SPLWG Special Study Proposal: STLS Program Management

Summary: The goal of the Small Tributary Loading Strategy (STLS) over the next few years is to continue to provide information to RMP stakeholders and the public that directly supports the identification and management of PCBs, Hg, and other pollutant sources, concentrations, and loads in stormwater, and the determination of trends in relation to management efforts in San Francisco Bay. This proposal is to provide STLS program management to help achieve this goal. The outcome of this task is to maintain communication with the BASMAA program and Water Board representatives via in-person and phone meetings. Specific activities include coordinating regular meetings, planning and developing agendas and materials, preparing meeting summaries, and attendance at key external meetings.

Estimated Cost: $25k
Oversight Group: STLS/SPLWG
Proposed by: Alicia Gilbreath, Lester McKee, Tan Zi, Jennifer Hunt (SFEI)
Time Sensitive: Yes - since the RMP does not provide general program funds for this level of coordination, this budget is needed each year to run the program.

Proposed Deliverables and Timeline

Deliverable	Due Date
Prepare for and hold 6 STLS meetings during calendar year 2021	12/2021
Meeting summary and action items for each meeting	12/2021
Attending key external meetings	12/2021

Background

The San Francisco Bay Hg and PCB TMDLs call for a reduction in loads by 50 and 90% by 2028 and 2030, respectively. In response, the Municipal Regional Permit for Stormwater (MRP) (SFRWQCB 2009, SFRWQCB 2015) called for a range of actions, including gaining a better understanding of which Bay tributaries contribute the most loading to sensitive areas of biological interest on the Bay margin, better quantification of sediments and trace contaminant loads on a watershed basis and regionally, a better understanding of how and where trends might best be measured, and an improved understanding of which management measures may be most effective in reducing impairment. In response, the STLS was formed to develop and outline a set of evolving management questions (SFEI, 2009) that have been used as the guiding principles for the region’s stormwater-related activities.

Study Objectives and Applicable RMP Management Questions

With an increased focus on collaboration synergy between projects funded by the RMP and those funded directly by BASMAA, it was recognized in 2009 that an annual budget allocation was needed to ensure constant and efficient communication between RMP program staff and BASMAA and Water Board representatives. This objective helps ensure quality planning and implementation of projects that aim to answer the priority management questions.

Table 1. Study objectives and questions relevant to RMP 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?	Provide constant and efficient communication between RMP program staff and BASMAA and Water Board representatives to ensure quality planning and implementation of projects that aim to answer the management questions.	N/A
Q2: Which are the “high-leverage” small tributaries that contribute or potentially contribute most to Bay impairment by POCs?		N/A
Q3: How are loads or concentrations of POCs from small tributaries changing on a decadal scale?		N/A
Q4: Which sources or watershed source areas provide the greatest opportunities for reductions of POCs in urban stormwater runoff?		N/A
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

Approach

RMP staff will manage the STLS process and STLS projects, as well as work with the other workgroups to maximize efficient collaborative efforts within the RMP. Tasks include:

- Six STLS meetings/year
- Planning and developing meeting agendas and materials
- Preparing meeting summaries, and
- Attending key external meetings (e.g., BASMAA Monitoring / POC Committee meeting, BASMAA BoD meetings)

Budget

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

Table 2. Proposed budget.

Expense	Estimated Hours	Estimated Cost
Project Staff	150	$25,000
Grand Total	150	$25,000

Budget Justification

Labor Costs: 150 hours of staff time to prepare for, hold, and follow up on six STLS and two external meetings over calendar year 2021.

Reporting

Written meeting summaries are prepared after every meeting and archived and available upon request. A list of action items and due dates are also maintained.

References

SFEI, 2009. RMP Small Tributaries Loading Strategy. A report prepared by the strategy team (L McKee, A Feng, C Sommers, R Looker) for the Regional Monitoring Program for Water Quality. SFEI Contribution #585. San Francisco Estuary Institute, Oakland, CA. http://www.sfei.org/sites/default/files/biblio_files/Small_Tributary_Loading_Strategy_FINAL.pdf

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SPLWG Special Study Proposal: Regional Model Development to Support Watershed Loads and Trends

Summary: The 2018 Small Tributary Loading Strategy (STLS) prioritized further assessment of the spatial and regional estimates and temporal trends in Pollutants of Concern (POC) loads, and developed a 5-year plan out to 2022 for model development. Although initially conceived as a tool for evaluating PCB and Hg trends, advice provided at the May 2019 SPLWG meeting placed even more emphasis on developing a model to support better estimates of other POC loads, sediment, and emerging contaminants in addition to PCBs and Hg. The focus in 2020 is on developing and calibrating the hydrology model. Following the modeling implementation plan (MIP), this proposal is for funding in 2021 to complete the sediment model and continue working on the conceptual design of the POC model (both legacy and emerging contaminants). The two main objectives are: 1. to create a flexible watershed modeling platform for more general POC simulation. The hydrology and sediment model, once established, will be used as a basis for POC modeling in subsequent years. 2. To answer management questions related to the PCB and Hg TMDLs, the model will be used to evaluate PCB and Hg loadings at watershed and regional scales. The trial using these two well sampled pollutants will provide a proof of concept for other contaminants. Trends associated with control measures, land-use changes, or other scenarios could then be explored.

Estimated Cost: $150k
Oversight Group: STLS/SPLWG
Proposed by: Tan Zi and Lester McKee (SFEI)
Time Sensitive: Yes - this is the third year of a sequential four-year study

Proposed Deliverables and Timeline

Deliverable	Due Date
2021 funding: Sediment model setup completed	06/2021
2021 funding: Sediment model initial calibration ready for review	08/2021
2021 funding: Sediment model calibration and documentation completed; PCB and Hg model data collation and general POCs model planning started.	12/2021
2022 funding: PCB and Hg model setup, calibration, review and documentation, Review CECs monitoring and conceptual modeling outcomes from the strategy report and continue POCs model planning.	2022
2023 funding: Collation of additional control measure data and receipt of updated land use[1]. Model application runs for answering RMP questions. Possibly start modeling other POCs (e.g., CECs).	2023

[1] Note, although not contingent on this data set, the new dynamic regional watershed model will benefit from this data set in the application of water quality trends.

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. In supporting these TMDLs, the Municipal Regional Permit for Stormwater (MRP) (SFRWQCB 2009, SFRWQCB 2015) called for the implementation of control measures to reduce PCB and Hg loads from urbanized tributaries. In addition, the MRP has identified additional information needs associated with improving understanding of sources, pathways, loads, trends, and management opportunities of POCs. In response to the MRP requirements and information needs, the Small Tributary Loading Strategy (STLS) was developed and outlined a set of management questions (MQs) that have been used as the guiding principles for the region's stormwater-related activities (Table 1; SFEI, 2009; Wu et al., 2018).

Over the past decade, the RMP and BASMAA have focused on Q1, Q2, and Q4. In recognition of the need to answer Q3, in particular Q3.2, the STLS team updated the Strategy in 2018 to include a trends component. The new Modeling and Trends Strategy identified the development of a regional watershed model as a priority, with an initial focus on POC loading, but prepared and developed in a way that would facilitate its use for evaluation of future trends. Although there is a more general objective to support multiple pollutants, initially the model will be developed for PCBs and Hg simply because we have the most loading data for these pollutants. But the regional model could also be developed to include other pollutants, such as contaminants of emerging concern (CECs) and nutrients, and provide a mechanism for evaluating management actions and management impact on future trends of POC loads or concentrations in support of Q5.

The 2018 Modeling and Trends Strategy included a multi-year work plan that would obtain initial answers to loading questions by 2022 and the trends or other questions in years beyond. The first step of this plan, completed in 2019, was to develop a Modeling Implementation Plan (MIP) to guide model development, which included model platform and development procedures and a timeline (Wu and McKee, 2019). The MIP was reviewed by the STLS in April 2019 and the Sources, Pathways, and Loadings Workgroup (SPLWG) in May 2019 and approved later in 2019. Subsequently, RMP funding was provided for 2020, and so far, the tasks of model data collection and model setup have been completed. This proposal is for 2021 funding to implement the third year of the multi-year work plan, which includes completing calibration and validation of the regional model for hydrology and suspended sediment. The hydrology and sediment model will be used as the basis for POC modeling in 2022.

Study Objectives and Applicable RMP Management Questions

The study will provide information essential to understanding spatial and temporal characteristics of hydrology and sediment loads, at the scales of both individual watersheds and the region as a whole in relation 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?	Complete a regional hydrology and sediment model to serve as the basis for POC modeling and as the first stage of regional model development to support trends evaluation.	The model will produce an estimate of flow and sediment concentrations and loads at each individual watershed.
Q2: Which are the “high-leverage” small tributaries that contribute or potentially contribute most to Bay impairment by POCs?		Estimates produced by the regional model at each individual watershed can be compared to explore relative loading rates and how those pass into specific priority margin areas, operational landscape units, or RMP Bay segments.
Q3: How are loads or concentrations of POCs from small tributaries changing on a decadal scale?		Time series of flow and sediment loads for 1999-2018 can be used to assess trends for individual watersheds and the region as a whole.
Q4: Which sources or watershed source areas provide the greatest opportunities for reductions of POCs in urban stormwater runoff?		Model outputs of flow and sediment will help identify high yield areas that can be targeted for management actions.
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?		Management actions, both existing and planned or anticipated, could be evaluated in the model through scenario runs.

Approach

A phased approach is being employed to develop the regional model, starting with hydrology, followed by suspended sediment, and then by POCs. The following table lays out the whole road map for the whole project from inception (2015) through to the end of the 5-year plan as it currently stands. The tasks being proposed for completion in 2021 represents the second phase of model development and will primarily cover development and calibration of the suspended sediment model, and the beginnings of a POC model. In addition, any necessary improvements to the hydrology model will also be carried out. Overall and generally, the following road map lays out a standard model development and application process. Although there is a more general objective to support multiple pollutants, initially the model will be developed for PCBs and Hg, the analytes for which we have the most field data.

Year	Budget ($k)	Deliverable	Completion Date
2015-2018	235	Loads and trends strategy conception; Conceptual model development; Statistical analysis of PCB trends in Guadalupe River; Completion of Small Tributaries Loading Strategy: Modeling and trends Strategy.	2018
2019	60	Modeling Implementation Plan	2019
2020	100	Hydrology initial calibration ready for review	08/2020
		Hydrology calibration completed Sediment model data collation and model setup started	12/2020
2021	150	Review and incorporation of new land use data[2] (15k)	03/2021
		Sediment model setup completed (30k)	06/2021
		Sediment model initial calibration ready for review (65k)	08/2021
		Sediment model calibration and documentation completed (15k) PCB and Hg model data collation and preparation (15k)	12/2021
		General POCs model planning started (10k)	12/2021
2022	150	PCB and Hg model setup completed	02/2022
		Regional watershed model webpage (optional element) will be drafted for SPLWG review	04/2022
		PCB and Hg model initial calibration ready for review	08/2022
		PCB and Hg model calibration and documentation completed.	12/2022
		Review CECs monitoring and conceptual modeling outcomes from the strategy report and continue POCs model planning.	12/2022
2023	150	Collation of additional control measure data and receipt of updated land use[2] Model application runs for answering RMP questions.	12/2023

[2] Note, Although not contingent on this updated land use data set, the new dynamic regional watershed model will benefit from this data set in the application of water quality trends

		Possibly start modeling other POCs (e.g., CECs). Options may include: a) Model refinements for better representation of spatial variability b) Model refinements for assessing trends associated control measure implementation and land use[2] change c) Characterization of sedimentation process in flood control channels d) Assessment of future scenarios loading estimates e) Model development for other contaminants f) Linking and doing model runs to support models of physical and biological processes on the Bay margins or in the Bay	

Budget

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

Table 2. Proposed budget.

Expense	Estimated Hours	Estimated Cost
Project Staff (Modeling)	700	$100,000
RMP staff and stakeholder interactions and SPLWG review	120	$30,000
Project/Contract management		
Data technical services	80	$10,000
GIS services	80	$10,000
Total	***980***	***$150,000***

<u>Budget Justification</u>

Labor Costs: Staff time to perform calibration/verification, process model results, and write up technical reports; to collect and process GIS data and construct a webpage; consult on water quality and control measure data and get technical support from related other parties; and senior staff contributions and review.

Reporting Costs: RMP staff will produce a model development report to document all aspects of model development, including input data, key assumptions, calibration/verification, and model results.

Reporting

- Annual Model Development presentations to STLS and SPLWG will be prepared.
- Improvements to model documentation will be appended each year as the model development evolves.
- Regional watershed model webpage drafted for SPLWG review by May 2022.

References

SFRWQCB, 2009. California Regional Water Quality Control Board San Francisco Bay Region Municipal Regional Stormwater NPDES Permit, Order R2-2009-0074, NPDES Permit No. CAS612008. Adopted October 14, 2009. http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/stormwater/Municipal/index.shtml

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Wu, J., Trowbridge, P., Yee, D., McKee, L., and Gilbreath, A., 2018. RMP Small Tributaries Loading Strategy: Trends Strategy 2018. Contribution No. 886. San Francisco Estuary Institute, Richmond, CA. https://www.sfei.org/sites/default/files/biblio_files/STLS%20Trends%20Strategy%202018%20FINAL.pdf

Wu, J., and McKee, L.J., 2019. Modeling Implementation Plan-Version 1.0. A technical report prepared for the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP). Contribution No. 943 San Francisco Estuary Institute, Richmond, California. https://www.sfei.org/documents/regional-watershed-model-implementation-plan

Special Study Proposal: Integrated watershed modeling and monitoring implementation strategy

Summary: The RMP modeling of concentrations and loads delivered to the Bay from the small tributaries in the nine county Bay Area, along with monitoring to support the modeling, has largely been funded and led by the SPLWG and focused on PCBs and Hg. Other workgroups with modeling or monitoring needs have largely just retrofitted the models or piggybacked on the monitoring programs. As the focus of modeling moves towards supporting a broader suite of contaminants including sediment, nutrients and CECs beyond just PCBs and Hg, the information and the monitoring required to model contaminant groups with similar characteristics (chemical and physical properties, sources, pathways, etc.) needs to be systematically identified, and the model structure needed to support these priorities needs to be considered from inception. This proposal aims to address these issues by building an integrated watershed modeling and monitoring implementation strategy to lay out the information needs and associated monitoring and modeling processes to address management questions for any contaminant of interest when the need arises.

Estimated Cost: $50k
Oversight Group: TRC
Proposed by: L McKee and T Zi (SPLWG), R Sutton (ECWG), S Dusterhoff (SedWG), J Davis (PCBWG), D Senn (Nutrients Management Strategy), and M Foley (RMP Manager)
Time Sensitive: Yes, bridge monitoring and modeling efforts to avoid inefficiencies.

Proposed Deliverables and Timeline

Deliverable	Due Date
Draft strategy and processes for incorporating pollutants of concern into models and identifying monitoring needed to support the model	April 2021
Complete full draft FINAL integrated watershed modeling and monitoring implementation strategy	September 2021
Final report	December 2021

Background

The SPLWG is a recognised leader within the RMP and the Bay Area in the design and implementation of monitoring and modeling programs to support estimates of the flow of stormwater, suspended sediment (SS), and contaminant concentrations and loads in the small tributaries that flow into the Bay from the nine counties that ring the Bay. To scientifically understand and support water quality management questions of pollutants of concern, a phased monitoring and modeling progress has been adopted. Taking PCB and Hg as an example, first step was to lay out the conceptual models for stormwater monitoring designs for PCBs and Hg based on the outcomes of several efforts, including regional estimates of contaminant loads using simple model (Davis et al., 2000), pilot monitoring program (e.g.Guadalupe loads monitoring program), and literature review (“urban runoff literature review”, McKee et al., 2003). Monitoring then continued on Guadalupe River through 2006 and then in Zone 4 Line A through 2010. This was then followed by strategy development (SFEI, 2009), and a multi-year plan (BASMAA, 2011) that included the development of the Regional Watershed Spreadsheet Model (RWSM), as well as a monitoring plan for PCBs and Hg loads at a selection of tributaries. These efforts resulted in the design of a “reconnaissance field monitoring method” to characterise PCBs and Hg concentrations and particle concentrations. This method was piloted in WY 2011 using a discrete sampling design (McKee et al., 2012), and refined in 2015 and 2016 to use a composite design (Gilbreath et al., 2017), and enhanced in 2016-2018 to include several remote sampler methods as an initial characterisation tool (Gilbreath et. al., 2019). The RWSM hydrology model was completed in 2012 (Lent et al., 2012) and a calibrated RWSM for PCBs and Hg was completed in 2016 (Wu et al., 2017). In 2015, the SPLWG began transitioning towards a greater focus on trends. Consistent with the history of the workgroup (WG), the phased approach from past PCB and Hg work experiences was then repeated: 1) Pilot monitoring and research; 2) Conceptual model development based on existing knowledge, literature review and knowledge gained from step 1 (McKee and Yee, unpublished); 3) Statistical analysis of loads and trends in a well-sampled archetype watershed (Melwani et al., 2018; 4) Refined monitoring design based on the results of conceptual model and statistical analysis, 5) evaluation of the data needs of dynamic modeling (in preparation); 6) Prepare Modeling Implementation Plan (Wu and McKee, 2019); and 7) start dynamic modeling of contaminants (in preparation).

These efforts were largely designed to support management questions and permit provisions that evolved out of the PCB and Hg TMDLs for San Francisco Bay. Yet, the reconnaissance field monitoring design has been adopted for microplastics and other CECs, and those groups along with the PCB workgroup have been “piggybacking” on the PCB and Hg field program for the past three wet seasons, placing a larger demand on and competition for field staff resources, particularly when sites for PCBs and Hg are not optimal for microplastics and other CECs. In addition, the RWSM has been retrofitted to estimate regional scale nutrient and microplastic loads and PCB loads for priority margin units and the Bay Area Hydrology Model (BAHM) was updated and the flow information was used to estimate loads of nutrients and CECs. Now, as the SPLWG is embarking on the development of a new dynamic simulation model to support tributary concentrations and load questions for the RMP, there is a concern that a design of the model with a narrow focus on PCBs and Hg (the contaminants with the most robust supporting data) will lead to cost inefficiencies when retrofitting the model for other contaminants. In addition, although a basic component of the new model will be a calibrated sediment transport, again, if the focus is on its use to support contaminant loadings alone, the urban component of the model will need to be optimised, yet the SedWG will need equal effort placed on the calibration for non-urban erosion and SS transport processes. There are also concerns that a focus of the model development on initially supporting PCBs and Hg loads and trends may not adequately address the objective of broadly addressing watershed modeling needs for any future contaminant of interest. Although there is a generous amount of data available to calibrate either model for flow, suspended sediment, PCBs (and other trace organics such as OC pesticides, pyrethroid pesticides, and PBDE), Hg (and other trace metals, e.g. Cu), and nutrients, and there is a wealth of nationwide modeling experience on these, there is a paucity of data to support calibration for emerging contaminants and a lack of modeling experience to learn from.

This proposal aims to address these issues by bringing together a cross-disciplinary supragroup of RMP staff with broad WG review to transcend the focuses of any single WG and build an integrated modeling and monitoring strategy that lays out a road map of the information needs and associated monitoring and modeling processes that would support the broad range of contaminants, RMP WG, and management needs.

Study Objectives and Applicable RMP Management Questions

This proposal is unlike other proposals brought forward during the last decade by each single WG with only limited input from other workgroups. Instead, it explicitly requires collaboration across the staff of multiple work groups (and multiple WG review of the product) to identify and fill watershed monitoring and modeling needs across multiple contaminants. The objective is to increase information development while reducing programmatic cost over a 5-year term. Thus, the standard format of listing applicable workgroup-specific management questions does not appear to apply. Instead we offer Table 1 for consideration and review.

Table 1. Framework for information development via the watershed modeling and monitoring strategy to inform surface water quality management.

	Information Phases		
	Early Evaluation	**Support for Regulatory Goal Setting**	**Evaluating Control Measure Implementation and Adaptive Management**
Core Management Questions	What are the risks? Which ones are high priorities? Should it be regulated?	What are the current loadings and concentrations at the regional scale? What should be the regulation targets? Are effective control measures feasible?	What are the effective water quality improvement implementations? What are the load and concentration after the implementation of control measures?

Monitoring Objectives	Identify the concentrations in different media for risk evaluation	Regional concentration and load estimation, modeling support	Trend and load estimation to evaluate the control measure implementation; regional and watershed specific load and trend monitoring to support modeling
Monitoring Design	Water, Sediment, Biota Samples	Water, Sediment, Biota Samples	Water, Sediment, Biota Samples
Modeling Objectives	Risk evaluation	Regulation (e.g., TMDL) development	Trend, load, control measure evaluation
Modeling Design	Conceptual model (food web, transport and accumulation in the Bay), RWSM, single box model of the Bay	Conceptual (RWSM) and/or dynamic watershed model for regional loading and target scenarios testing	Integrated watershed-Bay model for regional and watershed specific loading and implementation scenarios and linkage analysis

Approach

Conceptual models have already been developed by the RMP for watershed sources and transport processes for suspended sediment, nutrients, PCBs, and Hg. These will form a useful framework for developing conceptual models for new and emerging contaminants to support monitoring design and model structure. In addition, MYPs have been written for WGs and Strategies. The approach we propose to take combines these concepts. We will prepare a draft framework for the ongoing identification of management questions and associated monitoring and modeling needs with respect to high priority contaminants (or contaminant groups) and the implementation of monitoring and modeling through the RMP to address these needs. High priority contaminants may include sediment, PCBs, Hg, nutrients, and individuals or groups of CECs of interest. The framework will include elements of a road map to support the water quality management for emerging contaminants:

a) documentation of the decision rationale for the suite of contaminants or contaminant classes for consideration,
b) an evaluation of data requirements loads estimation for each contaminant/class,
c) conceptual model development for each contaminant class in direct relation to the model data requirements,
d) a data gaps evaluation,
e) a series of recommended studies (literature reviews or field monitoring programs) to address data gaps, and
f) a decision tree to support monitoring decisions and when to start modeling

For the initial draft, we will draw upon existing materials and reports prepared by the SedWG, ECWG, PCBWG, Nutrient Management Strategy team, and RMP staff expertise. The draft will then undergo review and input from multiple WG experts through normal WG channels before being finalised as “Version 1” of the strategy. The strategy will be written as a living document in case updates are needed in 2-5 years as new information emerges.

Budget

The following budget represents estimated costs for this proposed special study (Table 2). Efforts and costs can be scaled back by reducing the number of sampling sites.

Table 2. Proposed budget.

Expense	Estimated hours	Estimated Cost
Labor		
Draft report (Project Staff)	200	$34,000
Project management and Program manager and lead scientist review	32	$5,440
Review process and final report	60	$10,200
Grand total		$49,640

<u>Budget Justification</u>

- Development of many other strategy documents and conceptual models.
- Assumes a lot of coordination between internal RMP staff during the drafting.
- Assumes a lot of review and input from approximately 7-10 work group experts from the five (5) work groups engaged on the project.

Reporting

The outcome of the study will be a concise technical report.

References

BASMAA, 2011. Small Tributaries Loading Strategy Multi-Year Plan (MYP) Version 2011. Submitted to the Water Board, September 2011, in support of compliance with the Municipal Regional Stormwater Permit, provision C.8.e. http://www.swrcb.ca.gov/rwqcb2/water_issues/programs/stormwater/MRP/2011_AR/BASMAA/B2_2010-11_MRP_AR.pdf

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SPLWG Special Study Proposal: Small Tributaries Loading POC Watershed Reconnaissance Monitoring

Summary: Over the past six years, the RMP has funded reconnaissance monitoring to identify high leverage watersheds and subwatersheds for PCBs and Hg sources and to develop a remote sampler method to decrease costs and increase ease of data collection. We propose to continue reconnaissance monitoring during winter storms in WY 2021. The study will help gain further knowledge and understanding of PCB and Hg concentrations, particle ratios, congener patterns, and yields in areas that have a disproportionately larger area of older urban and industrial land use. In addition, this sampling program is being coordinated with the needs of the ECWG (for specific emerging contaminants), the microplastics WG, and the PCBWG, all who pay a share of the field cost, their own analytical and data management costs. It is primarily a field study and the level of effort will be tailored to the amount of budget available and collaboration with the other groups. There is no phasing proposed.

Estimated Cost: $65k (and ~$55k carryover from WY 2020)
Oversight Group: STLS/SPLWG
Proposed by: A Gilbreath, D Yee, T Zi, and L McKee (SFEI)
Time Sensitive: No, but this is a continuation of a multi-year study to identify PCB and Hg sources to inform management actions.

Proposed Deliverables and Timeline

Deliverable	Due Date
Selected site list	09/2020
Wet season water samples collected and sent to the labs for analysis	04/2021
Laboratory analysis, QA & Data Management	09/2021
Interpretation & reporting for BASMAA	02/2021
Draft report	03/2021
Final report	06/2021

Background

The San Francisco Bay Hg and PCB TMDLs call for a 50% reduction in Hg loads by 2028 and a 90% reduction in PCB loads by 2030. In supporting these TMDLs, the Municipal Regional Permit for Stormwater (MRP) (SFRWQCB 2009, SFRWQCB 2015) called for a range of actions, including gaining a better understanding of which Bay tributaries contribute the most loading to sensitive areas of biological interest on the Bay margin, better quantification of sediment and trace contaminant loads on a watershed basis and regionally, a better understanding of how and where trends might best be measured, and an improved understanding of which management measures may be most effective in reducing impairment. In response to the MRP requirements and information needs, the Small Tributaries Loadings Strategy (STLS) outlined a set of evolving management questions (SFEI, 2009) that have been used as the guiding principles for the region’s stormwater-related activities.

During water years (WYs) 2015-2020, the RMP funded a watershed characterization reconnaissance study to locate high leverage watersheds and subwatersheds, and develop a remote sampler method designed to decrease costs and increase ease of data collection. Over the six years of watershed characterization, in addition to a similar effort in WY 2011 (McKee et al., 2012), a total of 86 sites have been characterized for PCB and Hg concentrations and particle ratios during at least one storm using this method (McKee et al., 2016; Gilbreath et al., 2017; Gilbreath et al., 2018, Gilbreath et al., 2019, Gilbreath et al., 2020)[1]. A total of 17 sites have now been characterized using the remote sampler methods. Through these efforts, it was discovered that PCB concentrations at 25 sites are highly elevated (> 0.2 ug/g, or > 140x the TMDL target[2]), and four sites have highly elevated Hg concentrations (> 1 ug/g, or > 5x the TMDL target)[3]. Initial results of the remote sampling pilot indicate a reasonable correlation between the particle concentrations observed in the remote samplers and particle ratios observed in the manual water samples. As such, the remote sampler method has been adopted as a screening tool.

Study Objectives and Applicable RMP Management Questions

This study will provide information essential to understanding concentrations of PCBs and Hg in a broad number of sites around the Bay. The objectives of the project and how the information will be used are shown in Table 1 relative to the Sources, Pathways, and Loadings Workgroup (SPLWG) high-level management questions. In addition, site selection is being coordinated with ECWG (for specific emerging contaminants), the microplastics WG, and the PCBWG. Thus, the study objectives are broader than just those of SPLWG.

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

Management Question	Study Objective	Example Information Application

[1] Data were also collected by the Santa Clara and San Mateo Stormwater programs using the same watershed characterization reconnaissance study design.

[2] The TMDL did not have a concentration target but rather a total load target, and through back calculation we determined the average concentration required to meet that target.

[3] Note: These data reflect WYs 2011, 2015-2019 results. WY 2020 data are not yet available.

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?	Use remote samplers to collect samples at new locations as a screening method to determine if they are likely high-leverage. Use these results to rank these locations relative to each other and sources. Use manual water composite sampling methods to revisit previously sampled locations	Where are the highest leverage watersheds for potential management action? How variable are concentrations from storm to storm?
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?	Provide a regional map of concentrations and loads for baseline comparison to the effects of BMP application.	Where should BMPs be located to have the greatest benefit for water quality?

Approach

A wet weather field monitoring program is proposed to continue during the winter months of WY 2021 sampling at watersheds, subwatersheds, or finer scales to assess management priority. The sampling program will largely mimic the program implemented during WYs 2011, and 2015-2020 (McKee et al., 2012; Gilbreath et al., 2020 in review); the improved decision tree for site and storm characteristics developed by the advanced data analysis in WY 2019 (McKee et al., 2019; Davis and Gilbreath, 2009) will also be used to augment the program.

- Monitoring Design

  At each site, collect a minimum of:

- o One composite stormwater sample during a rainfall event that is forecast to exceed 0.5 inches of rainfall in a 6-hour period using a manual sampling techniques OR
- o One remote sampler (settled suspended sediment) sample during a rainfall event that is forecast to exceed 0.5 inches of rainfall in a 6-hour period using a Hamlin Sampler or Walling tube, dependent on site logistics (Walling Tubes are best suited for a natural bed while Hamlin Samplers are superior in storm drains or concrete channels).

- Site Selection
  - o Objective 1: Find new high-leverage watersheds or sub-watershed areas (watershed locations near the Bay margin or further downstream than the source tracking approach). Remote samplers,where feasible, are ideal for this objective, although manual sampling may also be used. Approximately half of the field labor and analysis budget will be allocated to this effort.
  - o Objective 2: Re-sample locations where additional information is necessary to inform ranking. In these watersheds, manual water composite sampling methods will be used for direct comparison to the prior data. Approximately half of the field labor and analysis budget will be allocated to this effort.
  - o Other selection criteria:
    - ▪ Larger watersheds with an existing USGS gauge
    - ▪ Re-sample potential false negatives
    - ▪ PCB Strategy priority margin unit watersheds
    - ▪ Nested sampling design to track sources upstream in known polluted areas to help better define source areas and management options
- Number of sites: Dependent on site logistics, proximal site associations, analytes, budget, and other factors; likely 10-12 sites.
- The 2020 analyte list will be continued (PCBs, Hg, SSC) in WY 2021. In addition, other alaytes will be sampled and paid for through ECWG piggyback.

Budget

The following budget represents estimated costs for this proposed special study (Table 2). Efforts and costs can be scaled back by reducing the number of sampling sites.

Table 2. Proposed budget.

Expense	**Estimated hours**	**Estimated Cost**
Labor		
Project Staff	600	$40,000
Project Management	70	$12,000
Data Management	175	$20,000
Reporting	147	$20,000

Subcontracts		
SGS AXYS Analytical, Brooks Applied Laboratories, USGS		$22,000
Direct Costs		
Equipment		$1,500
Travel		$1,000
Shipping		$3,500
Grand Total	600	**$120,000**

Budget Justification
Field Costs: This special study proposal has a budget of $120,000, which includes up to $40,000 devoted to stormwater sample collection (site selection and reconnaissance, permit applications, development of sample collection protocols, and field work for approximately 10 sites).

Every effort will be made to minimize field costs through monitoring multiple sites per team per storm, and leveraging existing stormwater monitoring activities of the RMPs.

Laboratory Costs: Up to 14 independent samples will be analyzed, including field duplicates and a field blank. 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 a draft and final report on the results will be completed.

Note, if there was a guarantee of two more years on this project (i.e. funding in 2022 also), we could save money by missing a data management and reporting year.

Reporting

The outcome of the study will be a concise technical report. The main objective of this report will be to report and rank concentrations and particle ratios observed at each location and compare these to existing data. The methods developed in the Advanced Data Analysis project may be applied.

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SPLWG Special Study Proposal: POC Data Interpretation - Advanced Data Analysis

Summary: Reconnaissance data collected during single storms have provided evidence to support enhanced management efforts in watersheds with high PCB concentrations in water and on sediment particles. However, sources have not been located in all watersheds exhibiting high concentrations and data have had limited value for prioritizing management efforts in watersheds exhibiting moderate or lower concentrations, yet these watersheds likely contain patches with elevated concentrations. In 2018, the RMP funded the development of advanced data analysis methods based on loads and yields and congener patterns to add additional information to support management decisions (McKee et al., 2019; Davis and Gilbreath, 2019). With method development complete (2018 funding), the loads and yields methods were applied with 2019 and 2020 funding to data that were in existence up to WY 2019 (>140 watersheds) and the congener method was applied in 75 watersheds (McKee et al., in preparation). Ranking based on yields reveal some stark contrasts to those based on concentrations and particle ratios.

This project proposes to complete the analysis on all remaining sites (WYs 2020, 2021) and those sampled by San Mateo and Santa Clara Programs for which there is congener data for both water and sediment/soils. The output will be a comprehensive and inclusive comparative ranking of all watersheds based on concentrations, particle ratios, loads, yields, and congener patterns. The outcome will be more informed decisions on watersheds to prioritize for enhanced management or further sampling.

Estimated Cost:
Option 1: $15.5k (Analysis of water samples only for loads and yields)
Option 2: $30k (Analysis of water samples only for loads and yields and aroclors)
Option 3: $50k (Analysis of water and soil samples loads and yields and aroclors)

Oversight Group: STLS/ SPLWG
Proposed by: L McKee, A Gilbreath, J Davis, and D Yee (SFEI)
Time Sensitive: No.

Proposed Deliverables and Timeline

Deliverable	Due Date
Compilation of data	09/2021
Analysis of data and presentation of draft results	09/2021
Draft a brief report for STLS review	10/2021
Draft report for SPLWG review	11/2021
Address review comments and finalize report	02/2022

Background

During water years (WYs) 2011 and 2015-2020, the RMP funded efforts to characterize a total of 86 sites during at least one storm for PCB and Hg concentrations and particle ratios (the ratio of a pollutant concentrations measured in a stormwater sample to the suspended sediment concentration in that same sample) (e.g. Gilbreath et al., 2019; Gilbreath et al., 2020, in review). These data build upon and complement a more detailed sampling program that was carried out at eight locations where samples were taken during multiple storms over a minimum of two years (WYs 2003-2010, 2012-2014) (McKee et al., 2015). Water concentrations and particle ratios from these studies have been ranked from high to low to help identify watersheds for management consideration (e.g. Gilbreath et al., 2020 in review). In addition, the same field monitoring protocol was also implemented in WYs 2016-2019 by the San Mateo and the Santa Clara Valley Programs (EOA, 2020a and 2020b). These data, along with >1200 samples from soils and sediment in storm drains and around potential source properties (Yee and McKee, 2010; Geosyntec and EOA, 2017), are being used by BASMAA to identify areas for management action.

When concentrations are high, water samples, coupled with other evidence—including land use and source area characteristics, records review, soil concentration surveys, and facility inspections—have identified a number of small industrial watersheds and properties within them of management interest. However, evidence and a rationale for management prioritization in watersheds and on potential source properties exhibiting moderate or lower concentrations are still lacking.

To address this gap, new techniques were developed and applied in 2018 and 2019 as a pilot study to support decision making. The first technique used data from seven well-sampled watersheds, and stormwater concentration data collected from 15 locations in the Guadalupe River watershed along with rainfall data, RWSM watershed specific runoff coefficients, empirical storm rainfall-load relationships and land-use data to estimate storm-based yields for standard-sized storms. The pilot study results provided new evidence on areas to consider for management. For example, East Gish Road Storm drain, which had previously ranked as moderate for concentrations and particle ratios was identified as higher yielding and higher leverage (McKee et al., 2019).

The second technique used congeners representative of the four most commonly used Aroclors as indicators to estimate relative contributions of source areas in watersheds to the concentrations and congener profile seen at the outlet (Davis and Gilbreath, 2019). As an example, data from the Pulgas Pump Station watershed indicated that outflow was uniquely dominated by Aroclors 1242 and 1260 due to two distinct source areas in the watershed. If the Aroclor 1242 source area were to be eliminated, it was suggested that the load exported could be reduced considerably.

In addition, a third method was trialed using a combination of partial least squares regression (PLSR) and random forest (RF) statistical routines to explore the relationships of PCB water concentrations, particle ratios, and area yields with a large array of candidate climatic and landscape variables. The most influential variables largely matched our expectations (e.g., storm load correlated to total event rainfall, and yield [load per area] inversely correlated to percent open space), but some results were ambiguous (e.g., positive or negative correlations to antecedent rainfall, depending on watershed). At this time, we are unable to use this method to identify variables that point to sites of interest or alternative methods for accounting for other factors (e.g., for normalizing ranking metrics). This method will not be pursued any further.

Overall, the results from the first two methods provide additional supporting evidence for management focus and indicate that reducing loads in sub-areas with higher yields or specific congener profiles within the larger watersheds may help speed the recovery of the nearby receiving waters and ultimately the Bay as a whole. With method development complete (2018 funding), the loads and yields methods were applied with 2019 and 2020 funding to data that were in existence up to WY 2019 (>140 watersheds) and the congener method was applied in 75 watersheds (not completed for Santa Clara and San Mateo Counties watershed program data) (McKee et al., in preparation).

Recent results

Preliminary comparisons of rankings between particle ratio (PR), water concentration (WC) and yields reveal stark differences. Ten of the 20 top ranked sites based on PR and 12 of the 20 top ranked sites based on WC dropped out of the top 20 sites ranked by yields. As anticipated, a number of medium and lower ranked sites for PR and WC were ranked high in relation to yields. Some examples include Line 12A at Shellmound Pedestrian Br. (Alameda County), where a storm of 0.80 inches was sampled in 2018. The watershed is 10.48 sqkm and 14% RWSM old industrial and source areas, old commercial, and old transportation. This watershed jumped in ranking from the middle third of the overall data set for PR and WC to a ranking of 2 for yields. SM-RCY-333A (San Mateo County), was sampled during a relatively small storm of 0.27 inches in 2018. The watershed is just 0.06 sqkm in size and 11% RWSM old industrial and source areas, old commercial, and old transportation. This watershed jumped in ranking from the bottom half of the overall data set for PR and WC to a ranking of 4 for yields. Rodeo Ck at Seacliff Pedestrian Br., (Contra Costa County), was sampled during a relatively large storm of 0.84 in 2017. The watershed is 23.41 sqkm and 4% RWSM old industrial and source areas, old commercial, and old transportation. This watershed, like Line 12A at Shellmound Pedestrian Br., also exhibited a relatively low rank for PR and a moderate rank for WC but was ranked 5 based on yields. These two watersheds very aptly illustrate the role that dilution of clean water and clean sediment from uncontaminated land uses plays in masking sources in these watersheds when using WC or PR as indicators for management decisions. The last example is another micro catchment, that of Seabord Ave Storm Drain 050GAC580 (Santa Clara County) with a watershed area of 1.35 sqkm but 98% RWSM old industrial and source areas, old commercial, and old transportation. This watershed was sampled in 2014 during a very rare large storm. It ranked 43 for PR and 31 for WC in the overall data set but ranked 8 for yields. These watersheds are all great illustrations of the power of the new methods to reveal new aspects of the data as part of a weight of evidence approach for management consideration. Watersheds exhibiting the highest yields tended to be dominated by Aroclors 1248 and 1254. Aroclor 1248 was primarily used in capacitors (45% of the total volume use) and Aroclor 1254 was primarily used in transformers (25% of the total volume use) and caulk and joint sealants (Erickson and Kaley, 2011). Overall there was a large variation in aroclor signals between watersheds. This is being explored to help to provide evidence that a source upstream with a similar pattern to downstream is possibly a primary source. The aroclor analysis also provides a means to trace sources upstream in new watersheds of interest.

The 2021 funding proposed would enable the completion of the analysis to all remaining sites, those sites sampled during WY 2020 and 2021 and those sampled by San Mateo and Santa Clara Programs for which there is congener data suitable for source profiling. The objective is to provide a full and comprehensive assessment of yields and congener patterns to support the weight of evidence approach for management decisions or further sampling. As the data set expands, the method grows more powerful as a tool to support management.

Study Objectives and Applicable RMP Management Questions

The study will provide information essential to understanding the relative importance of watersheds, subwatersheds, and source areas for management consideration in relation to reducing loading-based impacts of PCBs in San Francisco Bay. 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 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 load, yield, and congener-based analysis methods to identify watersheds, subwatersheds, and source areas for management consideration.	The project will provide new insights into relative loads for ~ 170 watershed locations.
Q2: Which are the "high-leverage" small tributaries that contribute or potentially contribute most to Bay impairment by POCs?		The project will identify high yielding areas and areas with unique congener patterns in relation to general concentrations found in Bay sediment and fish tissue.
Q4: Which sources or watershed source areas provide the greatest opportunities for reductions of POCs in urban stormwater runoff?		The study will compare yields and congener profiles for individual source areas to those of other sources within subwatersheds and watersheds to identify areas that may be of higher interest.

Approach

Budget option A ($15,000): Collate stormwater data on concentrations collected in 2020 and 2021 by the SPLWG reconnaissance study (~ 16 sites), and the data RMP priority margin units winter sampling sites (4 sites, multiple storms each) as well as remaining ancillary data for a further 22 sites that were not included in the 2020 work for a total of 42 sites. Prepare a (very) short report that cites the previous reports and provide the basic meta data on data collation and the results for all 170+ sites.

Budget option B ($30,000): Carry out option A plus collate congener data collected by the San Mateo and Santa Clara County programs in 2016-2018 (~80 sites). Apply the congener based data analysis techniques to all these data and combine with the results from the 2020 analysis (McKee and Gilbreath 2020 in preparation). Prepare a (very) short report that cites the previous reports and provide the basic meta data on data collation and the results for all 170+ sites.

Budget option C ($50,360): Carry out all the work in Option A and B plus collate the 1000+ samples from soils and sediment in storm drains and from potential source properties (Yee and McKee, 2010; Geosyntec and EOA, 2017), and apply the congener method to sites that are nested inside the watersheds sampled during storms. The power of combining the two methods along with the congener profiles for the sediment/soils samples analysed with the overall outcome being a comparative ranking of all data using concentrations, particle ratios, loads, yields, and congeners.

Method 1. Yields-based Comparisons

Yields for watersheds where there are suitable concentration data collected during storms will be estimated using the following steps:

1. Using storm-based rainfall data and estimates of runoff from the RWSM, storm volume will be estimated
2. The storm volume will be combined with estimated event mean concentration data to estimate storm loads
3. Storm loads will be adjusted to a standard sized storm
4. Standard storm yields will be estimated by dividing the loads by the source areas of interest in the given watershed or subwatershed
5. These will then be used to compare sites and estimate relative leverage to identify areas for management consideration

Method 2. Congener Profile-based Comparisons

The relative contributions of four different Aroclor mixtures (1242, 1248, 1254, and 1260) in stormwater and sediment will be estimated using the following steps.

1. Determine the percent contributions of four relatively unique indicator congener sets for each Aroclor that are a major contributor to the overall sum of PCBs (Aroclor 1242: PCBs 18, 28, 31, 33; Aroclor 1248: 44, 49, 66, 70; Aroclor 1254: PCBs 487, 101, 110, 118; Aroclor 1260: PCBs 149, 170, 180, 187).
2. For each sediment, soil, or water sample, compute the index as the sum of the percent contributions of the indicator congeners for each Aroclor.

3. Standardize the index for each Aroclor as a % of the sum of the four indices.
4. The data for the Aroclor indices are then binned into the following categories
    a. greater than or equal to 40% of the sum of Aroclor indices (primary contributor);
    b. greater than or equal to 20% and less than 40% of the sum of Aroclor indices (secondary contributor); and
    c. less than 20% of the sum of Aroclor indices (minor contributor).
5. Compare the profiles found in individual water and sediment/soils samples in upstream areas of a watershed with those observed at the outlet further down to make inferences about relative contributions.

Budget

The budget is based on experience from work completed in 2018-2020.

	Option A (water - loads and yields only)		**Option B (water - loads and yields and congeners)**		**Option C (water and soils/ sediment - loads and yields and congeners)**	
Expense	Hours	Cost	Hours	Cost	Hours	Cost
Project Staff	70	$11,200	140	$22,400	240	$38,400
Senior Management Review	4	$640	6	$1,140	8	$1,520
Project/ Contract Management	6	$960	8	$1,360	12	$2,040
Data Technical Services	5	$800	8	$1,200	16	$2,400
GIS Services	12	$1,920	24	$3,600	40	$6,000
Grand Total		$15,520		$29,700		$50,360

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