal sites get the highest priority during each storm event in which these requirements are met, and yet such opportunities have been rare. Further, we only have so much field capacity to sample each event, so we are limited in the number of tidal sites we can sample when these conditions occur. For several years, the Pollutants of Concern (POC) reconnaissance report stated: "A different sampling strategy may be required to effectively assess what pollution might be associated with these areas and to better identify sources for potential management" (Gilbreath and McKee, 2022).

In response to this challenge, two RMP projects funded the development and early pilot testing of a remote sampler in WY 2023. The EPA had developed a remote, micro-pump sampler and successfully used it over 100 times (Kahl et al., 2014). This formed the prototype from which SFEI developed a modified variant in WY 2023. USGS is currently working on modifications to the EPA design as well, and SFEI benefitted from discussions with USGS about sampler development. This modified variant, the "SFEI Mayfly," is suitable for both CECs sampling in non-tidal pipes and storm drains further upstream, as well as for sampling in tidal areas. The sampler is a compact, automated micro-pump sampler such that staff need not be present during sampling, and can be deployed and retrieved during lower tides prior to and after a storm. Although the samplers may be inundated at times with tidal waters, a salinity sensor triggers the sampler only during low salinity periods when urban stormwater is dominant. The data logger on the sampler is also telemetered such that remote access to real-time data is available over the internet. It is currently not enabled to program remotely, though this would be a highly beneficial feature for a variety of reasons and has been proposed as part of the remote sampler proposal.

Last year, in addition to developing the samplers, we deployed them during storm events at three tidal locations (as well as two non-tidal locations), all of which were mostly successful. These were pilot testing locations to assess the feasibility of field deployment only. No samples were submitted for analysis as these were not locations where information on PCBs or Hg was desired. Some lessons were learned in this pilot phase that will be applied in future sampling. The sampler was in development most of the rainy season and we only began field deployments towards the end of the season, therefore we were not able to collect samples desirable for lab analysis. There is approximately \$45,000 in remaining funds for the project, and we propose to carry that over into this year and thus lessen the cost of the proposed project by that same amount (see Budget Table 2).

In this study, we propose to deploy these samplers for collection of Hg and PCBs and data analysis at eight locations. This study will solidify our experience and understanding on the field deployment of these samplers, and identify industrialized or other urban drainage areas on the Bay margin for further investigation and management consideration, thus providing a much-needed new tool for stormwater managers.

## Study Objectives and Applicable RMP Management Questions

The goal of this project is to further modify and deploy a remote sampler for sampling in tidal areas.

The near-term objectives of the sampling approach will be to (a) deploy the sampler at eight sites, and (b) collect PCBs, Hg, and SSC samples at each site and have these samples analyzed by commercial labs.

**Table 1.** Study objectives and questions relevant to SPLWG management questions.

Management Question	Study Objective	Example Information Application
Q1: What are the loads or concentrations of Pollutants of Concern (POCs) from small tributaries to the Bay?	Deploy a remote sampler to collect POC data in tidal areas that we have previously been unable to sample due to tidal constraints.	What are the concentrations of POCs downstream of industrialized areas close to the Bay margin?
Q2: Which are the “high-leverage” small tributaries that contribute or potentially contribute most to Bay impairment by POCs?	Indirect, via answering Q1	Identify high leverage drainages to sensitive Bay margins downstream of tidally influenced industrial areas.

Management Question	Study Objective	Example Information Application
Q3: How are loads or concentrations of POCs from small tributaries changing on a decadal scale?	N/A	N/A
Q4: Which sources or watershed source areas provide the greatest opportunities for reductions of POCs in urban stormwater runoff?	Indirect, via answering Q1	Confirm/refute if high PCB concentrations are found downstream of suspected PCB source areas.
Q5: What are the measured and projected impacts of management action(s) on loads or concentrations of POCs from small tributaries, and what management action(s) should be implemented in the region to have the greatest impact?	N/A	N/A

## Approach

Our approach during this second year of work with the SFEI Mayfly is to deploy the samplers at eight locations where PCB measurements are desired. The intent is to deploy the two sampling units that are currently built at two different locations during four storm events for a total of eight locations.

In this study, we will work with the BAMSC team to select suitable and desirable locations for deployment. We will either access sites by land or utilize a low draft boat or other means to access tidal sites downstream from old industrial areas. There we would anchor the coarse-screened micro-pump sampler and an auto-logging micro salinity probe in the water column. The sampling equipment would be installed just prior to a storm and retrieved after. The whole water sample would be analyzed for suspended sediment, PCB, and Hg concentrations.

## Budget

The following budget represents estimated costs for this special study (Table 2).

**Table 2.** Proposed budget.

Expense	Estimated hours	Estimated Cost
<b>Labor</b>		
Field Deployments	168	\$33,840
Project Management	60	\$9,712
Data Management	90	\$12,600
Reporting - SOP Development and Report	156	\$30,480
<b>Subcontracts</b>		
SGS AXYS Analytical, Brooks Applied Laboratories, USGS		\$12,065
<b>Direct Costs</b>		
Equipment		\$6,000
Travel		\$330
Shipping		\$1,800
<b>Grand Total for WY 2024</b>	474	<b>\$106,827</b>
<b>Total Remaining for WY 2023</b>		<b>\$44,800</b>
<b>Total Requested for WY 2024</b>		<b>\$62,027</b>

### Budget Justification

*Labor Costs:* 574 hours of staff time to research and modify the remote sampler, deploy the sampler, analyze the data, and present to SPLWG in spring 2024.

### Early Funds Release Request

If this project is approved, we request early release of funds for use in 2023. We would begin modifying the remote sampler in fall of 2023 such that we are ready for deployments in Water Year 2024 (which begins fall of 2023).

## Reporting

The data for the remote sampler will be presented to SPLWG in the spring of 2024. Additionally all data will be uploaded to CEDEN and a technical report (draft and final) will detail the methods and a brief presentation of the results. Further, a detailed Standard Operating Procedure document will be created to describe the sampler development and operation.

## References

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## SPLWG/ECWG Proposal: Remote Sampler Purchase

### Summary

This proposal will fund the purchase of a set of remote samplers for RMP stormwater work to support stormwater CECs monitoring in Bay Area watersheds and urban runoff monitoring in tidal zones (e.g., to measure PCBs in runoff from industrial areas that flows to tidal waters). These samplers have other potential uses, such as for future urban stormwater microplastic monitoring.

As part of an ongoing project, the 2023 “Stormwater CECs Monitoring Groundwork,” RMP scientists have developed a new small, flexible, relatively low-cost remote sampler (the “SFEI Mayfly”) and are testing and comparing it to the traditional ISCO sampler. Both have already proven their feasibility for field deployment in Bay Area creeks. We have conducted and are currently awaiting results of QA/QC testing of side-by-side blank samples from both samplers. We also await the result of container adherence tests of the flexible containers preferred for use with the SFEI Mayfly. These chemical analysis data for four CECs families of interest to the RMP will inform assessment of the usability of these remote samplers for RMP stormwater CEC monitoring.

This proposal is a placeholder because the analytical laboratory data necessary to support the remote sampler selection will not be available until summer 2023. The sampler selection is anticipated to be made this summer, in consultation with the Stormwater CECs Stakeholder-Science Advisor Team (SST). Upon the sampler selection decision, the sampler purchase/construction task will be developed under the oversight of the SST and brought to the Steering Committee for approval to ensure sampler availability to pilot implementation of the new Stormwater CECs Monitoring Approach in wet season 2023/2024.

Estimated Cost: \$180,000 (early release of RMP funds requested)  
Oversight Group: SPLWG and ECWG, Stormwater CECs Stakeholder-Science Advisor Team  
Proposed by: Kelly Moran, Alicia Gilbreath, and Don Yee  
Time Sensitive: Yes because it supports implementation of the Stormwater CECs monitoring program in wet season 2023/2024.

### PROPOSED DELIVERABLES AND TIMELINE

Deliverable	Due Date
Task 1. Develop scope and budget for remote sampler purchase	Summer 2023
Task 2. Remote sampler purchase/construction (deliverables to be determined)	Fall 2023-Spring 2024

## Background

The RMP transition to a primary focus on CECs monitoring heightens the need to develop a practical, cost-effective method for remotely collecting stormwater samples. Remote sampler capabilities reduce collection costs and make it possible to obtain many more samples per storm event than is possible with current manual sampling techniques. Having this capacity will shorten the time frame necessary to address management questions requiring stormwater monitoring data and will provide new capacities, such as to monitor in difficult to access tidal zones.

## Study Objectives and Applicable RMP Management Questions

**Table 1.** Study objectives and questions relevant to RMP SPLWG management questions.

Management Question	Study Objective	Example Information Application
1) What are the loads or concentrations of pollutants of concern from small tributaries to the Bay?	Indirect through building sampling capacity with the remote samplers.	Implementing monitoring projects to address near-term priority stormwater CECs management questions.
2) Which are the “high-leverage” small tributaries that contribute or potentially contribute most to Bay impairment by pollutants of concern	Indirect through building sampling capacity with the remote samplers.	Identification of tributaries with elevated PCBs that drain into margins of concern such as San Leandro Bay.
3) How are loads or concentrations of pollutants of concern from small tributaries changing on a decadal scale?	Indirect through building sampling capacity with the remote samplers.	Understanding the changes in presence of CECs in the stormwater pathway.
4) Which sources or watershed source areas provide the greatest opportunities for reductions of pollutants of concern in urban stormwater runoff?	Indirect through building sampling capacity with the remote samplers.	Identification of tributaries with elevated PCBs.
5) What are the measured and projected impacts of management action(s) on loads or concentrations of pollutants of concern from the small tributaries, and what management action(s) should be implemented in the region to have the greatest impact?	N/A	N/A

**Table 2.** Study objectives and questions relevant to the RMP ECWG management questions.

<b>Management Question</b>	<b>Study Objective</b>	<b>Example Information Application</b>
1) Which CECs have the potential to adversely impact beneficial uses in San Francisco Bay?	N/A	N/A
2) What are the sources, pathways and loadings leading to the presence of individual CECs or groups of CECs in the Bay?	Indirect through building sampling capacity with the remote samplers.	Implementing monitoring projects to address near-term priority stormwater CECs management questions.
3) What are the physical, chemical, and biological processes that may affect the transport and fate of individual CECs or groups of CECs in the Bay?	N/A	N/A
4) Have the concentrations of individual CECs or groups of CECs increased or decreased in the Bay?	Indirect through building sampling capacity with the remote samplers.	Design and initiate monitoring capable of informing general understanding of changes in CECs presence in the stormwater pathway.
5) Are the concentrations of individual CECs or groups of CECs predicted to increase or decrease in the future?	N/A	N/A
6) What are the effects of management actions?	N/A	N/A

## Approach

RMP scientists are currently testing two very different remote stormwater samplers. The first, the compact “SFEI Mayfly” is based on a USEPA in-stream remote sampling device (Kahl et al., 2014) which collects whole water samples using a micropump (USGS is currently developing a similar device), and the EnviroDIY Mayfly (<https://www.envirodiy.org>), which was designed as a citizen science watershed monitoring device with telemetric data logging capability. SFEI has combined and modified these designs to use sensor measurements (conductivity, temperature, depth) and programmed collection rules (e.g., time intervals, interval and total volumes of collection, minimum and/or maximum salinity and depth ranges) to trigger sample collection. The sampler is outfitted with telemetry such that near-real-time (15 minute

interval) measurements are available via the web. In wet season 2022/2023 the SFEI Mayfly was successfully field tested using several deployment approaches, proving its suitability for use in fixed installations (attached to a bridge piling or anchored to an item on a creek bank) and suggesting that other less tightly secured deployment options may also be feasible. These samplers would be less expensive, less labor-intensive, and offer much greater sampling location flexibility compared to traditional commercial remote samplers.

If the SFEI Mayfly sampler is selected, several refinements are planned, including revising the sample collection programming, seeking replacements for parts identified as containing chemicals from the organophosphate ester family, and adding the ability to use telemetry to reprogram the sampler remotely.

The second remote sampler option being tested is a traditional automated pumping sampler (ISCO 6712). These samplers are placed on the side of or above the channel with tubing extending into the channel. This traditional sampling approach is well-proven, although, as with the SFEI Mayfly samplers, blank samples have been collected and results will determine for which chemicals the samplers have acceptable levels of blank contamination. Another case where an ISCO may be preferable is for sites or studies where large numbers of discrete grab samples are desired; some configurations of ISCO samplers can accommodate up to 24 separate bottles. The practical limit of the Mayfly is currently 4 bottles/containers. Deployment of the ISCO samplers is anticipated to be more labor-intensive (securing the conduit and tubing in the channel, housing the ISCO or leaving it outside a lock box, which leaves it vulnerable to vandalism) and overall more expensive (due to the cost of the sampler, tubing and cleaning costs for the tubing, as well as a more intensive effort to deploy) than the SFEI Mayfly samplers.

To evaluate the feasibility of using these remote samplers for the stormwater CECs monitoring program, SFEI conducted side-by-side blank testing of the two samplers (SFEI Mayfly and an ISCO model 6712) to evaluate potential for sample contamination for four CECs families of interest to the RMP (PFAS, OPEs, bisphenols, and vehicle/tire contaminants). In parallel with analyzing these samples, the laboratory (SGS/AXYS) will be conducting container adherence testing of the flexible LDPE containers preferred for use with the SFEI Mayfly with the same four CECs families. We are awaiting the results from the laboratory. However, even if the flexible containers prove to be unsuitable for specific CECs, the SFEI Mayfly may still be able to collect into a different type of container instead of or in addition to the flexible container.

After RMP scientists evaluate the laboratory results, the sampler selection will be made in consultation with the Stormwater CECs Stakeholder-Science Advisor Team (SST). The SST includes representatives from the Steering Committee and Technical Review Committee, as well as science advisors and stakeholders. This decision is anticipated in summer 2023, at which time we will develop the remote sampler purchase scope and budget in consultation with and under the oversight of the SST. We plan to move this

process forward quickly once the sampler is selected, as we propose to use the samplers to pilot implementation of the new Stormwater CECs Monitoring Approach in wet season 2023/2024.

In the unlikely event that the QA/QC testing rules out the use of both types of remote samplers for stormwater CEC sampling, the purchase proposal will be scaled down and unused funds will be returned to the RMP.

Task 1: Develop scope and budget for sampler purchase

We will develop a scope and budget for remote sampler purchase under the oversight of the SST. It will subsequently be provided to the SC for final approval.

Task 2: Remote sampler purchase/construction

In addition to purchasing equipment (e.g., parts for SFEI Mayfly construction or ISCO samplers, installation supplies), the sampler purchase task may include labor to construct the samplers (SFEI Mayfly), to refine the design and operation of remote samplers (e.g., improving tidal adjustments, adding the ability to reprogram the samplers without physically revisiting the site providing more flexibility to better tailor the collection to the site and event characteristics), to refine methods for sampler installation, and to obtain permits for any long-term installations.

We roughly estimate that the budget would pay for purchase/construction and installation setups for about a dozen SFEI Mayfly samplers or about half a dozen ISCO samplers. For the SFEI Mayfly, this estimate includes cost for refinement of the sampler design and could include permitting and installation setups at up to three fixed, long-term locations. For the ISCO option, this estimate includes permitting and installation housing at up to three fixed, long-term installation locations. Purchase and installation plans and refined cost estimates will be developed under Task 1.

## Budget

The proposed budget includes labor and direct costs. Hours and costs for the sampler purchase are not listed below and will be estimated when the purchase scope is developed.

Expense	Estimated Hours	Estimated Cost
<b>Labor</b>		
Task 1: Develop scope and budget for remote sampler purchase	35	\$7,000
Task 2: Remote sampler purchase/construction/methods	TBD	TBD
<b>Direct Costs</b>		
Equipment and supplies		TBD
<b>Remaining tasks (primarily equipment)</b>		\$173,000
<b>Grand Total</b>		<b>\$180,000</b>

### Budget Justification

#### *SFEI Labor*

Labor hours for SFEI staff to complete all project elements.

#### *Direct Costs*

Other direct costs are anticipated to include sampler equipment, and other miscellaneous sampler-related supplies. Estimates of other direct costs will be provided in the purchase budget.

#### *Early Funds Release Request*

If this proposal is approved, we request early release of funds for use in 2023 to ensure samplers are available to initiate monitoring during the 2023/2024 wet season.

## Reporting

Reporting for Task 1, Scope and budget for sampler purchase, will be the scope and budget presented for SST review and SC approval. Reporting for the sampler purchase will be determined in conjunction with the scope and budget. Reporting may be combined with deliverables for other related projects.

## **References**

Kahl, M.D., Villeneuve, D.L., Stevens, K., Schroeder, A., Makynen, E.A., Lalone, C.A., Jensen, K.M., Hughes, M. Holmen, B.A., Eid, E., Durhan, E.J., Cavallin, J.E., Berninger, J., and Ankley, G.T. 2014. An inexpensive, temporally integrated system for monitoring occurrence and biological effects of aquatic contaminants in the field. *Environmental Toxicology and Chemistry*, Vol. 33, 7, pp 1584-1595.

## Proposal: Watershed Dynamic Model (WDM) Maintenance

**Summary:** This project will fund the maintenance of the Watershed Dynamic Model (WDM). This proposal provides a list of tasks that can be done with the maintenance fund and proposes a process to decide on which of the maintenance activities and documentation are needed each year. The maintenance tasks will be proposed early each year and submitted to the Steering Committee for approval after consultation with the Modeling Council of Wisdom (COW). A log of model improvements and modifications will be updated by the end of each year. Model simulations of updated time series will be uploaded to SFEI's data portal.

**Estimated Cost:** \$50,000 per year

**Oversight Group:** SPLWG, Modeling Council of Wisdom (COW)

**Proposed by:** Tan Zi, Pedro Avellaneda, and Lester McKee

**Time Sensitive:** Yes

### PROPOSED DELIVERABLES AND TIMELINE

Deliverable	Due Date
1. Proposed maintenance tasks	April each year
2. Updated modeling log and new modeling output	December each year

## Background

The Watershed Dynamic Model has been developed to support the management questions relevant to sources, pathways, and loadings of sediment and contaminants with continuous support from the RMP (Zi et al., 2021, 2022). The WDM will be used to provide watershed load estimates for sediment, PCBs, Hg, and future contaminants as appropriate, and provide insights into data gaps and monitoring design. Changes associated with control measures, land-use and climate change, or other scenarios can be explored by utilizing WDM and these can be used as boundary conditions for the in-Bay dynamic model to explore water quality and biological responses in the Bay to changing watershed management conditions (Table 1).

Like any other piece of equipment, tool, or model, the WDM requires regular updates, calibration, improvements, and technical support to remain accurate and relevant. For the WDM to be a valuable and immediately available tool for supporting the different RMP Workgroups and every evolving management question, a maintenance fund will ensure that there are adequate resources available to address issues such as data updates, model calibration, and bug fixes. It also allows for ongoing evaluation of the model's performance, which is essential for maintaining its accuracy and reliability. Additionally, a maintenance fund will support capacity building activities, such as training for model users, updating model documentation and data sharing portal. Overall, having a maintenance fund for a watershed model is essential for its continued functionality, usability, and value in supporting RMP workgroups.

## Study Objectives and Applicable RMP Management Questions

This proposed fund will provide the sustainability that the existing WDM needs to support the SPLWG high-level management questions as well as the SPL-relevant management questions of other RMP workgroups. The objectives of the project and how the information will be used are shown in Table 1.

**Table 1.** Study objectives and questions relevant to RMP workgroup management questions.

Management Question	Study Objective	Example Information Application
SPLWG 1) What are the loads or concentrations of pollutants of concern from small tributaries to the Bay?	Provide a modeling platform for watershed load estimation	The model will produce an estimate of PCBs and Hg concentrations and loads at each individual watershed.
SPLWG 2) Which are the “high-leverage” small tributaries that contribute or potentially contribute most to Bay impairment by pollutants of concern	Provide a modeling platform that can be linked with in-Bay model to identify the ‘high-leverage’ tributaries	Estimates produced by WDMI at PMU regions can be provided to in-Bay modeling to explore relative loading rates and the transport and fate of those loads into specific priority margin areas, operational landscape units, or RMP Bay segments.
SPLWG 3) How are loads or concentrations of pollutants of concern from small tributaries changing on a decadal scale?	Provide a modeling platform for trend analysis and management scenario predictions	Support for the 2028 PCB TMDL update. 1. Provide a new robust estimate of watershed PCB loads to the Bay. 2. The load reductions from control measures could be estimated via the control measure module and can be used to assess trends for individual watersheds and the region as a whole.
SPLWG 4) Which sources or watershed source areas provide the greatest opportunities for reductions of pollutants of concern in urban stormwater runoff?	Provide a modeling platform for identifying the watershed with high loading rate	Model outputs of PCBs and Hg will help identify high yield areas that can be targeted for management actions.
SPLWG 5) What are the measured and projected impacts of management action(s) on loads or concentrations of pollutants of concern from the small tributaries, and what management action(s) should be implemented in the	Provide a modeling platform for management action scenarios test and evaluation	Management actions, both existing and planned or anticipated, could be evaluated in the model through scenario runs. This could be used to support the

region to have the greatest impact?		2028 PCB TMDL reevaluation by providing a reasonable assurance prediction of likely future load reductions with further management effort.
PCBWG 1a) What would be the impact of focused management of priority margin unit (PMU) watersheds?	Provide a modeling platform for management action scenarios test and evaluation at PMU	Estimates watershed loadings at PMU regions given different management scenarios, and provides the boundary conditions to in-Bay modeling.
ECWG 2) What are the sources, pathways and loadings leading to the presence of individual CECs or groups of CECs in the Bay?	Provide a modeling platform for watershed CECs load estimation	Estimates stormwater loading for specific CEC.
ECWG 4) Have levels of individual CECs or groups of CECs changed over time in the Bay or pathways? What are potential drivers contributing to change?	Provide a modeling platform for CECs stormwater pathway loading estimation and scenario tests for pathway contributions	Estimates the changes of stormwater loading for specific CEC under different scenarios.
MPWG 3) What are the sources, pathways, processes, and relative loadings leading to levels of microplastics in the Bay?	Provide a modeling platform for stormwater MP load estimation	Estimates watershed loadings of microplastics.
SedWG 3) What are the sources, sinks, pathways, and loadings of sediment and sediment-bound contaminants to and within the Bay and subembayments?	Provide a modeling platform for watershed sediment load estimation	Predict watershed sediment loadings under different future scenarios.

## Approach

The model maintenance fund will be used for the following types of activities.

1. Model simulation extension: Model output with the latest water year is desirable to support answering RMP management questions and providing boundary conditions to in-Bay modeling. A maintenance fund will support annual model output extension by processing the weather data and applying the WDM for the latest water year. This could be done every year.
2. Model performance evaluation: Regular evaluation of the WDM's performance is essential to identify any deviations or inaccuracies and to assess its effectiveness in meeting its intended goals. The maintenance fund will support ongoing data analysis, performance evaluation, and reporting on the model's

performance to stakeholders. This might need to be done periodically every three years.

3. Data updates and calibration: WDM relies on accurate and up-to-date data, including precipitation, streamflow, land use, and soil data. A maintenance fund can support regular updates of these data, as well as recalibration of the model to improve its accuracy and reliability. We propose to do recalibration every five years.
4. RMP WDM meeting: As WDM starts to support multiple workgroups within RMP, it needs a platform so the maintenance fund can be used to support to host a WDM-specific meetings to introduce the progress of WDM relevant projects, discuss modeling needs with stakeholders, and engage local modelers and modeling experts to help improve the WDM. We propose to have an annual RMP WDM-specific meeting.
5. Capacity building and training: Ensuring that users of the WDM are trained and equipped with the necessary skills to operate the model effectively is crucial. The maintenance fund will support capacity building activities, such as model training workshops, providing educational materials to continuously improve the model's usability and effectiveness. This might be triggered when a new staff person is hired or when a stakeholder requests training.
6. Model updates and improvements: WDM may need periodic updates and improvements to incorporate new scientific findings, refine the tools for data process and analysis, or enhance model functionality. The maintenance fund will support minor development efforts to update and improve the model, such as adding new features, or expanding its capabilities. Triggered as necessary.
7. Outreach and communication: The maintenance fund will support outreach and communication efforts, such as developing educational materials, developing and updating the web portal for data and results sharing, and disseminating information through various channels to promote the understanding and use of the model. The fund can be used to support organizing modeling workshops for stakeholders and with modeling groups from other regions (e.g. Chesapeake Bay). It can also support SFEI staff to participate in relevant conferences to communicate and outreach WDM modeling efforts. Triggered as necessary.
8. Technical support and troubleshooting: Users of the WDM may encounter technical issues or require assistance in troubleshooting problems. The maintenance fund will provide resources for technical support, such as engaging external experts to provide assistance when needed.

Among these tasks, we envision the first four tasks are regularly scheduled activities. Part of the funds can be reserved each year for a larger task such as the recalibration (proposed to recalibrate the model every 5 years or if there are major data updates, such as land use or advances in the methods for inputting climate data). Other tasks are based on the needs, and the modeling team will provide a proposed task list and estimated budget for COW review, TRC review, and SC approval. The end-of-year cost (unused maintenance fund is rolling over to the next year) and the tasks that have been completed will be documented in the model development log, and presented to the SPLWG and COW.

## Tasks and Budget

The tasks of model maintenance can vary from year to year. We proposed a standardized procedure to conduct WDM maintenance activities each year:

Step 1. At the beginning of each calendar year, review a one year plan of model maintenance activities and provide justification for priorities for model maintenance for COW review and address any concerns.

Step 2. Submit revised model maintenance work plan for TRC review and SC approval.

Step 3. Host a RMP WDM modeling specific meetings at mid-year to update the work. progress and planning, and gather feedback from stakeholders and scientific advisers.

Step 4. Complete model maintenance activities.

Step 5. Update the model development log and report outcomes to RMP WGs and the COW.

The proposed budget includes estimated hours for the tasks. Estimations of hours and costs for maintenance tasks proposed for each following year are not included. If the fund is not used up by proposed tasks in one year, the fund can be rolled over to the next year.

Expense	Estimated Hours	Estimated Cost
<b>Labor</b>		
Task 1: Extend the modeling results to the latest water year	80	\$12,000
Task 2: Re-evaluate modeling results every 3 years	160	\$24,000 (8,000 per year)
Task 3: Recalibrate model every 5 years	320	\$48,000 (9,600 per year)
Task 4: RMP WDM meeting and preparation	40	\$6,000
Modeling development log update	40	\$6,000
Other proposed activities	TBD	\$8,400
<b>Annual Budget</b>		<b>\$50,000</b>

### Budget Justification

#### *SFEI Labor:*

Labor hours for SFEI staff to complete all project elements.

## Reporting

A proposed model maintenance task list and budget will be sent to the COW for review and for SC approval. The proposed update will be presented at SPLWG. The model development log will be updated each year and an annual summary of activities completed will be provided to the SPLWG and COW.

## References

Zi, T.; Mckee, L.; Yee, D.; Foley, M. 2021. San Francisco Bay Regional Watershed Modeling Progress Report, Phase 1. SFEI Contribution No. 1038. San Francisco Estuary Institute: Richmond, CA.

Zi, T, A. Braud, L. McKee, and M. Foley. 2022. San Francisco Bay Watershed Dynamic Model (WDM) Progress Report, Phase 2. Report prepared for the Sources Pathways and Loadings Workgroup of the Regional Monitoring Program for Water Quality. SFEI Contribution #1091. San Francisco Estuary Institute, Richmond, California.



## **RMP Sources, Pathways and Loadings Workgroup Meeting Summary**

May 23, 2022 10:00 AM – 3:00 PM

and

May 25, 2022 10:00 AM – 2:30 PM

REMOTE ACCESS ONLY

### **Attendees**

Alicia Gilbreath	SFEI
Bonnie de Barry	SMCWPPP
Bryan Frueh	City of San Jose
Chris Sommers	Santa Clara County Program, EOA
David Peterson	SFEI
Diana Lin	SFEI
Don Yee	SFEI
Ed Kolodziej	University of Washington
Emily Corwin	Fairfield-Suisun Sewer District/Solano Stormwater Alliance
Lisa Sabin	EOA
Ezra Miller	SFEI
Greg Gearheart	SWRCB
Jay Davis	SFEI
Jon Butcher	Tetra Tech, Technical Advisor
Kelly Moran	SFEI
Keunyea Song	Washington State Dept. of Ecology
Lester McKee	SFEI
Lisa Austin	Geosyntec
Lisa Sabin	EOA

Lisa Welsh	Geosyntec
Luisa Valiela	EPA Region 9
Martin Trinh	SFEI
Melissa Foley	SFEI
Richard Looker	SFBRWQCB
Rob Carson	MCSTOPPP
Robert Budd	CDPR, Technical Advisor
Seteney Frucht	SFBRWQCB
Steve Corsi	USGS, Technical Advisor
Tan Zi	SFEI
Tom Jobes	Indep advisor, Technical Advisor

# Day 1

## 1. Introductions and Goals for This Meeting

Melissa Foley (SFEI) started the meeting by welcoming the workgroup members and participants, and by giving an acknowledgement that SFEI and many of the members of the RMP reside on the ancestral territory of the native peoples of the San Francisco Bay, including the numerous villages and tribes of the Ohlone, Patwin, Coast Miwok, and Bay Miwok. We recognize that through a violent history of colonization and dispossession, today, as guests, we benefit from living and working on the traditional homeland of these Native People. We wish to show our respect to them and their ancestors by acknowledging the injustices inherent to this history and by affirming their sovereign rights and their current efforts to achieve restorative justice. This land acknowledgement evolved out of the collaborative efforts of the original native peoples of the San Francisco Bay.

She then reviewed the Zoom meeting etiquette and protocols and reviewed the guidelines for inclusive engagement (adapted from Visions, Inc) to facilitate a productive discussion from all points of view. The Work Group's two returning advisors, Jon Butcher and Tom Jobes, and two new advisors Robert Budd and Steven Corsi introduced themselves. Melissa then asked attendees to identify themselves as Steering Committee and Technical Review Committee members, stormwater community, government partners, other RMP stakeholders, and SFEI staff. The day's agenda was reviewed, which was as follows:

1. Introductions and Goals for This Meeting	10:00
2. Information: Strategy and Management Questions Review and Upcoming Update	10:15
3. Information: SF Bay Regional Water Quality Control Board Perspectives	10:25
4. Information: Permittee Perspectives	10:45
5. Scientific Updates on Current Projects: Introduction	11:05
6. Scientific Update: Integrated WATERSHED Monitoring and Modeling Strategy	11:20
Break	11:40
7. Scientific Update: Stormwater Monitoring Activities	12:20
8. Scientific Update: Watershed Dynamic Model (WDM) Development to Support Watershed Loads and Integrated Watershed Bay Modeling Strategy and Pilot Study	1:00
9. Scientific Update: Stormwater CECs Monitoring Approach	2:00
Adjourn	3:00

Melissa gave a brief background of the RMP, which has the overarching goal of collecting data and communicating information about water quality in SF Bay in support of management decisions. There are roughly 65 entities involved in any one year. There is a Steering Committee (SC) and Technical Review Committee (TRC) made up of both dischargers and regulators. Workgroups are focused on evaluating proposed projects and getting input from experts and ideas from stakeholders. The Sources Pathways and Loadings Workgroup (SPLWG) in recent years has been seeing more overlap and coordination with other Workgroups. The RMP has an annual budget of \$4M, and for the 2023 calendar year \$1.4M will be allocated to Special Study projects. This year's planning budget is \$2M, so each Workgroup will prioritize proposed projects and send them to the TRC and SC for funding decisions.

The goal for these two SPLWG meetings was to get perspectives on stakeholder priorities, get updates on recent and ongoing projects, highlight related proposals in other Workgroups, and review and prioritize proposals for recommendation to the TRC and SC.

## **2. Information: Strategy and Management Questions Review and Upcoming Update**

Alicia Gilbreath (SFEI) explained the SPLWG is currently undergoing a transition from a focus on monitoring and modeling legacy pollutants towards a greater focus on a more integrated monitoring and modeling approach, and a focus on contaminants of emerging concern (CECs). In light of this transition and the release of the new Municipal Regional Permit, it is an important time to revisit the guiding strategy and Management Questions for the Workgroup. This revision process will be funded in 2023.

In 2009 the MRP was developed, and the RMP created five SPLWG Management Questions:

Q1. What are the loads or concentrations of Pollutants of Concern (POCs) from small tributaries to the Bay?

Q2. Which are the “high-leverage” small tributaries that contribute or potentially contribute most to the Bay impairment by POCs?

Q3. How are loads or concentrations of POCs from small tributaries changing on a decadal scale?

Q4. Which sources or watershed source areas provide the greatest opportunities for reductions of POCs in urban stormwater runoff?

Q5. What are the measured and projected impacts of management action(s) on loads or concentrations of POCs from small tributaries, and what management action(s) should be implemented in the region to have the greatest impact?

The RMP was interested in other pollutants, but the primary drivers were Polychlorinated Biphenyls (PCBs) and mercury (Hg), so questions were centered around those pollutants. These have served the SPLWG thus far, but we are facing new challenges and new ways of working together. The RMP is still interested in supporting the region in understanding PCBs and Hg, specifically for load estimation and trends in relation to management actions. As CECs come more to the forefront, the workgroup direction is simultaneously shifting focus to more integrated modeling and monitoring. More than ever the Workgroup is asking “what answers do we need from our models?” and letting that drive our monitoring design. The joint proposals being presented in this meeting regarding CEC modeling and monitoring benefit from the 20+ years of work done with PCBs and Hg, but a key difference is moving the foundational analysis to the

beginning. By understanding the necessary inputs to model a given CEC, the RMP can design a streamlined and cost effective sampling program.

The SPLWG is a “service” part of the RMP and the most integrated of the Workgroups. Eleven Special Study proposals this year span multiple Workgroups and the SPLWG is involved in almost all of those. The difference to note as the Workgroup shifts toward CECs is these are actively used products rather than legacy contaminants. The group will need to determine what sampling techniques are appropriate and best for modeling.

The SPLWG 2009 strategy and management questions need updating. First we’ll form a subcommittee that will meet a few times in early 2023, and present ideas to the full Workgroup in May 2023. By October 2023, we will have a draft strategy and Management Questions to include in the Multi-Year Plan. They will be finalized by 2024. Our progress will partly hinge on the progress of other Workgroups that are going through the same process.

### **3. Information: SF Bay Regional Water Quality Control Board Perspectives**

#### **4. Information: Permittee Perspectives**

Richard Looker and Chris Sommers provided a history of the workgroup and framing of its needs and priorities from both the regulator perspective (Richard, Water Board) and permittee perspective (Chris, EOA/Santa Clara Urban Runoff Program). Richard explained that rather than show two opposing perspectives, they collaborated to give a consensus view this year. He said the goal of this item was to orient newer participants in the Workgroup, including new advisors, by getting back to the basics. The mission of SPLWG is to provide info to managers, so what is motivating that, and what are managers interested in?

In the early to mid 2000’s the SPLWG was motivated by the need for info associated with the PCBs and Hg TMDLs for SF Bay (legacy contaminants). Urban runoff and tributary loadings were identified as major pathways. For Hg, the Central Valley, Guadalupe watershed, and urban runoff were identified as contributing major loads. For PCBs, urban runoff was the main loading pathway. Requirements were placed in permits for urban runoff programs and wastewater dischargers to reduce loads. The other management driver for the SPLWG is contaminants of emerging concern (CECs), which is a broad category and less understood in terms of sources, transport and effects. No water bodies are currently categorized as impaired based on CECs, so there are no TMDLs in place. It’s a matter of time before the data show that some CECs are impairing beneficial uses. Managers want to identify CECs in stormwater, generate

preliminary loading estimates, identify sources and source areas, understand pollutant characteristics and transport processes, and assess performance of control measures.

A “superpower” of the RMP structure is that the work is anchored to general scientific questions that are honed into specific investigatory goals. This Workgroup’s Management Questions were developed with legacy contaminants in mind. They have been useful for more than a decade.

The first question gets at understanding concentrations and identifying pathways (so far focused on urban runoff, large rivers and tributaries). The second question asks to identify areas with high leverage. Imagine two tributaries with equal loading of Hg, one discharges to an area with immediate energetic mixing and Hg is transported out the Golden Gate. The other is discharged to a protected, shallow area with less mixing. The Hg out of that second tributary has a higher probability of being methylated and incorporated into the food web, so that second trib has higher leverage. We aren’t sure if that leverage-based thinking applies to CECs, but we’ll discuss it. The third question focuses on how loads and concentrations are changing over time on a decadal scale. The fourth question regards finding source areas/watersheds with greatest opportunity for reductions. This includes finding areas with high concentrations and loadings. The fifth question is for managers who want to know if implemented control measures are working, as well as how certain measures will be effective if implemented in the future.

Chris gave an overview of what the Workgroup has been doing and what it will be doing in the future. Prior to 2000 the RMP was focused on all pollutant pathways, but has since been entirely focused on stormwater and tributaries. We started by monitoring the largest tributary to the Bay, the Sacramento River, and provided context for local tributary inputs (identified as “small tributaries” in the Management Questions). That work directly influenced PCB and Hg TMDL development. In parallel, interest in the South Bay focused on the loading of the Guadalupe watershed which was of concern due to historical mining of Hg. We were able to build great calibration datasets. The RMP developed a turbidity surrogate method to estimate loads to the bay. The RMP also built a hydrodynamic watershed HSPF model for mercury in the Guadalupe watershed. SFEI and local municipalities teamed up to identify the best controls for PCBs and Hg in a conceptual model.

This foundation informed the next decade of work (2010-2019). We created strategies to get information on loadings and concentrations. We began monitoring more locations with the goal of creating a calibration dataset for regional modeling. This came to the development of the Regional Watershed Spreadsheet Model (RWSM), which gave us

best fit land use specific yields and average concentrations for specific land uses, and gave us regional sediment and pollutant loading estimates. This introduced the concept of “old industrial land uses” for pre-1980 industrial and commercial areas that are large sources of PCBs. The stormwater permittees have used these yields at the regional scale to develop more watershed specific reasonable assurance analysis (RAA) modeling. In 2015, we moved away from monitoring a few locations over multiple storms and focused on getting single samples from more places, hoping to identify disproportionate source areas. This got us closer to identifying sources at the property or subcatchment scale. The RMP and permittees collected >100 of using this reconnaissance monitoring style of monitoring to get as much geographical knowledge as possible. In 2016 the RMP produced a multi-year synthesis to document and summarize our knowledge to date. Then we refocused on tools that would identify temporal trends. Can we monitor to detect trends? To answer that, the RMP conducted a statistical analysis of the monitoring of Guadalupe River for PCBs. The level of monitoring needed to detect a change is quite large, so we might need to rely on modeling to detect temporal trends.

In the current RMP transition (2020-?) we have been trying to utilize the recon-style data records. Jay Davis and Lester McKee (SFEI) led an effort that turned our storm composite catchment-style data to normalized storm loading estimates which allowed us to prioritize catchments for controls. Jay also looked at PCB congener data to see if there were unique sources within catchments. Moving forward, CECs will be our focus while we continue to support PCB and Hg efforts. There is a deadline of 2028 and 2030 for Hg and PCB TMDLs for us to reflect on load reductions. We will build onto the RWSM with a Watershed Dynamic Model (WDM) to provide a foundation to make loading estimates that would lead to informing control measures earlier in the process. In the past we have compartmentalized the Bay vs the Watersheds and we’re now trying to merge those. We are moving away from monitoring to find sources, toward monitoring to support model development.

Members of the Workgroup took a moment to acknowledge the great impact Barbara Mahler has had on this Workgroup.

The group also gave appreciation for the positive effect that has come from long-term participation of technical staff involved in this Workgroup for basically the entirety of its existence. Thanks go to Lester McKee who was involved from the start and Alicia Gilbreath who joined in 2006. Don Yee and Jay Davis have been strong influences throughout and Kelly joined as an advisor in 2007, and is now part of SFEI staff. It has helped with cohesion and continuity of knowledge within the Workgroup. Chris said the

RMP has done a good job of documenting our process. There's a good repository of information for those who come next (not that anyone is moving on at the moment).

Lester asked if Richard or Chris could discuss the MRP 3. What should we know as we revise our Management Questions? Chris said the Municipal Regional Permit (MRP) covers over 80 municipalities in the Bay area, which is the vast majority of urbanized area that drains directly into the Bay. There has been a major shift in monitoring approaches and requirements with the adoption of the new permit (MRP 3.0). The permittees had been spending a good amount of time looking at local tributaries, and those resources were being redirected to other types of monitoring. One of the key requirements is monitoring Green Stormwater Infrastructure/Low Impact Development (GSI/LID) to understand effectiveness of removal of PCBs and Hg as well as hydrologic effects. The RMP is not directly addressing this, but it does play into our modeling strategy. For POCs there are still requirements to collect stormwater events to characterize catchments, and that will continue at the same level as MRP 2.0. Regarding CECs, stormwater programs will collectively contribute more dollars to the RMP specifically for CEC research.

## **5. Scientific Updates on Current Projects: Introduction**

The rest of the day's meeting was focused on providing updates on recent and ongoing SPLWG activities, and preparing the Workgroup for discussion on Wednesday about the proposals for 2023.

Alicia gave an overview of the following items where Lester will talk about SFEL's integrated monitoring & modeling strategy, Alicia will discuss stormwater monitoring, Tan will discuss modeling, and Kelly will discuss CECs. The work being presented is engaging other Workgroups as well. On Wednesday Kelly and Lester will discuss proposals from other Workgroups that are relevant.

## **6. Scientific Update: Integrated WATERSHED Monitoring and Modeling Strategy**

Melissa framed Lester's presentation by reminding the group this was funded in 2021 to ensure the monitoring and modeling efforts are coordinated to more efficiently answer RMP Management Questions. Lester noted this project has a relatively small budget (\$50K) and has collaboration at its core. The SPLWG, ECWG, and SedWG are all involved. Lester then reiterated the timeline discussed by Chris and Richard. As the focus has shifted from PCBs and Hg to CECs, this strategy will develop an integrated approach that can help streamline our PCB and Hg monitoring and incorporate a broader range of contaminants, including CECs.

The strategy is a sequential approach that begins with conceptual models. Then it lays out a “menu” of options that include Management Question evolution, GIS improvement, decision trees for sampling designs, interpretive technique decision trees for modeling, sampling methods related to Management Questions, and a trends development process. The menu and conceptual models will be used to create an integrated monitoring and modeling roadmap.

A challenge for this project is the large number of related projects being worked on across Workgroups. We see this as an umbrella project primarily for CECs, but it can also help optimize PCB and Hg work. The RMP has used modeling opportunistically, but has not approached modeling and monitoring synergistically. The most cost efficient approach going forward is to design them hand in hand. In the past, modeling efforts have had to wait years for monitoring to be completed, but there’s an opportunity with models to get answers quickly and use monitoring to refine those results.

We’re starting off with a watershed roadmap, but in the near future we could couple the watershed and Bay strategies (maybe in 3-4 years). The key management questions guiding this effort include: what is the future sediment supply in relation to climate change and landscape change? What are the trends in PCBs and Hg watershed loads? What are the more contaminated subwatersheds/properties? Where should we monitor for CECs? Is stormwater load to the Bay for a specific CEC big or small compared to other pathways?

Lester then discussed conceptual models. There are three basic ones that are useful for informing this effort. First, the 10 largest watersheds cover 74% of the area draining to the Bay. Second, the dry season is 7% of flow into the Bay on average, and if you consider dry weather flow during the wet season, that brings it up to 15%. If pollutant concentrations are high in dry weather flows, that could be significant. Third is the Bay water budget conceptual model which shows that wastewater is half the volume of stormwater coming into the Bay. Conceptual model development will hinge on two endmembers: three larger watersheds that have lots of variety in source areas, or 36 small watersheds with specific sources. This second option would require a much stronger conceptual model from the start.

The deliverable for this effort is a report that will be completed by late summer 2022. It will be written as a synthesis rather than separated by contaminant type. There’s an opportunity to use this report to reduce costs in PCB and Hg analyses going forward. Lester asked if the elements discussed address the needs that founded the project.

Steve Corsi said he likes the approach of monitoring + modeling. He was involved in a 20 year project that had lots of delays from monitoring program adjustments. In general, modeling would help speed that process along. Steve noted that PCBs are primarily legacy contaminants, and Hg is not only legacy, but there are current sources. What lessons have been learned from mercury that will help with CECs? Some CECs do have legacy sources. Will any of the work done with Hg help in understanding current vs legacy processes for CECs?

Lester said they've looked at bioavailability of loads coming into the bay, and there aren't a lot of similarities with CECs as far as bioavailability. Jay mentioned they have done isotope work with Hg that tracks inputs from mining. Another project included sediment cores near watershed inputs to assess the long-term input profile, which could work for CECs. Kelly said the Bay Area has a history of mercury mining associated with the gold rush. That mercury is the primary source to the Bay, so they don't have current or recent uses influencing their work. The idea with CECs is to cut them off before they get to legacy status. Lester will explore adding an atmospheric component to the conceptual model that could be tested with Hg and possibly used for CECs.

Melissa asked if Richard or Chris are in favor of the approach for this project because they were influential in kicking off this effort. Chris said the vision was an umbrella report guiding our way at a macro scale towards how we're doing modeling and monitoring as we integrated watershed and in-bay efforts. Chris was happy with where the RMP is going with watershed modeling and bay modeling, and there's a lot of discussion of how to couple those. Tan is heavily involved with both and that's super important and needed in trying not to compartmentalize. With CECs over the last couple of years the RMP has zoomed in the focus to watershed inputs as being important pathways and sources of CECs.

Jon Butcher said the difference between PCBs/Hg and CECs is that there was already background research on PCBs and Hg and that's not true regarding CECs. For conceptual models, we should have a basic understanding of how CECs move through the environment. Kelly responded saying the CECs they're working on span water soluble, sediment binding, and have complex chemical properties.

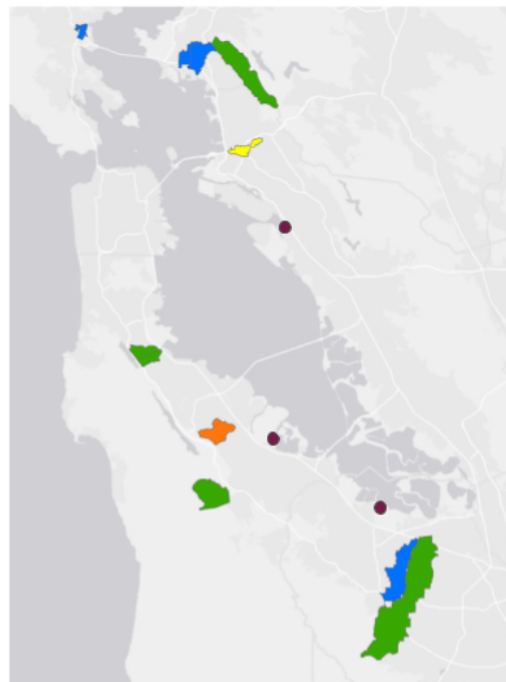
## **7. Scientific Update: Stormwater Monitoring Activities**

Alicia gave an update on stormwater monitoring activities in water year (WY) 2022, including context for precipitation amounts from the past three seasons. The average rainfall in San Francisco is 23 inches. The three year period from 2020-2022 was the second lowest consecutive three year period in the 120 year record. The deficit in WY 2020 was 8.25" and in that season they sampled eight sites over two storm events. In

WY 2021 the deficit grew to 22.18”, and they sampled two sites in one storm event. Sampling in WY 2020 and WY 2021 was also inhibited by COVID. In WY 2022, the three-year rainfall deficit increased to 25.68”. The team was able to sample 11 sites in 4 storm events, including CECs in 10 watersheds. For context, the 2012-2014 dry period was the fifth lowest on record.

## Stormwater Studies WY 2022

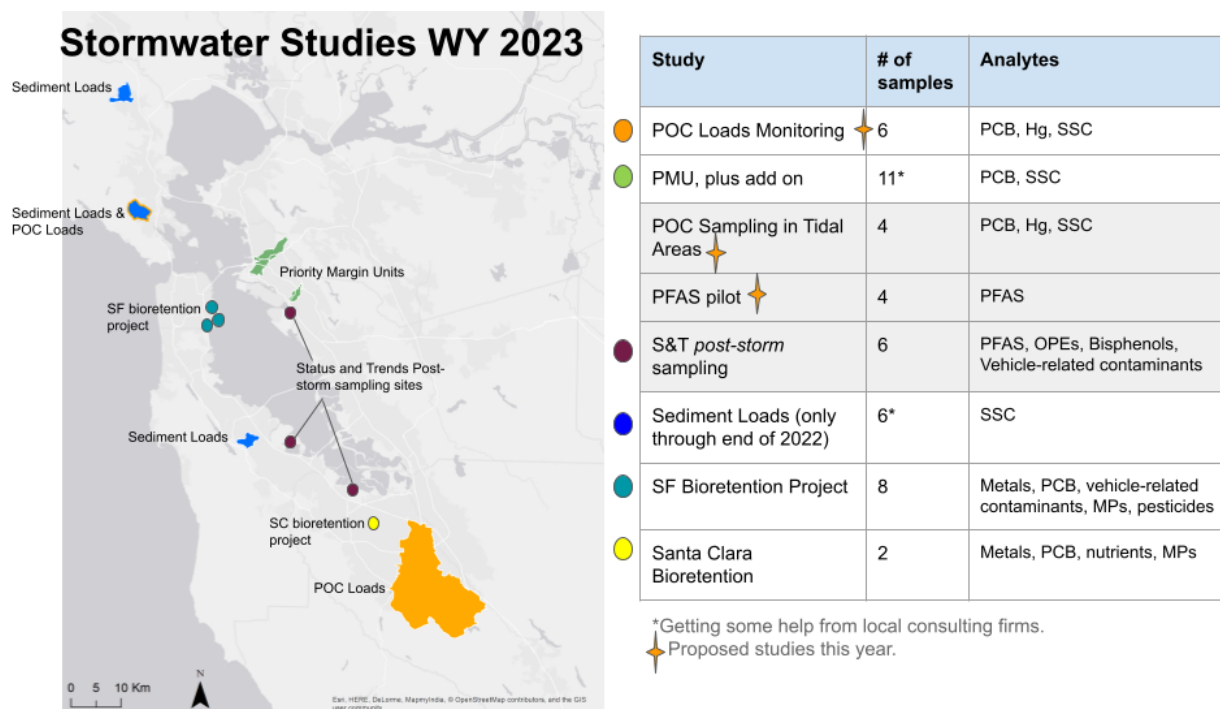
Study	Oversight WG	# of samples collected in WY 2022
POC Reconnaissance	SPLWG	4
POC discrete sampling	SPLWG	1
CECs in stormwater	ECWG	10
Priority Margin Unit	PCBWG	1
Sediment SEP	SPLWG	Flow monitoring only
SF bioretention project (Next Gen Urban Greening)	SFEI	0
S&T post-storm monitoring	RMP	3



A four year CEC study just concluded this year, which included five CEC families: tire-related contaminants, OPEs, bisphenols, ethoxylated surfactants, and PFAS. Of the sites sampled in WY 2022, two were reference sites and eight were urban sites. Additionally for the Status and Trends study, three near-field Bay (location where stormwater and Bay water mix), and four open Bay sites were sampled. Of the tire contaminants, 1,3-diphenylguanidine (DPG) had the highest concentrations in urban stormwater runoff. As samples moved away from that spatially or temporally, concentrations were lower, but exposure times for organisms may have lasted days to weeks. 6PPD-quinone and hexa-(methoxymethyl)melamine (HMMM) followed similar patterns. Other CECs might not follow this exact trend because these three are from tires, but the data informs the conceptual model.

For WY 2023 the proposed PCB and Hg monitoring includes intensive load monitoring at two locations with flow gauges to support modeling, and continued monitoring in the

Priority Margin Units (PMUs). Sediment loads monitoring sites only have funding through 2022, so early season events may be able to be captured. A remote sampler could be used to monitor tidal areas and possibly for the proposed PFAS stormwater pilot locations, both of which are outlined in proposals for 2023.



Lisa Austin asked if the values for CEC reference sites and open Bay were below the detection limit. Most reference samples were below the reporting limit, but some reference sites did have detectable concentrations. Highest concentrations were at creek mouths. In the summer, the open Bay samples were low or below the reporting limit. Wet season open Bay samples had regular detections of DPG and HMMM. 6PPD-Q was below the reporting limit, which could either be due to dilution or degradation (half life not yet known). It is compelling to see contaminants from a single product (tires) in the center of the Bay 10 days after a storm. Lisa asked if the chemicals were sediment bound or in the dissolved phase. Kelly said they are soluble, but cannot confirm these are purely dissolved because the smallest tire particles could pass through the filters in the lab.

Chris wanted everyone to be aware that the variability in stormwater runoff is important here as well. It's important to define spatial and temporal variability in the watersheds. These results show there is good mixing in the Bay. It would be good to know what bay edge areas look like three or six months out, although that might not be feasible right now.

Tom Jobes asked if the chemicals are coming from tire particulates, is it worth looking at sediment? He asked how much is settling out vs degrading. Kelly said the particles are very small, and she will get into that on Wednesday. Melissa mentioned that sediment monitoring is done on a regular basis for Status and Trends. The current plan doesn't include tire contaminants in margins close to stormwater runoff, but that may change prior to our monitoring in 2023.

Lester commented that the SPLWG opened with an estuarine phase pilot study in 1998-2000, and he's excited to revisit this. Estuarine concentrations were used to derive first estimates of loads to the Bay from Coyote Creek and Guadalupe watersheds. Those watersheds were later sampled and increased load estimates. This is an approach that could be used for CECs.

Don Yee commented that Bay edge dry season sampling might be somewhere where we have to consider air deposition (major highway and urban areas near shore). Jon Butcher said high variability in stormwater runoff suggests the concentration might depend on the time since the last rain event due to gradual buildup. Tom said that's especially applicable to road washoff.

Lester asked about the size of tire related particles and noted 50% of the SSC that comes into the bay is 5 microns or less. Kelly said tire particles are <100um, with most mass between 5-100 um, but numerically most particles in the <1 um size range. The relative surface areas (proportional to chemical release into water) of the small vs. the large particles is unknown.

Steve said they've been seeing tire particles in streambed sediment and are sometimes the dominant microplastics. Sediment might be worth looking at. How long those chemicals leach out of tire particles is unknown. The boxplot of 6PPD-quinone looks lower than what we've seen in the literature in other areas. Is that representative of what we'll see going forward or do we need more data? Kelly said we definitely need more data. The four-year stormwater CECs project collected more samples than Alicia presented today, which are just from 2021. Alicia said this is not much data and it doesn't cover a large gradient of urbanization or transportation land uses. This is the end of a four year study, in total we have 26 urban sites and four reference sites.

Chris asked if we have an idea of environmental significance levels yet. Ezra Miller (SFEI) informed the group that we know very little of 6PPD-quinone toxicity, but a recent publication looking at freshwater rainbow trout (same species as steelhead) provides LC<sub>50</sub> values (lethal concentration that kills half the fish). Sublethal toxicity data are not

yet available. We understand that such studies are in progress. To provide insights on toxicity, Ezra explained that it is possible, but highly uncertain, to estimate the likely range of sublethal effects concentrations using  $LC_{50}$  values. This estimation indicates that it is possible that observed concentrations at nearfield Bay locations may exceed protective thresholds for this contaminant, meaning 6PPD-quinone could be environmentally relevant in stormwater and the Bay edge. Current data suggest DPG and HMMM are less toxic than 6PPD-quinone, and our sample concentrations are probably below protective thresholds. Kelly added that tires are complex particle-chemical mixtures. There are data available regarding tire particles and tire leachate toxicity as a whole for a variety of species at total tire material concentrations that the authors believe to be environmentally relevant, but we don't have local monitoring data to do comparisons with these other studies.

Luisa noted that the literature is expanding quickly. Are species being studied in both freshwater and saline systems? Are there species-specific studies that need to be tracked in both those types of systems? Ezra said some groups are doing estuarine species in addition to freshwater species. We expect to see lots more data to help us evaluate effects of these chemicals in the Bay. Luisa asked if it is all academia? And Ezra confirmed that it is. The EPA and states aren't doing this work. There are some individual studies in Washington or Canada, but no organized effort.

#### **8. Scientific Update: Watershed Dynamic Model (WDM) Development to Support Watershed Loads and Integrated Watershed Bay Modeling Strategy and Pilot Study**

Tan Zi discussed ongoing modeling efforts. He paused for discussion after each section of his presentation, which included Watershed Dynamic Model (WDM) sediment modeling results, WDM PCBs and Hg model setting & assumptions, integrated watershed and bay modeling strategy & pilot study, and other related modeling projects.

##### WDM Sediment Modeling Results

The Modeling Implementation Plan was developed in 2019 to prioritize the regional watershed model for PCB and Hg load and trend evaluation. The original goal of the WDM was to look at PCB and Hg loads and trends at a regional scale. The hydrologic model was finished in 2020 and the sediment model in 2021. The focus for 2022 was PCB and Hg baseline load modeling. The proposal for 2023 is to look at control measure modeling for PCBs and Hg, as well as another proposal to begin work on CEC load estimation.

The application of the WDM has extended beyond the loads and trends of PCBs and Hg. For example, the model was used to produce forecast-based flow predictions and provide flow boundary conditions for the in-bay hydrodynamic model. It has also been used to estimate sand supply from local tributaries. The flow and sediment load from the WDM has been used by Anchor QEA for in-Bay sediment transport modeling. Future goals for the model include estimating loads and trends for CECs and providing a linkage to in-Bay modeling efforts.

Tan reviewed the basic structure of the model, which is based on Hydrologic Response Units (HRU) that represent a combination of soil type, land use, and slope, imperviousness, geology. Using this construct, the model was delineated into 204 local watersheds that flow into the bay for the 1995-2020 timeframe for flow and sediment at an hourly time step.

The general approach for sediment modeling is to divide erosion and sediment transport processes into two categories, upland watershed and instream. Tan ran simulations to predict suspended sediment yield (SSY) from different land uses and compared those to our previous study (McKee et al., 2009). The ranking of SSY from land use groups was consistent with the previous study, especially for urban land use.

The in-stream sediment transport process is based on hydraulic simulation of the model. Shear stress was calculated for each stream segment and calibrated the thresholds of shear stress to determine when deposition or scour occurs.

Tan calibrated the model with five gauged watersheds that have USGS daily suspended sediment load data available. These were Guadalupe, Coyote, Alameda, San Lorenzo, and Corte Madera. Most of the calibration watersheds were in the Central and South Bay, and one in the northern portion of the Bay. Tan showed graphs of flow, SSC, and SSL, and they followed the patterns of observed data well. Simulations were within +/- 10% of observed. Annual loads from the model were compared to a previous study (Schoelhammer et al., 2018) that used a rating curve based method to determine average annual load for water years 1995-2016. The Schoelhammer study had 1.3 Mt/yr of loading to the Bay, and the WDM modeled 1.25 Mt/yr, with a similar spatial distribution.

Tan acknowledged existing model uncertainties that may include monitoring data gaps and data quality, channel geometry, and in-stream processes.

We now have a calibrated dynamic watershed sediment model for the Bay Area! It can provide sediment load for the whole region and for specific watersheds at an hourly

scale. It gives us sediment yield from different land uses. It represents channel and flow dynamics. It can also be used to test and evaluate potential future effects of management actions, land use change, and climate change. We also now have the basic model structure for both particulate and dissolved contaminants.

Jon Butcher asked Tan to clarify he's using a sediment delivery ratio, not simulating sediment delivery based on depth of flow. Tan said the sediment delivery ratio is used for sediment model calibration. The sediment delivery is based on the depth of flow. Tan used the sediment delivery ratio derived from the index of connectivity method at the grid scale and summarized it at the HRU level to guide the calibration on sediment delivery. Jon said a potential concern is that kind of calibrated sediment delivery ratio is to some extent an extension of the flow regime. If you're looking at climate change, that might not be appropriate.

Tan asked if he has any suggestions for exploring climate change and sediment delivery. Jon said if you were simulating overland transport based on flow depth, it would change as rainfall patterns change. Tom mentioned in the early phases of the Chesapeake Bay watershed modeling program, they used USLE to generate calibration targets for field scale erosion (from the literature), and then calibrated the overland flow depth to reach that annual load. Then they further applied a delivery ratio to get from field scale to watershed scale. He was not familiar with the methodology they used to generate those delivery ratios. Jon said there have been some revisions to that. It's an intensive process that should give more details in the report. Tan said a draft report will be sent out for review in June.

Rob asked if stream substrate was accounted for in the model. Tan said channels were classified into types (artificial vs natural) and adjusted for roughness. Jon suggested Tan look at the hydro modification management program that did detailed studies of channels in Santa Clara and other counties.

Lester asked Jon and Tom if there is anything special about the Bay Area's tectonics that wouldn't allow learnings from the Chesapeake Bay to be directly applied to the SF Bay. Jon said that when you simulate sediment delivery based on flow depth, you have to get the surface and subsurface flow exactly right to make it work. That's also important for contaminant transport, and a good thing to do. Being tectonically active, uplift provides additional sediment sources that are difficult to model. You can deal with those to some extent by adding sediment sources. You can't predict when landslides will happen, so it's a background rate that's added. Tom added the complexity of tectonics on bank sloughing is hard to predict. It's more of a poisson event distribution rather than a normal distribution. You can only build it into the bed scour if you assume the whole

wetted perimeter will erode. The Chesapeake Bay values won't apply, but the methodology does.

Chris mentioned that deposition, storage and erosion is being accounted for in streams to some extent, but we aren't modeling by a HEC-RAS approach. That finer segment-by-segment resolution and calibration that would be needed is beyond our current modeling approach. Tan said our current verification of the channel sediment storage is done by looking at monitoring data from flood control analysis. We identify channels that most of the sediment passes through, and those that capture more sediment. We can qualitatively compare channel segments in that way.

#### WDM PCBs and Hg model setting & assumptions

WDM stormwater contaminant loading is divided into dissolved load and particulate load. Dissolved load is equal to flow volume times dissolved pollutant concentration. Particulate load is equal to suspended sediment load times pollutant concentration in sediment.

PCB and Hg data are being collected from RMP, CD3/CEDEN, CW4CB, and municipal stormwater monitoring programs. Spatial distribution of water and sediment reconnaissance data have good coverage of urban areas around the bay. Load monitoring includes five sites for Hg (0.4% of modeling domain), and seven sites for PCBs (4.5% of modeling domain).

Because our predominant data type is reconnaissance, calibration of PCB and Hg data was divided into two tiers, first at the HRU level and second at the watershed scale. For HRUs we want to parameterize potency factors in sediment and dissolved concentration. We will pool the reconnaissance data for calibration. Samples with delineated drainage areas will have the distribution of HRUs within that area, sediment yield, and flow. We can then assign concentrations to HRUs and compare with monitored data to calibrate the model.

For PCBs, the sum of 40 will be used as a surrogate for the sum of 209 congeners. We will use a fixed partitioning ratio for particulate and dissolved portions of PCBs. For Hg, the Guadalupe watershed data will not be used due to mining impacts. Dry and wet atmospheric deposition will be added to the Hg model for both HRUs and reaches.

The model is simulating total mercury (HgT) because the TMDL was based on HgT so there are less management and policy drivers for other Hg species.

Bonnie de Berry (EOA) noted that almost all of the load and reconnaissance monitoring stations were selected because they are assumed to have high PCBs loads based on land use. What impact (if any) do you think this has on the model? Tan said yes, we want to specify which areas have high loadings and separate those out to avoid the high bias of monitoring data.

Tan clarified the assumption of no contaminant phase change in the model. We assume there won't be a large change in attachment of PCB or Hg to sediment. It comes out at the same fractionation as it comes in.

Chris Sommers questioned the assumption on which we're basing the concept of separating PCBs and Hg into a dissolved phase and sediment-bound. Tan said we have some data that identify what portion will be in sediment and how much dissolved. If we just simulate contaminants in sediment, we might miss the dissolved phase in total loadings. Monitoring data will be used to give approximate proportions. Chris emphasized that this is an important concept. The model will eventually be used to understand the treatability of pollutants, which depends on how pollutants adhere to sediments.

Lester noted that stormwater agencies during the Proposition 13 grant did collect dissolved phase data, but ~90% of Hg is transported in the particulate phase. We haven't finished our deliberations on how we bring that into the model. Jay said we had discussions of this for conceptual model reports for PMUs. We did review the available info in those reports, although those were based on PCBs and we didn't have enough local info to make that dynamic. For Hg we have a little better understanding. Jon said in general you're okay here. The bulk of the PCBs will be sorbed. A challenge is the solubility varies across congeners. It would be nice to get into more detail, but can't really do that here. Chris again noted that we just need to make sure our assumptions are clear moving forward. Make sure we base this on what we can do and make assumptions based on best available information, then clearly document that. Lester mentioned a further complication: the relationship between dissolved and particulate does change during storms. But the question is do we need to bring that into the model now or can we address it later?

Don asked Tan how quickly could you turn on dynamic partitioning in the model if it becomes important for CECs? Tan said it is easy to turn that on, but to decide how to parameterize it is difficult. We need data to support that parameterization. Don suggested, to get started, maybe test some initial values and experiment with results.

#### Integrated Watershed and Bay Modeling Strategy & Pilot Study

The Main goal of this project is to develop a strategy to integrate different models (mostly watershed and in-Bay models) to better support future modeling and monitoring. In the second year, a pilot study will be implemented to test the strategy on one or more contaminants. The strategy will speak to what we can do now, what we can do in the near future, and what are our long term modeling goals.

Watershed models include the WDM and RWSM, which can provide stormwater flow, sediment supply, and contaminant load to the Bay. We also have the GreenPlan-IT tool that focuses on urban hydrology and urban contaminant load. It can simulate Green Stormwater Infrastructure/Low Impact Development (GSI/LID) impacts on load reductions. It can optimize GSI/LID for cost-effectiveness.

For in-Bay modeling, the Nutrient Management Strategy (NMS) has developed a 3D hydrodynamic model that will be coupled to a comprehensive fate and transport model that integrates stormwater and wastewater loads. It is currently able to model the dissolved phase of contaminants, but we have a strategy to develop a whole-Bay sediment fate model in the next 3-5 years.

We have developed a modeling Council of Wisdom (COW) to guide us in this work. Our first meeting was last week. There will be a draft modeling strategy for review in Fall 2022, and a modeling roadmap for the next five years will be ready by the end of 2022.

Jon asked if there had been thoughts about the feedback between the in-Bay and watershed models. It will be important to use the in-Bay model to inform the watershed model as well. Tan said that is a very good point, and currently we are focusing on the one-way input for providing the boundary conditions. Tan and Jon will connect to further discuss how the info from the in-Bay modeling can inform the watershed model.

### Other Modeling Updates

The final modeling project update included the CEC modeling evaluation that will provide suggestions for future CEC modeling. A draft report will be produced in the second half of 2022.

The ABAG land use update should be released in 1-2 months, which will allow the SEP-funded update to the RWSM to proceed. The RWSM update will incorporate new land use data and rainfall forcing data.

Lester said it's exciting to have a regional dynamic sediment model for the Bay. It's something we've wanted for 20 years. With the linkages to all other modeling work, the value will be well beyond what we've spent. It's exciting to see how that will drive the understanding of other bay processes.

Jay gave a preview of where the in-Bay strategy is going. The PCB Workgroup is interested in San Leandro Bay. It's had a lot of monitoring and is of high regulatory interest. That will be a prime place to start linking the watershed and in-bay model. Estimated loads from the watershed are lower than what is being seen in the data, suggesting watershed load estimates need to be revised.

## **9. Scientific Update: Stormwater CECs Monitoring Approach**

Kelly Moran gave an update on the stormwater CECs monitoring approach. This strategy was funded in 2022 as a two year effort. It is the first project to be developed that explicitly integrates monitoring and modeling. This is a cross-Workgroup project with SPLWG (monitoring) and ECWG (contaminants and conceptual models). Kelly introduced the ECWG team, which includes herself, Dr. Rebecca Sutton, Dr. Ezra Miller, Dr. Diana Lin, and Miguel Mendez (SFEI). The Workgroup's expert advisors are Dr. Bill Arnold (University of Minnesota), Dr. Miriam Diamond (University of Toronto), Dr. Derek Muir (Environment & Climate Change Canada), Dr. Dan Villeneuve (US EPA), Dr. Lee Ferguson (Duke University), and Dr. Heather Stapleton (Duke University). She also shouted out Dr. Ed Kolodziej, who isn't an advisor, but has been a valuable academic partner at the University of Washington.

Near-term priority management questions for stormwater CECs are:

1. Presence. Is a specific CEC or CEC family present in local stormwater runoff?
2. Load. Is the local watershed runoff load to SF Bay of a specific CEC big or small as compared to loads from other pathways (e.g., municipal wastewater)?

The RMP's efforts to establish a long-term stormwater monitoring network to estimate CECs loads to a surface waterbody is novel.

This Stormwater CECs Monitoring Approach Project has two elements:

1. Prioritization approach (ECWG) to select CEC families for monitoring
2. Stormwater CECs sampling design process (SPLWG & ECWG) that incorporates modeling

The deliverable will be a manual to guide future work, with a draft in spring 2023 and final in fall 2023. Kelly noted this project will not be a list of CECs for monitoring and it won't give a sampling plan. Each CEC family is unique and contains complex chemicals.

There are a lot of elements of this project. There is a need to do foundational research for many of these contaminants. Foundational work includes literature review and conceptual models, a chemical list and analysis selection, and a modeling-based sampling design.

Conceptual models are based on literature reviews. We also need to think about fate and transport issues. Jon mentioned the fugacity models, and one challenge we have in stormwater is non equilibrium conditions, so fate and transport is more complicated. Any prior monitoring data will be used in developing the conceptual model as well.

Process-based modeling will look for monitoring needs as we develop our study design and sample site selection. We recognize we need remote samplers and a formalized stormwater sampling database that has more information on each sampling site.

After monitoring, we'll take the data and our conceptual model to build the load estimates. We'll consult with stakeholders and we expect one of three possible responses: 1. that the load estimate is too uncertain and we need to modify the design, 2. that the load estimate is important, or 3. that the load estimate is unimportant and we can stop monitoring it. If the load is important and stakeholders decide to go forward, stakeholders may want to further investigate sources and refine loads with a more detailed approach.

For load monitoring, models will likely need many samples at the same location and from diverse sample locations. Sampling at sites with flow gauges has advantages. There are new flow gauges being installed around the Bay Area. We need to consider staff capacity, as training requirements for CECs monitoring are higher than usual. Storm availability is key (typically just 2-5 storms per year meet the current RMP mobilization criteria). Finally, we need to generate information quickly and cost effectively.

We are seeking feedback on our working concept for load monitoring design, developed for budgeting purposes:

1. Remote automated samplers
2. 12 locations (2-3 reference)
3. Monitoring location selection driven by information specific to pollutant family
4. 2 storms/year
5. 2 year minimum.

Kelly said going forward she expects that the effort in progress to update the RMP CECs Strategy and its associated tiered, risk-based framework will result in moving

some CEC groups up in importance, helping us prioritize. We have yet to evaluate vehicle contaminants in the RMP's tiered risk-based framework. Kelly said we're hoping we can initiate loads monitoring of CECs in Water Year 2024. A key next step is to buy or build remote samplers. There is a lot of energy for work in this area, and because of that energy, we were requested to prepare a pilot project proposal even though we are at a very early phase of our work on the stormwater CECs strategy.

Kelly went over the potential timeline for this work. At any time we could do presence/absence monitoring. We'll do foundational work for one CEC family (possibly PFAS) in 2023, and buy remote samplers. Then we would move on to integrated monitoring and modeling, which would be a multi-year effort for Water Years 2024 and 2025 (i.e., starting in fall 2023). In 2026 we would have a load estimate for the first CEC family. We could tier and add on other families of chemicals, but need to be careful not to overload the project. We are working on if the budget levels are in the right range.

We are particularly eager to get feedback on the overall approach. What tradeoffs should we evaluate? Monitor more or fewer sites? What are the tradeoffs between speed to get management answers vs chemical breadth and cost?

Tom Jobes said the general approach is good. Do you have a general sense of what is the next CEC to add to the list? Kelly said that's up in the air. It is a balance between what are the priorities for the bay and what is feasible. PFAS is the pilot because it has a lot of stakeholder interest. It is also the most daunting of the chemicals in terms of its breadth and depth of complexity. It is a favorite because there is a lot of literature available. The other one that is likely to be in the top tier when the RMP's tiered risk-based framework for CECs is updated is OPEs (organophosphate esters), which will be difficult to approach because literature is just starting to be developed for outdoor uses.

Steve asked if there is perennial flow at these sites, and if low flow as well as storm flow would be monitored. Low flow could contribute a large part of the load. Kelly said we still need to select the sites. There are 50 to choose from, some have perennial, and some don't. It isn't part of the pilot project work plan to monitor low flow. Lester said for the Bay Area's wet/dry conditions, we see 7% of flow volume during dry months, if we add wet season dry weather flow that doubles to 15%. If actual flow volume is so small compared to storm volume, it might not be as important, but something to think about. Rob commented that dry weather loading is important to consider. In his experience in pesticide monitoring in southern California, annual loading of dry season is often greater than from the flashy storms when averaged across the year. Kelly thanked Steve and

Rob for these comments and committed to considering them in the development of the stormwater CECs monitoring approach.

Steve weighed in on the question: Is 12 sites enough? Depends on contaminants and how predictable the relationship is between contaminant presence and parameters such as land use. Will depend on variability of parameters. It's a tough decision.

Rob noted that regarding design, it's important to get the first flush. That's the driving force of getting contaminants off the landscape. Rob asked if the new gauges being put online are all USGS? Kelly said the Water Board did an updated flow gauge map last year. Some flood districts are putting them in to monitor flood flows and climate change. Most of the gauges are in eastern Alameda county and eastern Santa Clara county. Most are not USGS gauges. Kelly will share the map with Rob.

Rob then asked about the three reactions to load estimates that Kelly mentioned. What would cause your estimates to be uncertain and what could you do to proactively address those? Kelly said we've had this happen, and the biggest concern is not enough samples. The other is not enough confidence in modeling. Rob suggests trying to handle that upfront. Kelly said yes, and we're looking for feedback on what level of uncertainty is acceptable. A lot hinges on being able to analyze the available monitoring data, which is part of the anticipated workflow.

Ed advocated for sampling baseflow if possible. It's useful to have some baseflow samples in the sampling matrix. There are also dry weather irrigation influenced flows. It would be remiss not to have any data in that space. He also emphasized the importance of first flush, which may not be the first storm. The first big storm or two of the year can result in mostly subsurface infiltration, with later storms having higher overland flow. He isn't sure how that translates to the Bay Area. Lester mentioned in urban areas, it can take half an inch of rain to generate runoff, and in more pervious and agricultural areas, it can take 5-7 inches of rain to create runoff. Steve said the importance of first flush is site dependent. It depends on where you're sampling in the watershed. If it's a small watershed, the first flush could dominate flow. In large watersheds the first flush higher in the watershed doesn't get to your sampling point until later in the hydrograph. How you define your first flush is important. Most important thing is to cover the entire hydrograph with sampling to properly compute loads.

Steve concurred that spreading out different contaminants over multiple years is a good idea for cost effectiveness and limiting the potential for overwhelming logistics. He suggested customizing the sampling design each year. Kelly said we are hoping to have

some overlap, which might mean we'd be less custom for each contaminant each year. We don't yet know how different each CEC family might be.

Bonnie commented she's not sure how accurate the RWQCB map of gauges is. It's also risky to rely on gauges installed by flood control districts. Have you considered installing and maintaining your own stream gauge(s) (or supporting another organization in this effort)? This approach could open you up to conducting loads monitoring in creeks with the ideal mix of land uses. It could also benefit other RMP studies. Kelly said a significant part of the budget in the proposal will go toward building up the database. We are not taking on installing and maintaining our own gauges due to the large expense. We're confident we'll be able to rely on flow gauges from others.

Kelly asked if stakeholders in the Workgroup could comment on uncertainty of load. What kind of information would you need to give us input on that? Tom said it's difficult to have an agency to have a sense of how to approach uncertainty. They don't know how to interpret the uncertainty so they prefer an answer. Lester asked if there are situations where re-running the model would address the uncertainty rather than the time-costly collection of more monitoring data? Tom suggested it could be the case and that uncertainty analysis can provide feedback to the conceptual model too. The uncertainty may be due to the conceptual model being too simple. You could add new pathways or improve parameters. Kelly notes there is the potential for PFAS to be transported in subterranean flow from contaminated sites, such as those in the Water Board's database, and that might not be something we include at the start, but could add later on.

Ed said the biggest uncertainty might be extrapolating low/uncertain concentrations over long times. Combinations of analytical and flow error might have significant effects on load estimates, especially if baseflow load is somewhat large and contaminant loadings are temporal.

Steve mentioned that whenever he can, he designs a two year study. It's risky to have one year of data to make conclusions and decisions.

Richard said we can possibly draw from Lester's advanced data analysis, which normalizes storms to rank watersheds. To frame climate related uncertainty for the stakeholder discussion, we could catalog things leading to uncertainty—was it due to storm size, location, timing, etc. Kelly said that's a good idea, and we might lay out a table of sources of uncertainty.

## Day 2

## 10. Summary of Yesterday and Goals for Today

Melissa Foley started the day by recapping Day 1 of the Workgroup meeting. The goals for Day 2 and the agenda are listed below.

- Brief recap of yesterday's discussions and outcomes
- Update on the tires strategy
- Brief update on projects or proposals from other workgroups that have connection to the SPLWG
- Presentation of proposals for fiscal year 2023.
- Discuss and recommend/prioritize which special study proposals should be funded in 2023 and provide advice to enhance those proposals

10.	Summary of Yesterday and Goals for Today	10:00
11.	Scientific Update: Tires Strategy Update	10:15
12.	Other Workgroup Projects/Proposals with Connections to SPLWG	10:30
13.	Summary of Proposed SPLWG Studies for 2023	10:40
	LUNCH	12:00
14.	Discussion of Recommended Studies for 2023 - General Q&A, Prioritization	12:30
15.	Closed Session - Decision: Recommendations for 2023 Special Studies Funding	1:20
16.	Report Out on Recommendations	2:20
	Adjourn	2:30

## 11. Scientific Update: Tires Strategy Update

Kelly presented an update on the MPWG-funded Tires Strategy, a short-term multi-year plan to address tire-related water pollution. She noted the stakeholders here have been represented in other Workgroups, so the short time for this presentation is mainly for science advisor input. We are looking for high level feedback at this time.

The RMP and Ocean Protection Council funded a synthesis of microplastic sources and pathways in urban runoff, including a conceptual model for tires based on a literature review. SFEI's tire-related work is uniquely management focused, so there have been a lot of presentation requests. At the SETAC North America conference, Kelly co-organized a tires session that was the most well attended session at the conference, which is a strong indicator of the interest in the work.

Non-RMP scientific activity is mostly focused on aquatic toxicity. Some environmental monitoring and chemistry work is happening. For mitigation, with the exception of DTSC's anticipated Safer Consumer Products Program actions on 6PPD, almost the entire conversation is around treatment and very few other strategies are being

discussed. Little is happening in the fate and transport area, and as a result in the continued knowledge gap around tire wear particle surface area, it's not clear whether or not treatment right at highway road sides that is envisioned by many outside of the Bay Area as the primary response will be effective. We know 6PPD-quinone is lethal to coho, and a recent paper found lethal toxicity to rainbow trout (same species as steelhead). Kelly shared a summary of tire particle and leachate toxicity data, all of which is very recent (2021 and 2022), and more research is coming. None of these tire particle and tire leachate studies include chemical identification work due to the cost and complexity of the required chemical analysis, which is typically out of reach for toxicology labs. Research has been done on a wide variety of species that cover fresh and saltwater. The data show multiple types of adverse effects to multiple species at concentrations that the authors believe to be environmentally relevant. We can't draw a specific conclusion right now, as we do not have whole tire material monitoring data, so we cannot compare these results to our monitoring data, but there is a growing body of evidence that supports the conclusion that tire particles and chemicals are harmful to aquatic organisms.

The multi-year plan will include a brief summary of management decisions and recent findings, as well as a budget and brief descriptor of high priority work in subsequent years. A draft will be shared in mid 2022.

Kelly outlined the known management drivers of the work. The Department of Toxic Substances Control (DTSC) Safer Consumer Products Program just announced the nation's first tire regulation to protect salmon from 6PPD-quinone. To implement their work plan, they are eager to get monitoring data on both tire chemicals and microplastics. The California statewide Microplastics Strategy recently adopted by the Ocean Protection Council includes a tires sector pollution prevention strategy to be developed by 2023. The EPA trash free waters program has a tires work plan in the works. Regulations are not expected to come directly from that effort.

Kelly outlined the contents of RMP multi-year plans, focusing on the two elements where we are requesting feedback today, the proposed management question driving the plan and the list of special studies envisioned during the plan's five-year timeframe. The special studies list is based on the proposed management question: Do tire contaminants have the potential to adversely affect beneficial uses in the SF Bay? We are seeking input on this management question. In other workgroups, we received feedback that consideration should be given to broadening this question to include particles as well as chemicals, recognizing that the chemicals are inextricably linked to the particles that contain them.

Kelly described the draft special studies plan, which has three elements. The first is to continue the monitoring for the current group of tire and vehicle chemicals in the Bay and its margins in conjunction with the Bay wet season pilot study that we started this past winter (the information Alicia reviewed in Day 1). To respond to DTSC's request for monitoring data for other tire-related chemicals, there is a placeholder for a future special study to monitor additional chemicals of interest. We're also proposing special funding for the next five years to continue to track literature, identify other tire contaminants that could be monitored, and provide scientific information to management agencies. Based on feedback from the Emerging Contaminants and Microplastics Workgroups, there is interest in including a study proposal for measuring whole tire content of water samples in the Bay, and possibly in watersheds, in order to be able to compare Bay data to toxicity studies. This will also help link particles and chemicals.

Steve said everything they've seen in the literature is consistent with what Kelly is presenting. They are pursuing a way to do similar work in their area, and he's glad they're putting in the effort. Melissa asked if Steve is working on both particles and chemicals. Steve said their proposals focus on chemicals in runoff, not particles in sediment yet.

Rob commented on the proposed sampling. It's Bay focused and doesn't go upstream. It is important to go into watersheds to see sources and loads in the areas where affected organisms might reside. That seems like a missing piece.

Luisa Valiela (EPA) asked why the draft management question is focused on beneficial uses. It seems broad and could send you down a lot of paths. She was wondering if it's being framed appropriately at this point or if we want to be more specific and tie it directly to a management action. Luisa said beneficial uses can be fishable, swimmable, etc. Are we thinking about people or animals? Maybe our broad signal is that all of these need work, but the RMP may not be the place to fund all of them. Kelly has been thinking about endangered species habitat. So far there is evidence for direct effects on organisms. There has been some research on shellfish toxicity, which isn't a big issue in the bay because consumption is low. Richard added that the beneficial uses question is broad because it reflects a level one RMP question. For instance: are concentrations at levels of concern or are impacts likely? You don't make a judgement about the mechanism.

Keunyea Song (Washington State Department of Ecology) said that Washington has the same problem with 6PPD-quinone, so they've been going through a similar process to develop a monitoring plan to understand the potential impact. Keunyea's concern is

that 6PPD-quinone has a short half life (note: this was not confirmed by others in the meeting), which may be an important factor for monitoring design. The RMP conceptual model for tire contaminants includes transport in both dissolved and particulate phases, the latter where chemicals can continue to be released. It's not clear when or where that release is happening. Keunyea noted they have a 6PPD workgroup in Washington. Kelly said they've been tracking that workgroup, and will be in touch with Keunyea.

## **12. Other Workgroup Projects/Proposals with Connections to SPLWG**

Kelly gave an overview of three proposals from other Workgroups that are relevant to the SPLWG.

The first is the stormwater CEC monitoring strategy that was split into a two year project, funded by the RMP through the Emerging Contaminants Workgroup. The motivation is to develop a long term stormwater monitoring approach. Kelly presented this project on Day 1.

The second is an Emerging Contaminants Workgroup proposal for monitoring tire contaminants in wet season Bay water. Motivation for this work was the detection of tire-related chemicals at nearfield Bay sites in 2021. We have the option for the next two years to leverage pilot Status and Trends wet season monitoring, so we want to take advantage of that. Deliverables will be a short report and data uploaded to CEDEN. The budget is \$40k for Year 1, \$80k total.

Those first two projects were highly rated by the Emerging Contaminants Workgroup.

The third project is a proposal from the Microplastics Workgroup to evaluate fiber emissions from household dryers to estimate loads to urban stormwater and the Bay. Because fibers are one of the primary types of microplastics we need to understand if tumble dryers are a major source of fibers. The proposal includes seed funding from Patagonia, and they have expressed interest to partially fund the project over the next few years. The proposed Year 1 budget for the RMP is \$71,500.

## **13. Summary of Proposed SPLWG Studies for 2023**

2023 RMP SPLWG Special Study Proposals included:

1. Stormwater PCBs and Hg Monitoring to Support Modeling
2. Remote sampler development for tidal areas and pilot testing
3. CECs monitoring in stormwater: PFAS
4. WDM to Support Watershed Loads and Trends for Hg and PCBs (year 2)
5. Stormwater CECs modeling: PFOS/PFOA pilot

### Small Tributaries Legacy Pollutant Discrete Monitoring to Support Modeling

Alicia started by stating the motivation for this proposal is to learn more about PCBs and Hg to model loads, assess trends, and identify areas for management actions. Load monitoring is important for calibrating the WDM. Very few load monitoring stations are currently available for calibrating the model. Further, there will be a reevaluation of PCB TMDL in 2028 and Hg in 2030. The reconnaissance data only include concentration, not flow. Only by pairing concentration with flow data can we see if modeled loads are correct. In addition, the sampled calibration watersheds are highly urban and don't have a diverse HRU distribution, which is needed for the model.

The proposal includes selecting two stations with existing flow gauges and sampling six storm events over two years. During each storm four discrete samples would be collected over the course of the hydrograph. Alicia showed a map of potential watersheds to select. Guadalupe River is a good option for assessing trends, while the other proposed sites would increase spatial heterogeneity of monitoring. Deliverables include a concise technical report and data delivered to the modeling team. The budget is for \$90k in the first year, \$140k in second year (includes data QA and synthesis in the second year). There are \$80K of carryover funds from this year's sampling, so we only need \$10K for 2023.

Rob asked how many HRUs need to be represented in sampling for the model. He also commented that if sites are picked based on available flow data, does that limit the representation of HRUs? Tan said that most existing monitoring locations are industrial, impervious, and commercial. There is a big proportion of atmospheric deposition for Hg, so there will be loading from rural areas. We hope to have signals from those areas, but we are still looking at the combination of HRUs in the watersheds. Jon mentioned that when picking sites, if you prioritize based on type of land cover, there might be an argument for prioritizing watersheds with forest cover.

Jon asked which are more complicated and have higher laboratory costs: discrete samples or composite? Alicia said that from the monitoring standpoint, discrete are easier to collect but have higher laboratory costs. We need paired flow data to get a flow-weighted composite, which is harder to do. Jon suggested collecting large samples and making composites after the fact. For model calibration, it's better to have load over storm than the load within the storm. Composite has some advantages for that.

Chris said we should think about the reasons we're doing this. We want to inform trends. But there may be an information gap in understanding contributions from non-urban areas. In watershed selection, Sunnyvale East was presented as second tier, but it is one of the major sources of PCBs in that watershed. There has been work at

the Superfund site since previous monitoring was done there. We could maybe see a big change there, and it would be a good proof of concept watershed. Alicia said that they'll take all of that into account and do more work on analyzing HRU diversity before choosing a watershed.

#### Tidal Area Sampling Remote Sampler Development and Pilot Testing

Alicia showed a map of old industrial PCB source areas, and noted that it represents 3.5% of the landscape, but contributes 64% of PCB loading. Over half of this area is within 1 km of the Bay's edge, where it's tidally influenced. The motivation for the project is that permittees still need to identify source areas for management actions. Tides make sampling very difficult using our current sampling methods. Low tides must align with a storm event. If there is alignment at all, often the timing window of a storm event happening at a very low tide is very small, and it's hard to get a team there to capture it. We have found a sampler that's been tested and used by the EPA, and we think we could modify it to use successfully in tidal areas. It consists of a micro pump inside a Pelican case with an intake tube and a strainer that sucks samples into bags. It's held at mid depth by a buoy and a weight on the channel bed. EPA has used it over 100 times. USGS this fall/winter will be adding telemetry and other modifications.

We propose to pilot test one sampler from EPA/USGS or build our own and include a salinity sampler to only trigger sampling during stormwater flows. We want to test them at four locations around the Bay with field replicates and blanks at every site. Deliverables include quality analyzed data available through the CD3 web tool, and a methods report. The proposed budget is \$85k.

Tom Jobes said this is a very exciting endeavor and useful for characterizing loads and distinguishing boundary conditions. He asked if the salinity sensor was the only modification. Don Yee said that the salinity sensor is a first order modification, but they're thinking about building around a platform called Mayfly, which has many water quality capabilities. They could tag on things for flow weighted composites or depth that could trigger sampling.

Lisa Austin commented that this could be an important tool for the stormwater programs to identify PCB source properties that discharge directly to the Bay.

Jon noted that this proposal was brought up last year, and asked if there were changes. Alicia said this is a similar proposal, but learning about the new sampler has been a major breakthrough. Lester added that last year's proposal was to completely invent a sampler. This is now a slight modification of an existing sampler.

Richard recalled the conversation from last year regarding contaminant movement up and downstream (“sloshing back and forth”) in tidal influenced edge areas, and he wanted to cover those bases to ensure a sound sampling method. There is a potential challenge of distinguishing pollutant signals from upstream of the sample point vs stuff that has gone past and is being swirled back up and sampled a second or third time. Alicia said that the salinity sensor will only monitor during freshwater flow. Because of that her hunch is that we’ll only see signals coming downstream. Richard said that contaminated sediment is taken back upstream and deposits. He wanted to know how significant this might be. Rather than seek perfection, is there a bounding exercise to reassure people interpreting data? Don said even with perfect knowledge of the processes it’s hard to know how to sample that point. If you knew percentages of up- vs downstream load, and tried to separate out tidal influence, you’d likely miss new loads during a storm event.

Richard wondered if you could pair that info with a sampling point further upstream with much less potential of the confounding problem, and compare estimates. You could do it as a confirmatory study, not at every site. Don and Lester mentioned that this proposal is planning to sample at outflow locations, so there is no upstream option. By sampling further upstream, you would eliminate the source you were trying to get. Maybe taking samples way downstream would help—if it’s higher downstream, then sloshing is important, and if it’s lower that would be in the direction we expect from dilution. Another option is to take sediment samples and compare the concentrations in the sediment to the concentrations in the stormwater sediment. If concentrations are higher in the stormwater sediment, that would tell you there is an upstream source greater than the source from the bed. Richard wrapped up the discussion by saying thanks for the thoughts on the “sloshing” problem. It is not something that troubles him deeply, but he thinks it makes sense to take some reasonable measures to try and account for it to aid in interpretation of the results. He would definitely appreciate a less-than-perfect answer for these tidally-influenced sites.

Steve said a potential solution is to have a flow monitoring device, like velocity and stage. Then you could compute an estimate of flow in real time and do flow composite sampling. It will accumulate negative when it is going upstream. Then you’d wait until you accumulate positive to take the next subsample. You’ll never get the perfect answer, but it’s better than sampling without flow. That is extra effort and expense, so we need to decide how important it is. Ultimately the advantage is you get a load with flow.

Jon asked if there are certain sites where you could combine the tidal sensor with measurements from storm drains with one-way flap gates that keep out most Bay water.

Private property access seems to be the challenge here. Richard noted that it is not worth the Water Board's effort to require access through the tidal properties.

#### CECs Monitoring in Stormwater: PFAS

Before starting this item, Kelly addressed a question from Jon Butcher who had asked for clarification on the process of how we choose CECs to monitor. Our emerging contaminants work is guided by the RMP CECs strategy developed through the RMP's Emerging Contaminants Workgroup. It includes a tiered risk-based framework for evaluating and prioritizing contaminants. The process includes consideration of chemicals in commerce, their potential aquatic toxicity, and pathways to the Bay. We start in the Bay because we're the "Bay Monitoring Program."

Kelly began by informing the group that the team is planning to re-scope this proposal based on pre-meeting conversations with Technical Advisors, Tom Mumley, and Chris Sommers. . At the Emerging Contaminants Workgroup meeting, we heard a lot of energy for moving this program forward. Subsequent conversations have clarified that we were overly ambitious in thinking we could launch a pilot project next year right when we're so early in the development of the stormwater monitoring approach. Tom Mumley, the Steering Committee Chair, has recommended that we an idea to replace the current project scope with something less specific that would lay the groundwork for our upcoming stormwater CECs monitoring. We will work out the details as we go with the goal of monitoring in Fall 2023. We seek input today on what should be included in that revised proposal.

To illustrate the complexity of CECs monitoring, she described the process necessary to prepare a sampling and analysis plan for a single CECs chemical family. First we need to determine the analyte list, which is one of the outcomes of the groundwork that we have called the "conceptual model" development. Then we need to find a reliable analytical lab capable of processing the number of samples we generate in a timely, high quality manner and provide results for all the necessary analytes with useful reporting limits. This can be a challenge for novel chemical families and may require a year or more of laboratory method development before monitoring can begin.. Then we need to determine sampling equipment and methods that won't contaminate samples. There are many things to consider! For instance, SFEI's neighbor is a carpet contractor that could emit chemicals like PFAS and OPEs that could contaminate our equipment and prevent use of our lab for blank testing.

We are looking for input on:

1. What investments do we need to make to get from where we are to implementing our CECs monitoring?
2. Are there missing elements we haven't considered sufficiently?

Some parts of the proposal in your packet are specific to PFAS, such as the conceptual model chemical analysis methods. Other aspects provide general groundwork for our CECs monitoring design, such as the stormwater sites database and remote sampler development. As this proposal is being modified, we'll need to put more budget into the sampler than originally planned, as we have discovered that we will need to build our own samplers and that we may need completely different samplers for PFAS, as the primary strategy to avoid contamination when sampling other CECs is to use all teflon (PFAS-containing) parts.

One option to move forward would be to switch the pilot sampling from PFAS to the tire and vehicle contaminants that we are monitoring in the Bay. Focusing on tire related contaminants would reduce costs because a conceptual model has already been developed and a reliable lab partner for that work exists (UW). Those cost savings would allow more funds for other areas, such as remote sampler development.

Kelly asked for feedback on how we as a group want to structure this program and move forward as quickly as possible and do it in a quality way. Discussion for this proposal is in item 14 below.

#### Regional Model Development to Support Assessment of Watershed Loads and Trends (phase 2)

Tan Zi presented the modeling proposals. Based on the Multi-Year Modeling Plan, the proposal for 2023 builds upon the baseline load modeling being done in 2022 and evaluates control measures. The proposed approach is SWMM + WDM simulations. The EPA SWMM model will be used for specific GSI simulation to quantify load reduction. We will summarize load reductions for specific GSI at the HRU scale, and apply that to the WDM.

Data gathering and processing will be done in the first quarter. Three stakeholder meetings will be held to discuss local knowledge and model assumptions, as well as gather feedback for early stage setup of the WDM to update the RWSM. The deliverables are a regional GSI data layer and a report, with a \$130k budget. The report will be available by the end of the year.

Jon asked if Tan envisioned coming up with a single efficiency factor for each GSI type or something more dynamic? Tan said that different types of GSI will have different

efficiency factors, and they will be summarized for each HRU. It's challenging to represent the dynamics in WDM, even though we can do it in SWMM. Jon suggested there might be an intermediate point to think about. A lot of the pollutants that get past GSI are in large flows that can bypass treatment systems. You could divide the loading when it gets above a certain volume or rate of flow. Richard said he read the reasonable assurance analysis reports from different permittees and they followed a similar HRU approach. A lot involved figuring out a bypass component. Tan said he already has the RAA reports, and we can rely on those previous studies.

Chris said Jon brings up a good point. We should manage our expectations on what data and resolution of data we have on facilities. He's not sure whether or not there are many GIS data layers for these data. Tan said we haven't seen the data layer yet, but one crucial thing we need is the drainage area of GSI, and we might need to make assumptions. Lisa Austin said that in Contra Costa and Alameda counties, drainage area delineated will depend on the area treated. A large regional facility will possibly have a drainage area delineated. Often, there are multiple GSI on a parcel, and we only have the GSI boundaries, not drainage areas.

#### Stormwater CECs modeling: PFOS/PFOA pilot

Tan said we may need to rescope this modeling with the monitoring study presented by Kelly. The general methodology is to: 1. Develop an approach for screening-level stormwater loading estimation for one or two members of the PFAS family or other CECs, 2. Pilot a load estimation approach, and 3. Identify data gaps.

PFAS is a complicated family of chemicals, as discussed earlier in this meeting. The idea is that once we work through this family, we can apply that process to other chemicals, speeding up our work in the future. Piloting the load estimation approach would rely on the other project that was proposed to provide a conceptual model. That conceptual model will be necessary to support the CEC modeling exploration and we'll do literature review to provide model assumptions. Then we'll calibrate using monitoring data. We have 33 PFOS/PFOA grab samples from 2010/2011 at 10 sites. From 2019-2022 we collected 26 CEC urban stormwater samples and four reference samples that were analyzed for a variety of PFAS, including PFOS and PFOA.

In general we hope the conceptual model will help identify key fate and transport characteristics, and what type of watersheds we should look at. Literature review will focus on stormwater monitoring methods, validity of local conditions, and basic information from monitoring results.

The proposed approach is a hybrid modeling scheme that includes a conceptual model. We will pair the flow output from the WDM to concentration monitoring data to derive EMC based mean concentrations. This will give us simple first order load estimations.

Deliverables include a technical report and ECWG and SPLWG presentations. The budget is \$100k. Melissa noted that this proposal will likely change in step with Kelly's CEC monitoring project.

Tom observed that it depends heavily on conceptual model development. That is the most difficult part of PFAS. We don't know if there is enough information to inform the conceptual model for that family yet. Tan said we have a conceptual model for tire particles, but less monitoring data. Tom asked Tan to speculate on how much the reduced dataset will affect the reliability of first order estimates. Tan didn't think it would be a big difference because it hinges on the conceptual model. Although we have more data for a few chemicals in the PFAS family, it's still very limited, and it won't change data analysis much.

Keunyea asked what the baseline reference condition for monitoring and modeling will be. PFAS is everywhere, and the dominant PFAS compound differs by land use type. Will you develop a model and monitoring to consider those land uses? Kelly said we have criteria for reference sites and have data from those sites far upstream from sources. There are 26 urban sites, and 4 reference. We will evaluate baseline conditions with the full dataset later this summer. Our existing data doesn't include all outdoor use PFAS. Tan adds that we haven't figured out whether it is entirely land use based or if there are other factors. That will be derived from the conceptual model. Keunyea asked if sampling will be from MS4 outfall or receiving water monitoring? Kelly said because we're looking at loads it will be receiving water monitoring. The Bay area differs from Washington in that most creek flow during storm events is urban runoff.

#### **14. Discussion of Recommended Studies for 2023 - General Q&A, Prioritization**

After a break, discussion resumed with the CEC monitoring project, presented earlier by Kelly. Diana Lin (SFEI) briefly joined the meeting as a PFAS expert.

Rob asked if the project switches to tire contaminants instead of PFAS, does that alter the aspects of the design or proposal? Kelly said it allows us to transfer funds from development of a conceptual model to other activities such as pilot testing remote samplers. It would provide for cost savings and simplification. In terms of sampler design, sampling for PFAS has been worked out in wastewater, not stormwater. And there are lots of other considerations for PFAS as it's a more daunting and difficult chemical family for a pilot.

Jon asked if PFAS have a significant loading pathway versus wastewater systems. He noted some of them are quite mobile in groundwater. Diana said the goal of study is to better understand these pathways. Jon added that tire compounds are soluble and likely have a groundwater pathway.

Rob wondered about the utility of samplers in a stream setting. Sampling could occur in low flow or high flow streams. Base flows are often two feet or less. With the design of this sampler suspended between a cement block and buoy, there needs to be some perennial flow depth to make these workable. A lot of streams won't be viable. The other extreme is high flow like Walnut Creek or Guadalupe River during storm events. They have had high debris flows that can cause entire ISCOs to be lost. And how will you reach them at the end of the event when baseflow is still high? Rob said the remote samplers will be awesome for the tidal project, but how will they be used in streams for the CEC monitoring project? Don said we can't get something perfect for all situations. For low flow it could be used like a quick setup ISCO as opposed to floating design. For high flows, the sampler could be placed behind a hard structure. Samplers might not get fully into the main stem, but turbulent flow would give us a reasonable estimate of loads. We might need to validate with cross sectional studies.

Kelly said the intent is to use telemetry or flow-based triggering, so it wouldn't be turned on during low flow. Rob noted the main concern is you'd select sites based on where samplers will work rather than based on other site characteristics. Kelly said that is a good reason why we need a pilot to compare these remote samplers to ISCOs.

Chris stressed that this will start out at the pilot scale, and we will figure out applications that work well. Storm-driven monitoring in the Bay Area is of focus right now, including for macro trash monitoring in LID. We're getting on average three storms per year, so to hit our storm event goals we have to get multiple sites rather than a single site. Remote samplers are helping. He could see that some high flow situations with lots of sediment movement could bury a system. High flow events are needed for model calibration, so perhaps we have to think we will need people out in the field. Whatever we do with automated samplers vs crew sampling methods, make sure those methods are comparable. We will need to use contractors to cover this large amount of work, so it's important to be realistic about what we can achieve.

Chris said the Municipal Regional Stormwater Permit (MRP) requires LID monitoring, so we also have to go through methodology issues in the next year or so. LID monitoring is required to be in deployment by fall 2024. If we go away from PFAS, is there other work that could help the methodology development, including sampling, storage, and

processing methods? Kelly said if we start with another pollutant, we could pick up PFAS a year later. If we take on tire contaminants now, we could make PFAS the second pollutant because of high stakeholder interest. Diana added we are monitoring PFAS in wastewater in a separate project and learning how to collect samples. There are certain analytical methods available at commercial laboratories; what we can measure is a small subset of the broad class of PFAS.

Diana discussed the targeted analysis method, which ranges from 30-70 analytes. The Total Oxidizable Precursor (TOP) method incorporates more PFAS compounds by converting the oxidizable PFAS to terminal products. In the wastewater study, the TOP method measured concentrations an order of magnitude greater than the targeted method. That gives us an idea of the importance of looking at other PFAS we aren't capturing with the targeted method.

Steve asked what kind of information is known about groundwater/surface water interaction in the systems being considered. Will the mobility of PFAS in groundwater influence monitoring? Lester said we haven't done much groundwater analysis, but Tan could explore it with the WDM. We could draw from the expertise of water district staff. Kelly said that to avoid the influence of polluted groundwater, part of monitoring location selection for PFAS would be to identify and avoid areas with known PFAS contaminated sites.

Steve asked Diana if they have done a comparison of PFAS samples of stormwater in the area or just wastewater? Diana said we don't know how they compare yet as we are waiting for the rest of the stormwater monitoring data.

Steve wondered if there were any surprise hotspots. In the Great Lakes, they didn't find major hot spots in the 70-80 sites sampled in ambient monitoring. The most important findings were from evaluating upstream and downstream of sewage treatment plants. Depending on the type of treatment, they found a big jump in PFAS downstream. Airports upstream dominated the signal in a few cases. Lester asked if Steve found influence in areas where there are septic systems. It will be important to know the contributions of rural areas.

Steve said the EPA has used auto samplers in small streams (even 1 ft water). They can be adjusted for the type of stream. For instance, you could put a cap on end if it's exposed tubing and put a purge at the beginning of the cycle. High flows are a big concern. Can you run a chain back to the bank of stream or set an anchor of some sort? Lester said we've been lucky not to have lost equipment yet, but we've seen less plastic and debris now compared to over the past 20 years. After the pilot sampling of micro

samplers in Bay margins, that might become an easier method than sampling during high flow upstream. If that's the case, we could deploy them prior to a storm in 30-50 locations and it could completely change how we think about sampling design.

Chris asked for clarification on how the timing of CECs stormwater monitoring and modeling fit together. Kelly said that if we don't do them hand in hand then we won't be able to know how to do the monitoring to best inform the modeling or vice versa. Chris asked if they are a package deal. Kelly said if we stop one it will affect the scope and budget of the other. We're trying to build a program that integrates both.

Tom asked about the scalability of monitoring projects, especially those with a large budget. He also asked if switching to tire contaminants (that already has a conceptual model) would increase scalability. Kelly said the proposed budget is based on a preliminary conversation with the Steering Committee Chair. We want to be ready to implement full scale monitoring next year. She added that if we shifted to tire and vehicle contaminants, we could allocate the savings in conceptual model development to areas we under-budgeted like piloting samplers and the sampling locations database. It's a moving target because we're still learning. What do we need to do and at what scale? That's a conversation we still want to have and need to meet the expectation of stakeholders a year from now to be out there at full scale.

Rob noted CEC families are very dispersed and unrelated. He asked how will the info from the pilot be applied to full scale monitoring studies? Remote samplers might need to be different for each CEC family. Kelly said the budget will be used for the groundwork needed to design sampling plans. The following year would involve the foundational work for the next contaminant family. The process approach would be ready for the following years.

Steve said there is a lot of emphasis on PFAS around the country, so it's somewhat pressing to get information on that family. We need to identify if there are PFAS at high levels and which sites have dominant signals. We also need to include effort on developing general sampling methods for CECs. A fraction of PFAS chemicals are likely to be sorbed to sediment. Is it feasible to sample a bunch of sites for sediment (more straightforward) and to inform future efforts of water sampling after the CEC methods are in place. Kelly stated that there are many different PFAS with diverse uses and chemical properties. Unfortunately, it would be unlikely that learning about the PFAS in sediment would inform understanding of the different PFAS that occur primarily in water. Another consideration is that the State Water Board operates a statewide sediment monitoring program called the Stream Pollution Trends (SPoT) program, which is monitoring PFAS in sediment. Kelly wanted to think more about this, but was not sure

we'd get a leg up by doing sediment sampling at this point. Steve said that focusing on different chemicals makes a difference. We've found that total PFAS goes up and down in water and sediment, just different chemicals show up. Steve said that work was using the targeted method. Kelly said that given the wastewater results which revealed many new insights with the broader suite of PFAS and the TOP methods, we want to make sure we have the breadth provided by the TOP method and additional analytes. Melissa mentioned we will be monitoring PFAS as part of Status and Trends sediment sampling.

The discussion then shifted to the other proposals. Alicia gave a clarification of the small \$10k budget for the small tributaries loading monitoring. It's a two year study, and the first year is three storms at two sites with a \$90k cost, but \$80k is carryover from the prior year. Data quality analysis, interpretation, and reporting will be asked for next year for \$140k.

Melissa then gave an overview of planning dollars. The planning budget is \$335k, which is the sum of the four proposals not including the CECs stormwater monitoring project. That proposal is in the planning budget of the Emerging Contaminants Workgroup, but we would like the SPLWG to give their input on how to prioritize that work. The Special Studies are all funded from one pot, so there are some artificial constructs for relative budget guidance for each Workgroup.

## **15. Closed Session - Decision: Recommendations for 2023 Special Studies Funding**

Workgroup members discussed and prioritized the proposed studies while those who presented the proposals stepped out.

## **16. Report Out on Recommendations**

Chris Sommers reported the workgroup's conclusions.

He began by saying the Workgroup thinks all of this is a priority, which makes it difficult to prioritize. First, the extra \$10k to spend toward discrete monitoring was an easy investment and was a priority. The regional dynamic model was deemed important and ranked as number two. Then it became harder to prioritize the rest. The group agreed the tidal area remote sampling was important for legacy contaminants as well as informing work for CECs in the future. Monitoring properties at the edge of the bay will help inform models too.

The CEC stormwater monitoring project was ranked fourth. Ultimately, it came down to pacing of the sequential process of monitoring and modeling. Monitoring held a higher priority as we staggered monitoring and modeling. If monitoring gets funded, the

Workgroup was generally supportive of switching the focus from PFAS to tire contaminants. We still want to track scientific progress on PFAS. Finally, the group suggested that a reduced budget for first order CEC loads modeling could be sufficient (~\$25k). The group is hopeful all projects are funded in combination with SPLWG, ECWG and supplemented with water quality improvement funds (EPA).

Melissa thanked everyone for taking the time to attend and participate in this two day meeting. Special thanks went to the science advisors for their great input. Alicia and Tan will follow up after the TRC and SC meetings to communicate the final funding decisions. As the CEC stormwater monitoring and modeling proposals evolve, Kelly and Tan may reach out for further input.