REGIONAL MONITORING PROGRAM FOR WATER QUALITY IN SAN FRANCISCO BAY
sfei.org/rmp

RMP Sediment Workgroup Meeting

May 16, 2024
10:00 AM – 5:00 PM

Hybrid Meeting

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AGENDA

1.	**Introduction and Goals for Today's Meeting** The goals for today are to: • Review findings from Sediment Workgroup studies and other studies • Discuss Tier 1 and Tier 2 Special Study proposals for 2025 funding • Rank Tier 1 and Tier 2 Special Study proposals	10:00 am Scott Dusterhoff (SFEI)
2.	**Information: Overview of Workgroup Planning Efforts** This item will provide an overview of the timing of Workgroup strategic planning efforts in 2024/2025. Desired outcome: Informed workgroup	Scott Dusterhoff (SFEI)

3.	**Information: Presentation on Sediment Dynamics at Bay Marshes** USGS scientists will give a short presentation on their RMP-funded studies examining the relationship between suspended sediment concentrations in Bay shallows and sediment deposition on an adjacent marsh at Whale's Tail Marsh, Corte Madera Marsh, and San Pablo Bay NWR. Desired outcome: Informed workgroup	10:30 am Jessie Lacy (USGS)
4.	**Information: Presentation on Suspended Sediment and Wave Monitoring in South and Lower South Bay** SFEI scientists will give a presentation on continuous suspended sediment concentration and wave monitoring in South and Lower South Bay in 2022 and 2023 Desired outcome: Informed workgroup	11:10 am Lilia Mourier (SFEI)
5.	**Information: Presentation on Hydrodynamic Modeling using the DFM** Craig Jones will give an overview of the modeling work he is doing with the Delft-3D Flexible Mesh (DFM) model for PCBs and touch upon ways to use the DFM to address SedWG MQs Desired outcome: Informed workgroup	11:30 am Craig Jones (Integral)
	LUNCH (meeting break)	12:00 pm
6a.	**Information: Presentations of Tier 1 Proposals** The Tier 1 Special Study proposals being considered for 2025 RMP funding will be presented to the Workgroup. Meeting materials [*page numbers refer to the meeting packet*]: 1. Refining the Conceptual Understanding of Sediment Transport in San Pablo Bay (SFEI). Budget: $65,000 [packet pgs. 7 -13] 2. Develop a study plan to improve characterization of bed sediments and settling velocity to advance sediment transport modeling for San Francisco Bay (USGS). Budget: $106,900 [packet pgs. 14 - 20] 3. Analysis of satellite-based surface turbidity for improved sediment transport modeling in San Francisco Bay (Stanford Univ). Budget: $135,475 [packet pgs. 21 - 34] Desired outcome: Opportunity for clarifying questions about the proposals	12:45 pm Kyle Stark (SFEI) Jessie Lacy (USGS) Oliver Fringer (Stanford Univ)

	BREAK	2:00 pm
6b.	**Information: Presentations of Tier 2 Proposals** The Tier 2 1-page proposals being considered for EPA funding and placement on the SEP list will be presented to the Workgroup. Meeting materials [*page numbers refer to the meeting packet*]: 4. Napa-Sonoma Sediment Loads (USGS). Budget: $142,040/yr [packet pg. 35] 5. Bay Sediment Budget Update (SFEI). Budget: $50,000 [packet pg. 36] 6. Shoreline Change in San Francisco Bay (SFEI). Budget: $80,000 [packet pg. 37] 7. Suspended-Sediment Flux Measurements at Richmond-San Rafael Bridge, California (USGS). Budget: $15,000-$71,000 [packet pg. 38] 8. Spatial variability of sediment accretion in San Francisco Bay restorations: Expanded coverage (USGS). Budget: $115,000 [packet pg. 39] 9. Sediment dynamics in a fluvially influenced salt marsh (USGS). Budget: $121,500 [packet pgs. 40 - 41] Desired outcome: Opportunity for clarifying questions about the proposals	2:15 pm Scott Dusterhoff (SFEI)
7.	**CLOSED SESSION** **Decision: Ranking of Tier 1 and Tier 2 Proposals** 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. The Steering Committee makes the final funding decision. During this agenda item, the Workgroup will rank the special study proposals and study ideas, and recommend the special study ideas that should be developed into proposals. To avoid an actual or perceived conflict of interest, the Principal Investigators for study proposals and study ideas proposed special studies are expected to leave the room during this agenda item. RMP Stakeholders will be asked to do the ranking. SFEI staff who are not Principal Investigators will be in the room to provide input and information as needed. Meeting Materials: • RMP Charter (describes process for funding decisions) • RMP Multi-Year Plan that includes the Sediment Workgroup Multi-Year Plan (p. 30-32) • Sediment Monitoring and Modeling Workplan • Guidelines for Inclusive Conversations [packet pg. 5] Desired Outcome: Ranking of the Sediment Workgroup proposed 2025 Special Study Ideas that will move forward toward proposals for the TRC	3:45 pm Bridgette DeShields (TRC Chair)

8.	**Report Out of Proposal Idea Ranking and Recommendations to Principal Investigators**	4:45 pm Bridgette DeShields (TRC Chair)
	Adjourn	5:00 pm

Bay RMP Stakeholder and Workgroup Meetings

Guidelines for Inclusive Conversations

This document is intended as a guideline for engagement at Bay RMP Technical Review Committee, Steering Committee, and Workgroup meetings. This is a living document. If you have input on what could be added, please email Melissa Foley (melissaf@sfei.org).

Zoom Etiquette

- Rename yourself - consider adding your name, organization, preferred pronouns and whose native land you are on.
- “Raise your hand” virtually if you wish to speak.
- In the case of a land acknowledgement, take the time to determine whose native land you are on at the time of your meeting (https://native-land.ca/). People may be invited to share the name in the chat.

Meeting Agreements[1]

- TRY IT ON: Be willing to “try on” new ideas, or ways of doing things that might not be what you prefer or are familiar with.
- PRACTICE SELF FOCUS: Attend to and speak about your own experiences and responses. Do not speak for a whole group or express assumptions about the experience of others. Work on examining your default assumptions about another person's identity or lived experience.
- UNDERSTAND THE DIFFERENCE BETWEEN INTENT AND IMPACT: Try to understand and acknowledge impact. Denying the impact of something said by focusing on intent is often more destructive than the initial interaction.
- PRACTICE “BOTH / AND”: When speaking, substitute “and” for “but.” When used to connect two phrases in a sentence, the word “but” essentially dismisses the first phrase altogether. Using “and” acknowledges multiple realities and promotes inclusion.
- REFRAIN FROM BLAMING OR SHAMING SELF & OTHERS: Practice giving skillful feedback.
- MOVE UP / MOVE BACK: Encourage full participation by all present. Take note of who is speaking and who is not. If you tend to speak often, consider “moving back” and vice versa.
- PRACTICE MINDFUL LISTENING: Try to avoid planning what you’ll say as you listen to others. Be willing to be surprised, to learn something new. Listen with your whole self.
- RIGHT TO PASS: You can say “I pass” if you don’t wish to speak.
- AVOID JARGON: Try to avoid using jargon and/or acronyms.
- IT’S OK TO DISAGREE: Not everyone will be in agreement all of the time, and that’s ok!

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[1] Adapted from Visions, Inc. Guidelines for Productive Work Sessions found at: https://www.emergingsf.org/wp-content/uploads/2017/08/EBMC_AgreemntsMulticulturalInteractions15.09.13-copy.pdf.

Special Study Name	PI	Lead Organization	Partner Organizations	Year funded	Funded Amount	Total Funded Amount	Funding Source (RMP or SEP)	Completion Date	URLs for work products
Water and Suspended-Sediment Flux Measurements at the Golden Gate, 2016-2017	Maureen Downing-Kunz	USGS	--	2016	$68,500 (SEP) $33,000 (RMP)	$101,500	RMP funds SEP	December 2017	https://www.sfei.org/sites/default/files/biblio_files/Downing-Kunzetal_2017GoldenGateReport_FINAL.pdf
Sediment Monitoring and Modeling Strategy	Scott Dusterhoff	SFEI	--	2017	$50,000	$50,000	RMP Special Study	April 2021	Incorporated into the Sediment for Survival report https://www.sfei.org/sites/default/files/biblio_files/Sediment%20for%20Survival%20042121%20med%20res.pdf
Sediment Supply to San Francisco Bay, Water Years 1995 through 2016: Data, trends, and monitoring recommendations to support decisions about water quality, tidal wetlands, and resilience to sea level rise	Dave Schoellhamer Lester McKee	USGS	SFEI	2017 2018	$40,000 (2017 funds) $13,000 (2018 funds)	$53,000	RMP funds	June 2018	https://www.sfei.org/sites/default/files/biblio_files/Sediment%20Supply%20Synthesis%20Report%202017%20-%202018-06-11.pdf
DMMO Data Synthesis for PCBs	Don Yee Adam Wong	SFEI	--	2018	$45,000	$45,000	SEP	March 2019	https://www.sfei.org/sites/default/files/biblio_files/DMMO%20PCB%20Synthesis%20Report%20Final.pdf
Mallard Island Suspended-Sediment Monitoring	Maureen Downing-Kunz Dave Schoellhamer	USGS	--	2018	$30,490	$30,490	RMP Special Study	December 2017	https://waterdata.usgs.gov/ca/nwis/inventory/?site_no=11185185
Hosting and Support for Dredged Material Management Office (DMMO) Database	Cristina Grosso Don Yee Shelah Sweatt Brain Ross	SFEI	USACE USGS	2018	$55,000	$55,000	RMP Special Study	December 2018	
Napa River and Sonoma Creek Sediment Transport Monitoring	Scott Wright	USGS	--	2018	$115,000	$115,000	SEP	June 2019	https://waterdata.usgs.gov/monitoring-location/11458000/#parameterCode=00065&period=P7D&showMedian=true https://waterdata.usgs.gov/monitoring-location/11458500/#parameterCode=00065&period=P7D&showMedian=true
Improved Lower South Bay suspended-sediment flux measurements	Daniel Livsey Maureen Downing-Kunz Dave Schoellhamer	USGS	--	2018 2019 2020	$120,000 (2018 funds) $158,000 (2019 funds) $36,300 (2020 funds)	$314,300	RMP Special Study (2018) SEP (2019, 2020)	November 2020	https://link.springer.com/article/10.1007/s12237-020-00734-z https://link.springer.com/article/10.1007/s12237-020-00840-y
Special Study on Buk Density	Jeremy Lowe Katie McKnight	SFEI	--	2019	$30,000	$30,000	RMP Special Study	Apri 2020	https://www.sfei.org/sites/default/files/biblio_files/SFEI_BulkDensityReport_April30_2020_v2.pdf
Workshop on Sediment Screening and Testing Guidelines for Beneficial Reuse of Dredged Sediments	Melissa Foley	SFEI	SFBRWQCB BCDC EPA	2019	$30,000	$30,000	RMP Special Study	March 2020	https://www.sfei.org/sites/default/files/biblio_files/Workshop%20Report_final.pdf
Sediment Monitoring and Modeling Strategy	Lester McKee	SFEI	--	2019 2020	$78,000 (2019 funds) $26,000 (2020 funds)	$104,000	RMP Special Study	November 2020	https://www.sfei.org/sites/default/files/biblio_files/SMMS_Nov2020.pdf
Update of Erosion and Deposition in San Francisco Bay	Bruce Jaffe Theresa Fregoso	USGS	--	2019 2020	$77,000 (2019 funds) $77,000 (2020 funds)	$154,000	RMP Special Study	March 2023	USGS Data Release https://www.sciencebase.gov/catalog/item/619aeb70d34eb622f692f986 USGS Open File Report https://pubs.usgs.gov/of/2023/1031/ofr20231031.pdf
Sediment bioaccumulation threshold review for PCBs in dredged sediment	Miguel Mendez Diana Lin Ila Shimabuku	SFEI	--	2020	$22,500	$22,500	RMP Special Study	October 2022	https://www.sfei.org/sites/default/files/biblio_files/PCB%20Sediment%20Bioaccumulation%20Report_Final_Website_0.pdf
Simulating Sediment Flux Through the Golden Gate	Michael MacWilliams	Anchor QEA	--	2020	$45,000	$45,000	RMP Special Study	March 2021	https://www.sfei.org/sites/default/files/biblio_files/FINAL_RMP_GoldenGateFlux_031121.pdf
Characterizing the settling velocity of suspended sediment across channel and shoals in South San Francisco Estuary	Jessie Lacy	USGS	--	2020	$227,700	$227,700	SEP	Ongoing	Publication Coming soon - Allen et al. Physical controls on sediment flocculation impact settling velocity in estuarine channel and shallows. In prep for publication in JGR Oceans USGS data releases https://www.usgs.gov/data/hydrodynamic-sediment-transport-and-sediment-flocculation-data-south-san-francisco-bay
Conceptual Understanding of Fine Sediment Transport in San Francisco Bay	Katie McKnight Scott Dusterhoff	SFEI	--	2020 2023	$142,000 (2020 funds) $11,000 (2023 funds)	$153,000	SEP (2020) RMP general funds (2023)	July 2023	https://www.sfei.org/sites/default/files/biblio_files/Sed_Conceptual_Understanding_SFEI_071323_ADA.pdf
DMMO Database Enhancements	Cristina Grosso	SFEI	--	2021	$40,000	$40,000	RMP Special Study	Ongoing	
DMMO San Francisco Bay Floating Percentile Method Update	Don Yee Adam Wong	SFEI	--	2021	$34,000	$34,000	RMP Special Study	June 2023	https://www.sfei.org/sites/default/files/biblio_files/FPM%20Report_Final.pdf
Temporal variability in sediment delivery to a South San Francisco Bay salt marsh	Jessie Lacy Karen Thorne	USGS	--	2021 2022	$140,000 (2021 funds) $60,000 (2022 funds)	$200,000	RMP Special Study	Ongoing	Publication Coming soon USGS data releases https://www.sciencebase.gov/catalog/item/6308060ad34e3b967a8c15c7 https://cmgds.marine.usgs.gov/data-releases/datarelease/10.5066-P972R6AW/ https://cmgds.marine.usgs.gov/data-releases/datarelease/10.5066-P98BL0XF/ https://www.sciencebase.gov/catalog/item/64ff51e4d34ed30c2057b3ae
Upload Data to DMMO Database	Cristina Grosso	SFEI	--	2022	$20,000	$20,000	RMP Special Study	Ongoing	
Temporal variability in sediment delivery to a North and a Central San Francisco Bay salt marsh	Jessie Lacy Karen Thorne	USGS	--	2022 2023	$155,000 (2022 funds) $100,000 (2023 funds)	$255,000	RMP Special Study	Ongoing	Publication Coming soon USGS data releases Coming soon
Sediment Monitoring and Modeling Workplan	Lester McKee	SFEI	--	2022 2023	$10,000 (2022 funds) $17,000 (2023 funds)	$27,000	RMP Strategy funds (2022) RMP general funds (2023)	November 2023	https://www.sfei.org/sites/default/files/biblio_files/San%20Francisco%20Bay%20Sediment%20Modeling%20and%20Monitoring%20Workplan%20FINAL.pdf
Continuous Suspended Sediment and Wave Monitoring in South and Lower South San Francisco Bay (Year 2 and Year 3)	Lilia Mourier	SFEI	SBSPRP	2023 2024	$52,000 (2023 funds) $79,000 (2024 funds)	$131,000	SBSPRP (Year 1: 2022) RMP Special Study (Years 2 & 3: 2023 & 2024)	Ongoing	Year 1 (2022) and Year 2 (2023) monitoring data report avaiable upon request Year 3 (2024) data - Coming soon
Spatial variability of sediment accretion in San Francisco Bay restorations	Jessie Lacy Karen Thorne	USGS		2024	$203,528	$203,528	RMP Special Study	Ongoing	Coming soon
						$2,441,018			

RMP Special Study Proposal: Refining the Conceptual Understanding of Sediment Transport in San Pablo Bay

Estimated Cost	$65,000
Time sensitive	No
Oversight Group	Sediment Workgroup

Summary

McKnight et al. (2023) recently completed a conceptual model of fine sediment (i.e., sediment silt-sized and smaller) for San Francisco Bay. The report offered a high-level understanding of how fine-grained sediment moves at different scales within the Bay. This effort concluded with a set of key knowledge gaps and uncertainties. Among these was a recommendation to refine our understanding of the dynamic processes (e.g., between marshes and mudflats, changes in the erodible sediment pool) in individual subembayments.

This proposed effort is intended to be coupled with ongoing work through Destination Clean Bay, an EPA-funded effort that focuses on developing support tools for supporting multi-benefit water quality improvements, including funds to identify high priority data collection and data gaps for regional model development. Analysis through Destination Clean Bay will focus on updates to the fine-grained conceptual understanding of San Francisco Bay (McKnight et al. 2023). With this proposal, we focus on refining the conceptual understanding of two specific elements within the San Pablo Bay subembayment: compiling an updated evaluation of local tributary sediment loads within the subembayment and developing a deeper understanding of the tributary-marsh-erodible sediment pool pathway. The results of the proposed study are intended to act as a framework for understanding the Bay's subembayments at a more refined and deeper scale.

Proposed by Kyle Stark, Lester McKee, Alex Braud, and Scott Dusterhoff (SFEI)

Proposed Deliverables and Timeline

Deliverable	Due Date
Progress presentation at the annual Sediment Workgroup meeting	May 2025
Draft technical report submitted to the Sediment Workgroup	April 2026
Presentation to the Sediment Workgroup	May 2026
Final technical report completed	August 2026

Project Background and Overview

Sediment is a critical resource that is essential for sustaining San Francisco Bay tidal marshes and mudflats (or baylands) under a changing climate. Currently, there are approximately 80,000 acres of baylands that will need an increased sediment supply to keep pace with sea-level rise (Dusterhoff et al. 2021). In addition, tens of thousands of acres of restored tidal marsh planned throughout the Bay will need sediment to fill subsided areas and maintain tidal marsh elevation into the future. Changes in watershed sediment supply, along with changes in bayland extent, and sediment extraction from waterways have led to significant changes to the dynamics of sediment exchange within the Bay (Schoellhamer 2011, Barnard et al. 2013). Understanding these dynamics is crucial for evaluating the health of the Bay and predicting the effects of climate change.

McKnight et al. (2023) recently completed a conceptual model of fine sediment (i.e., sediment silt-sized and smaller) for the Bay. The report offered a high-level understanding of how fine-grained sediment moves around at different scales within the Bay. The effort concluded with a set of key knowledge gaps and uncertainties and recommendations for addressing them. Among these were a set of priority actions, including a recommendation to "…refine modeling of suspended sediment concentrations in Bay subembayments to account for more dynamic processes, such as mixing, flocculation, bioturbation, and variation over time." The report concluded that while the general pathways of sediment movement to the Bay are understood, the dynamic processes within subembayments (e.g., between marshes and mudflats, changes in the erodible sediment pool) are less understood. Other recent work has attempted to provide an accounting of sand-sized sediment and transport throughout the Bay (McKee et al. 2023a).

These data gaps and recommendations form the basis for several of the identified priorities of the Sediment Workgroup. Several priority science questions (SQs) were identified in the development of the Sediment Workgroup's Bay Sediment Modeling and Monitoring Workplan (SMMWP) (McKee et al. 2023b). The Workplan was designed to match the Sediment Workgroup management questions (MQs) with more specific, forward-looking projects that translate these MQs into actionable science questions.Several of these questions are aligned with this proposal, including: improving understanding of sediment transport processes and pathways within subembayments (SQ 3.3), assessing current and future sediment budgets (SQ 3.5), increasing deposition rates at marsh restoration sites (SQ 4.2), and evaluating accretion/erosion rates and fluxes between individual marshes, mudflats, and shallow subtidal shoals (SQ 4.4).

Study Objectives and Applicable RMP Management Questions

This study will produce a detailed conceptual understanding of sediment transport processes within the San Pablo Bay subembayment. The work will build on other previous efforts from the San Francisco Bay Regional Monitoring Program (RMP) Sediment Workgroup studies, including the Bay sediment conceptual model (McKnight et al., 2023), Spatial variability of sediment accretion in San Francisco Bay restorations (Lacey and Thorne, in progress), and Special Study on Bulk Density (McKnight et al. 2020). The output from this proposed project is intended to be coupled with ongoing work through Destination Clean Bay, an EPA-funded effort that focuses on support tools for multi-benefit water quality improvements. Analysis through Destination Clean Bay will focus on updates to the bay-wide conceptual understanding. When combined with this proposal, these efforts will accomplish two goals: update the bay-wide conceptual understanding and provide a framework to understand subembayments at a deeper level.

Specifically, this proposal will address three data gaps that have been identified within the SMMWP. First, this effort will compile available data related to local tributary sources of sediment to the subembayment. These data are largely already compiled, but our efforts will focus on evaluating recent changes to sediment delivery and explore how sediment supply may change over the next 20 years. Second, the proposed effort will refine our understanding of the exchanges between tributaries, marshes, mudflats, and erodible sediment pool. The erodible sediment pool is defined as any shallow subtidal area within the San Francisco Bay (mean low low water to 12 feet below mean low low water) containing sediment that can be mobilized and transported (McKnight et al. 2023). Rudimentary understanding of this pathway was defined bay-wide, but this pathway is another datagap that can be.Our focus will be on updating this understanding with new datasets, some of which have been produced through this RMP Workgroup.

The two focus areas defined in this proposal were chosen because of how they directly relate to the long-term goals of the Sediment Workgroup (Table 1). This proposal focuses largely on a deeper conceptual framework of two critical components of San Pablo Bay. From these conceptual efforts, we hope to identify missing datasets that are needed to develop Bay-wide dynamic models of sediment movement. These models have already been identified in the SMMWP and include the WARMER model (Swanson et al. 2014, Buffington et al. 2021) and the Deltares DFM model (Achete et al. 2015, Nederhoff et al. 2021). The focus areas of this proposal were identified as areas of high uncertainty within the current modeling domain. By building a conceptual understanding of these areas, we hope to improve the Bay-wide ability to accurately model sediment movement throughout the San Francisco Bay.

Table 1: RMP Sediment Workgroup management questions addressed by the proposed project

Management Question	Modeling / Monitoring Science Question
3. What are the sources, sinks, pathways, and loadings of sediment and sediment-bound contaminants to and within the Bay and subembayments? 4. How much sediment is passively reaching tidal marshes and restoration projects and how could the amounts be increased by management actions?	SQ 3.3. What are the main sediment transport processes and pathways within subembayments? SQ 3.5. What is the current sediment budget and how is the sediment budget changing? SQ4.2 What actions can we undertake to increase deposition rates in restoration sites? SQ4.4 What are the accretion/erosion rates and fluxes between individual marshes, mudflats, and shallow subtidal shoals?

Approach

Task 1 Literature review and advisor sub-team

This task focuses on gathering information related to sediment dynamics in the San Pablo Bay subembayment. Previous investigations of the subembayment (Ganju et al. 2004, Schoellhamer et al. 2008) will be combined with information from more modern efforts (e.g., Beagle et al. 2015, McKnight et al. 2023). This task will also include funds to convene an Sediment Workgroup sub-team, composed of a subset of the Sediment Workgroup members. This group will be convened with two goals in mind: advising the literature and data gathering efforts associated with the San Pablo Bay subembayment. The sub-team will be informed about ongoing efforts (such as the Destination Clean Bay effort) so that they may recommend ideas that lead to cost-sharing and efficiencies between the various ongoing work.

Task 2 Subembayment analysis

This task focuses on producing a refined understanding of sediment dynamics within the San Pablo Bay subembayment. Our intention is to focus on expanding the conceptual understanding of two specific elements: compiling an updated understanding of local tributary sediment within the subembayment and developing a deeper understanding of the tributary-marsh-sediment pool pathway. Other analyses may be needed, such as assessing the size and state of the area where wave resuspension is likely to occur. The effort will consist of:

- Augmenting existing tributary delivery estimates with the latest data from the last 10 years. When physical sampling is absent, utilize already existing RMP products (Zi et al. 2022).
- Refining the McKnight et al. (2023) conceptual model of the tributary-marsh-sediment pool pathway using an updated set of literature, as determined by the Workgroup sub-team.

Task 3 Report and scientific communication

Results of the study will be compiled into a technical report, anticipated to be completed by early 2026. This report will be presented to the RMP Sediment Workgroup, Technical Review Committee, and Steering Committee for review and acceptance. We will provide a project update at the spring 2025 RMP workgroup meeting(s) and plan to share findings at a sediment oriented conference in Fall 2025. The findings from the analysis will be archived to SFEI's server and be available to support future studies from other workgroups and stakeholders.

Budget Justification

The proposed work can be completed in one year with an estimated cost of $65,000. The expected deliverable is a final technical report focused on the San Pablo Bay subembayment.

Task	Estimated Labor Hours	Advisor Funds	Estimated Total Cost
1. Literature review and advisor sub-team	60	$6,000	$16,000
2. Subembayment analysis	185	--	$29,000
3: Report and scientific communication	125	--	$20,000
Total	**370**	--	**$65,000**

Labor

This is a reference and data gathering effort, combined with some desktop analysis. Funding is intended to support SFEI staff.

Advisor sub-team

This references funding for convening the advisory team. Funding will be provided to the advisors following the established SFEI guidelines.

Reporting

The draft of the technical report will be submitted for review in April 2026 to the RMP Sediment Workgroup, TRC, and SC. A final report is planned for delivery in August 2026.

References

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Develop a study plan to improve characterization of bed sediments and settling velocity to advance sediment transport modeling for San Francisco Bay

Summary: We propose to develop a study plan to improve modeling of sediment transport in San Francisco Bay through a combination of data collection and modeling. The plan will address two topics: 1) characterizing bed sediment properties including erodibility; and 2) representing settling velocity of particles in suspension. This proposal responds to the need identified in the RMP Sediment Workgroup Sediment Modeling and Monitoring Workplan (SMMWP) for a literature review and detailed workplan to address these two topics. Sediment transport models require specification of parameters related to each of these topics, yet both are poorly constrained by field measurements and are characterized by complex physical processes which are difficult to measure and model. Because of these complexities, a study plan reviewing existing knowledge and proposing an approach for constraining these parameters will increase the likelihood for success in the RMP effort to improve sediment transport modeling in the Bay.

Estimated Cost: $106,900

Time sensitive: Yes. Other elements in the SMMWP depend on this effort.

Oversight Group: RMP Sediment Workgroup (SedWG)

Proposed by: Jessie Lacy[1], Oliver Fringer[2], Rachel Allen[3], and Lester McKee[4]
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Proposed Deliverables and Timeline

Deliverable	Due Date
Convene technical workshop to inform the study plan (Task 2)	June 2025
Presentation to stakeholders through RMP SedWG (Task 3)	October 2025
Draft report presenting study plan for improving characterization of settling velocity and bed sediments to advance sediment transport modeling in San Francisco Bay (Task 4)	January 2026
Final report (Task 5)	March 1, 2026

Background

Numerical sediment transport models (STMs) can help resource managers in San Francisco Bay make decisions on a wide array of topics including phytoplankton dynamics, pollutant fate and transport, sediment availability for wetlands restoration, and dredged material management. The ability of numerical models to simulate large spatial scales and predict future conditions make them powerful tools for decision makers. Sediment transport in San Francisco Bay (the Bay) has been simulated with a variety of modeling systems including UnTrim (e.g. Bever et al. 2013), SCHISM (e.g. Wang et al., 2020), ROMS (e.g. Ganju and Schoellhamer, 2010), SUNTANS (e.g. Chou et al. 2018), and the Deltares suite of models (e.g. Van der Wegen et al. 2011, Allen et al 2021). All these model systems accurately compute hydrodynamics including currents, waves, and salinity transport. However, the sediment transport implementations of these models, like all STMs, are less accurate than the hydrodynamics owing to the inherent difficulty in modeling cohesive and mixed (sand/cohesive) sediments. Cohesive and mixed sediments exhibit complex flocculation, settling, and erosion physics that are nearly impossible to parameterize (e.g., Winterwerp et al. 2021), are not completely understood, and are difficult to measure or observe in the field. With such poorly constrained physics, tuning STMs to match observations is challenging (e.g., Allen et al., 2021) and best professional judgment is therefore typically used.

STMs can simulate suspended-sediment concentration (SSC), suspended-sediment flux (SSF), and geomorphic change. These quantities are governed by mixing and transport, erosion, and settling of sediment. While predictive equations for mixing and transport are incorporated in STMs, there are no such equations for the processes of erosion and settling; instead they are parameterized, with parameter values specified by the user. We propose to develop a study plan to constrain parameters related to erosion and settling through a combination of data collection and modeling. For both processes, the required input parameters are not well constrained by field observations in the Bay (or elsewhere) and the relevant physical properties or processes are difficult to measure and vary in time and spatially across the Bay, as summarized below. In both cases, it is likely that a combination of observations and model tuning or sensitivity analysis will be the best approach to parameterization.

1) STMs require specification of bed sediment particle size(s) and erosion rates (erodibility). Erosion can be represented in different ways; often models require erodibility parameters such as critical shear stress and an erosion rate coefficient, as well as depth of the erodible sediment layer(s). These properties may be specified based on available data or may be used as tuning parameters in model calibration. Sediment properties vary spatially and temporally in the Bay, but the extent to which inclusion of this variation in STMs improves performance is not clear. Erodibility parameters characterize the erosion response to bed shear stress, which in cohesive sediments can be influenced by physical and biotic properties as well as the history of physical forcing (Grabowski et al., 2011). Laboratory and *in-situ* methods have been developed for measuring erodibility, yet results from the various methods do not always agree well (Tolhurst et al, 2009) due to both the difficulty in measuring the relevant processes and differences in definition of the parameters between methods. An alternative to measuring erodibility directly is to use indicators of bed erodibility in cohesive sediments such as disaggregated bed-sediment particle size distributions and sediment bulk density, which are relatively straightforward to measure.

2) Most STM's track multiple particle size classes in suspension, each of which is characterized by a fixed settling velocity. One or more size classes may represent flocs, but flocculation and floc break-up, which alter the particle size, are not represented. Selection of the settling velocity for each size class is challenging due to lack of empirical data. Settling velocity is a function of particle size and density, and in muddy systems such as San Francisco Bay, is strongly influenced by flocculation dynamics. Flocculation is influenced by gradients in physical, chemical, and biologic processes. Field observations in the Bay reveal formation and break up of flocs over daily tidal cycles and differences in floc size between spring and neap tides (Allen et al. 2019), as well as significant spatial variation in floc size across the estuary (Manning and Schoellhamer, 2013). The relationship between particle size and settling velocity is complex for flocs, so estimating settling velocity from particle size is not straightforward. Measurement of floc properties, such as size, density, minerogenic and biogenic content, could help link settling velocity to particle size, but these properties are challenging to measure in the field. While STM's that simulate flocculation processes have been developed (e.g. Sherwood et al, 2018), these models require additional parameters that are difficult if not impossible to measure, such as the fractal dimension (Dyer and Manning 1999) or the critical yield stress for floc break up (Son and Hsu, 2009). Thus, it is not clear that this approach improves model performance for predicting large-scale or long-term sediment fluxes.

The Regional Monitoring Program for Water Quality in San Francisco Bay (RMP) is currently developing an in-Bay model for sediment and contaminant fate using Delft3D-FM (DFM), building on the San Francisco Bay-Delta Community Model (Martyr-Koller et al. 2017). The in-Bay model is initially being developed to apply to contaminant transport, which will require incorporation of important sediment transport processes in the Bay (Jones et al. 2022). Oliver Fringer's 2025 Special Study proposal to the RMP SedWG to assimilate satellite remote sensing of surface suspended sediment into the DFM model will help to constrain some of the parameters required for cohesive sediment transport modeling. The study plan proposed here will work in concert with the Fringer project to support and improve the in-Bay model as well as other STMs for the Bay.

Study Objectives and Applicable RMP Management Questions

This project addresses RMP SedWG Management question 5 (Table 1), specifically science questions 5.2 and 5.3 identified in the SedWG Sediment Modeling and Monitoring Workplan (McKee et al. 2023).

The goal of this project is to develop a study plan to constrain parameters that are important for modeling sediment transport in San Francisco Bay through a combination of data collection and modeling. The plan will address the two topics described in **Background**: 1) characterizing the sediment bed and 2) representing the settling velocity of particles in suspension. Our proposal responds to the need identified in the SMMWP for a literature review and detailed workplan to address each of these topics. For both topics we will develop an integrated observational and modeling plan, starting from existing data and model capabilities, using modeling to determine data needs, collecting data, and using data to check model performance, in an iterative manner. For both topics the goal is to collect data to constrain the range of each parameter, and at the same time use the model to guide data collection, by determining what level of accuracy and spatial or temporal resolution of the parameters is useful for improving model performance.

Table 1: RMP Sediment Workgroup management questions addressed by the proposed project.

Management question	Monitoring/modeling science questions from SMMWP
MQ5: What are the concentrations of suspended sediment in the Estuary and its subembayments?	5.2 How does bed erodibility vary around the Bay in relation to physical factors such as texture, tides, and waves, and biotic factors such as phytobenthos and bioturbation?
	5.3 How do flocculation processes and floc sizes vary throughout the Bay in relation to SSC, water column depth, tides, wind, and other drivers, and how do these influence settling velocity?

Approach

Task 1: Literature review and study plan outline

For each topic, we will review the literature on field observations, laboratory studies, and model sensitivity to the relevant parameters. For data availability and parameter estimation we will focus on San Francisco Bay studies, and for observational and modeling approaches we will consider estuaries worldwide.

We will outline a three-year study plan to address both topics through a combination of data collection and modeling. This initial outline will provide a structure for eliciting feedback through a workshop (Task 2) and from select reviewers outside the workshop. The structure and content of the document will reflect the initial thinking of the project team, and while we expect it to include building blocks for the final report, it may be structured differently or take the form of a presentation or outline. The expected content is outlined in Task 4.

Task 2. Convene a technical workshop

We will convene a one-day workshop for 20-25 regional scientists involved in modeling and observational studies of sediment transport in San Francisco Estuary as well as representatives of the RMP SedWG. The goal of the workshop is to gather input on the study plan and identify and refine approaches, for the three-year effort. The workshop will consist of scientific presentations and discussion of the study plan outline. We anticipate holding the workshop at Stanford University in summer 2025.

Task 3. Presentation to RMP stakeholders

After revising the study plan based on the technical workshop (Task 2), we will present it to RMP stakeholders at a half-day meeting convened by the RMP SedWG. The purpose of the meeting will be to get feedback on the scope, budget, and where applicable alternative approaches for the study plan. A revised outline of the study plan will be distributed to attendees prior to the meeting.

Task 4. Draft the study plan (final report)

Following the workshop and stakeholder meeting, we will complete a draft study plan and submit it to the RMP for review. The study plan will consist of:

1) Literature review for each of the two topics
2) Plan for three-year combined observational and modeling study for each of the two topics, including:
    - definition of a spatial scale or study area(s) for observational and modeling work
    - scope, methods, and estimated cost of initial data collection
    - scope, identification of model(s), and estimated cost of initial modeling
    - identification of model output(s) to be used for evaluating performance (e.g., suspended-sediment concentration or suspended-sediment flux)
    - a plan for iterating between modeling and measurements
    - estimated budget for the three-year study

Task 5: Final report

Following revision, the final report will be submitted by March 1, 2026 so it is available for the RMP SedWG 2026 proposal cycle.

Budget and justification

USGS budget includes salary and benefits for Lacy, Allen, and Andrew Stevens (a USGS modeler) and travel funds for Allen to attend the workshop.

Stanford budget includes salary and fringe benefits for Fringer and funds to run the workshop, which includes breakfast, lunch, and coffee/refreshments for 30 attendees ($2,500). The indirect cost rate is assumed to be 54.4%.

SFEI budget includes salary and benefits for SFEI staff.

Expense	USGS	Stanford University	SFEI
Task 1	$13,000	$11,000	$6,000
Task 2	$3,000	$2,500	$1,500
Task 3	$1,000	$500	$3,500
Task 4	$11,000	$10,000	$8,000
Task 5	$2,000	$1,000	$1,000
Subtotal	$30,000	$25,000	
Indirect	$18,300	$13,600	
Total	**$48,300**	**$38,600**	**$20,000**

Grand total: $106,900

In-kind and leveraged contributions for the project: USGS and Stanford PI's expect to spend more time than budgeted on this effort.

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Analysis of satellite-based surface suspended sediment concentrations for improved sediment transport modeling in San Francisco Bay

Summary: This proposal addresses part of a long-term goal of improving sediment transport modeling capabilities for the San Francisco Bay (SF Bay) RMP by assimilating satellite-derived surface suspended sediment concentrations (SSC) into the DFlow-FM model currently under development as part of the RMP Nutrient Management Strategy (NMS) and in-Bay modeling effort focused on contaminant and sediment transport modeling. For the first phase of the long-term goal, this proposal seeks to study satellite imagery to infer surface SSC and compare it to in-situ observations to evaluate the accuracy of different satellite products at inferring SSC throughout SF Bay. This proposal responds to the need identified in the SedWG Sediment Monitoring and Modeling Workplan (SMMWP) to develop satellite-based estimates of SSC to support hydrodynamic modeling of Bay sediment flux. The focus will be on Planet Cubesat imagery owing to its high spatial resolution of 3 m and its short revisit time of one day compared to 10-16 days for Sentinel-2 or Landsat. The accuracy of the satellite-based surface SSC will be assessed throughout the Bay. It will then be used to study trends over time in different SF Bay embayments. In follow-on work, these data will be used to improve the accuracy of SF Bay sediment transport models using state-of-the-art data assimilation techniques. The proposed work will lead to improved sediment transport modeling in SF Bay which is instrumental to aiding management actions for problems that rely on accurate predictions of sediment dynamics, such as marsh restoration, dredging operations, contaminant transport, and nutrient budgets.

Estimated cost: $135,475

Time sensitive: Yes. Other elements in the SMMWP depend on this effort.

Oversight Group: RMP Sediment Workgroup

Proposed by: Oliver Fringer[1] and Jessie Lacy[2]

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Proposed deliverables and timeline

The deliverables are based on the tasks indicated in the approach section of the proposal. The proposed work would last roughly 1.5 years, and for the purposes of timing it is assumed that it would begin in January of 2025.

Deliverable	Due Date
Task 1: Create database of in-situ datasets and surface SSC derived from satellite imagery. Assess accuracy of satellite-based surface SSC.	Summer 2025
Task 2: Analyze trends in satellite-based surface SSC.	Fall 2025
Task 3: Write up and submit a paper/final report. Submit the report to the RMP Sediment Workgroup for peer review.	Winter 2026
Task 4: Presentation to RMP Sediment Workgroup.	Spring 2026

Background

Sediment transport models of systems like San Francisco Bay (SF Bay) include suspended and bed-load dynamics driven by three-dimensional transport and mixing processes related to waves, tides, density-driven circulation, river inflows, and winds. While the hydrodynamic models that predict the flow processes driving transport and mixing are very accurate, accurate sediment transport modeling remains elusive owing to the difficulty in representing the many complex physical processes related to sediment transport in estuaries. Because these processes are difficult if not impossible to measure, many are represented with ad-hoc approaches like model tuning and are validated with qualitative comparisons to in-situ or remotely sensed observations. As a result, state-of-the-art sediment transport models can qualitatively predict general sediment trends in both time and space, but cannot predict details like tidal-scale peaks or spatial gradients throughout SF Bay. It is thus difficult to use the results of sediment transport models to answer related management questions, particularly because tidal and shorter timescale dynamics acting over long time scales dictate the distribution and long-term trends of sediment in the Bay. There is thus a need to develop methods that go beyond existing approaches to improve the accuracy of sediment transport models in SF Bay and similar estuaries.

This proposal focuses on analyzing surface suspended sediment concentrations (SSC) derived from satellite imagery and addresses part of a long-term goal of improving sediment transport modeling capabilities in SF Bay through use of state-of-the-art modeling techniques combined with high-resolution satellite imagery and in-situ observations. The goal is to incorporate these methods in the Deltares D-Flow Flexible Mesh (DFlow-FM or DFM) model (Marty-Koller et al. 2017; Holleman et al. 2017; King 2019; King et al. 2019) currently under development by SFEI as part of the RMP Nutrient Management Strategy (NMS). The DFM model is also being used for the in-Bay modeling effort which seeks to model contaminant and sediment transport in SF Bay (Jones et al. 2022). A related long-term goal is to have the ability to compute sediment dynamics using satellite imagery alone or in concert with a hydrodynamic model.

This proposal requests funds to support analysis of the satellite remote sensing of surface SSC. Funds to support the long-term goals have not been secured, although Fringer has Ph.D. students who will arrive at Stanford in fall 2024 to begin working on related projects (see in-kind and leveraged contributions in the budget section below). A tentative timeline and approximate budgets for the long-term goals are given below. The budgets assume hiring one postdoc at Stanford per year to work on the project.

Year 1 (2025): Analyze satellite remote sensing data of surface SSC and compare to in-situ observations to assess accuracy and determine trends throughout SF Bay. Cost: $135K (This proposal)

Years 2-4 (2026-2028): Incorporate satellite-based SSC into the SFEI DFM model using data assimilation techniques. Cost: $400K

Year 5 (2029): Study sediment fluxes at different transects in SF Bay to understand physical processes impacting the fluxes and to compute long-term sediment budgets. Cost: $135K

Year 6 (2030): Develop methods to compute fluxes and sediment budgets directly from the satellite data (i.e., without the sediment transport model). Cost: $135K

Jessie Lacy is submitting a 2025 Special Study proposal to the RMP Sediment Workgroup to develop a three-year study plan using a combination of observations and models to improve sediment transport modeling in SF Bay. The emphasis will be on characterizing bed properties impacting sediment erodibility and the settling velocity of particles in suspension. The long-term goals of the proposed work will support the study plan by analyzing the settling velocities and bed properties that are predicted with the data assimilation approach. We will focus on modeling the regions or processes outlined in the study plan.

Literature review

Accurate suspended sediment transport modeling in SF Bay and similar estuaries is extremely challenging owing to the difficulty in representing the many complex physical processes related to fine, cohesive sediments, which tend to aggregate and form flocs. The size and nature of flocs is highly dynamic and depends on turbulence, salinity and biological material in the water column, and the cohesive bed does not obey simplified erosion or deposition formulas meant for sandy environments (e.g., Winterwerp et al. 2021). Owing to the difficulty in modeling cohesive sediment transport processes, the standard approach to suspended sediment transport modeling in estuaries is to model the bed with simple erosion formulas and to model the distribution of particles or flocs as separate, static size classes that are transported independently with properties (i.e., settling velocity, density) that are based on a limited number of measurements and are often tuned to match observations.

Among the most well-developed models of suspended sediment in SF Bay is that of Bever et al. (2018), in which they implemented the SediMorph sediment transport model in the UnTRIM SF Bay model (MacWilliams et al. 2015). Bever et al. employed four sediment size classes in SediMorph including silt, flocculated silt and clay, sand, and gravel and showed that decreased turbidity in North SF Bay during 1995-2015 can be partially explained by decreased wind speeds. While the model could qualitatively predict the spring-neap variability of the SSC in North SF Bay, it generally underpredicted the peaks in the SSC time series related to the tides. The modeled surface SSC was also shown to qualitatively match the spatial distribution of the surface SSC derived from Landsat 8 imagery. Bever et al. noted that it is difficult to validate sediment transport models in SF Bay with turbidity because the relationship between the model-predicted SSC and in-situ or remotely sensed turbidity varies throughout the Bay owing to the impact of organics. As an example, the turbidity can vary by more than 100% throughout the bay for a typical SSC of 100 mg/L. Nevertheless, to obtain a better agreement between observations and model results at the Golden Gate Bridge, Anchor QEA, L.L.C. (2021) added a fifth size class to SediMorph representing the transport of fine silts from inflows that were contributing to the observed SSC.

A similar approach to represent flocs was employed by Wang et al. (2021) in their study of the impacts of turbidity on biogeochemical processes in SF Bay using the SF Bay SCHISM model of Chao et al. (2018) with the SED3D sediment model of Pinto et al. (2012). They employed three size classes and model results qualitatively matched spring-neap variability when compared to observations at Benicia and Richmond, but they also underpredicted the peak SSC concentrations.

Van Gijzen (2020) added fine sediment transport to the DFM model (Marty-Koller et al. 2017; Holleman et al. 2017; King 2019; King et al. 2019) currently under development by SFEI as part of the RMP Nutrient Management Strategy (NMS). Employing two size classes, the model was shown to underpredict the SSC in the spring and, because of weak horizontal gradients in the model, it also underpredicted SSC peaks in the tidal cycle. While scenarios were devised to show how the sediment parameters influenced the results in some regions of the domain at certain times, there was no parameter set that uniformly improved the results.

Although the SF Bay sediment transport studies employ separate size classes and static bed properties, Sherwood et al. (2018) outline a more physics-based approach to cohesive sediment transport modeling in the ROMS-based COAWST model (Warner et al. 2008). Flocculation and breakup dynamics are modeled with the population balance equations in which mass is exchanged between sediment size classes (Verney et al. 2011), thus giving dynamically varying floc settling velocities in response to turbulence and interacting floc sizes. The bed properties also vary with subsurface depth, dynamically respond to deposition and erosion of variable floc sizes, and relax toward a representative background state through swelling (increasing volume and decreasing erodibility) and consolidation (decreasing volume and increasing erodibility). While this first-principles methodology represents details of the many processes governing cohesive sediment physics, it also introduces many new parameters that are often difficult if not impossible to measure, such as the fractal dimension (Dyer and Manning 1999) or the critical yield stress for floc breakup (Son and Hsu, 2009).

A more viable alternative to the complex physics-based approach to sediment transport modeling is to employ data-driven methods to infer the parameters in more simplified models. Indeed, in many studies the parameters are tuned or calibrated to improve the model results. For example, Chou et al. (2018) simulated fine sediment transport in South SF Bay with the SUNTANS model (Fringer et al. 2006) and assumed two size classes which they referred to as micro- and macro-flocs, each with fixed settling velocities based on observations. To obtain the best match with observations at a site on the eastern shoals north of the Dumbarton Bridge, they tuned the ratio of microto macro-flocs that are eroded from the bed. Model tuning in this way often limits model reliability to specific locations and times where in-situ data are available. Satellite remote sensing offers the possibility of tuning parameters to yield results over larger spatial scales. For example, Ouillon et al. (2004) combined satellite-based surface SSC with in-situ measurements to tune erosion rates that best matched satellite-derived SSC in a sediment transport model of the lagoon of New Caledonia with just one size class.

The disadvantage of model tuning is that it is often ad-hoc and it is difficult to tune multiple parameters based on multiple or large data sets. Instead of tuning the parameters, a more quantitative approach is to employ data assimilation techniques that are commonly employed in weather prediction and regional ocean modeling. These techniques are gaining traction in sediment transport modeling due to the advent of high-resolution satellite remote sensing of SSC. Data assimilation involves two steps. In the first step, referred to as state estimation, measurements and model results are combined to obtain the best initial condition for a forecast. In the second step, measurements and model results are combined to estimate the parameters that yield the best match between simulated results and observations. As an example, Vitousek et al. (2023) employed the ensemble Kalman filter (EKF) approach to assimilate satellite imagery into a shoreline prediction model of the California Coast to obtain the optimal set of parameters for matching model results and the satellite-based measurements. Similarly, and more related to the proposed work, Serafy et al. (2011) employed the EKF approach to assimilate remote-sensing imagery of surface SSC into a Delft3D-based model of the North Sea. They were able to improve predictions of SSC through data assimilation while assuming just two sediment size classes. In another example, Yang et al. (2016) used satellite remote sensing to initialize the SSC in Hangzhou Bay, China, and showed that this significantly improved SSC predictions over the next two days. While this form of state estimation uses satellite imagery to obtain an initial condition that improves predictions, further assimilation would be needed to estimate the parameters that would improve predictions over more realistic, longer time scales.

At the heart of data assimilation techniques for suspended sediment transport modeling is satellite remote sensing of surface turbidity which can be inferred relatively accurately with the red or near-infrared spectral bands from satellite remote sensing (Nechad et al. 2010) after appropriate atmospheric corrections (e.g., Vanhellemont 2019). Evaluation of SSC from turbidity requires relationships based on observations (e.g.. Bever et al. 2018), or the satellite-derived imagery can be directly calibrated to match observed SSC. For example, Ruhl et al. (2001) calibrated Advanced Very High Resolution Radiometer (AVHRR) imagery from NOAA satellites with in-situ observations to study SSC in SF Bay and found that the relatively low spatial (1 km) and temporal (20 days) resolution made it difficult to resolve many processes. Adelson (2020) calibrated Landsat 7 imagery with full-Bay USGS Polaris transects and showed that the satellite-derived measurements were accurate enough to supplement the transect measurements to obtain a detailed understanding of the spatial variability of surface SSC in SF Bay. However, despite the high spatial resolution of 30 m, the temporal resolution of 16 days made it difficult to infer high-frequency temporal variability and limited the number of satellite images that coincided with the in-situ observations. Nevertheless, the results indicated that surface SSC was heightened in the shallow shoals of the Bay during summer months and has trended downward in Suisun and Grizzly Bays since 1999, consistent with observations. Similarly, Croteau and Potter (2024) analyzed Landsat 8 imagery to show that there was a downward trend in total suspended sediment in SF Bay during 2020-2021. Planet Cubesat satellite imagery is a promising remote sensing product for data assimilation into suspended sediment transport models since it provides daily imagery at a spatial scale as fine as 3 m (Vanhellemont 2019). As it is relatively new compared to other satellite products, to our knowledge the paper by Vanhellemont is the only one describing the application of Cubesat imagery to study turbidity in SF Bay.

Study objectives and applicable RMP management questions

The long-term objective of the proposed work is to improve the accuracy of sediment transport models in SF Bay to answer questions in the Sediment Modeling and Monitoring Workplan (SMMWP; McKee et al. 2023). The accuracy of sediment transport models will be improved with data assimilation methods which estimate the sediment parameters that give the best match between in-situ measurements and satellite-derived surface SSC throughout the Bay. A key component of the data assimilation strategy is that it will enable quantitative estimation of the uncertainty in the predictions, giving stakeholders a means of assessing the degree to which sediment transport model predictions can be trusted for decision making. Because sediment parameters will essentially be calibrated to match satellite-derived SSC throughout the Bay, model results will give better predictions throughout the Bay rather than solely where in-situ data is available. Knowledge of the spatial variability of the uncertainty in the predictions will give managers insight into regions where more observational campaigns may be needed to supplement the satellite data.

The improved sediment transport modeling strategy developed in this proposal will enable managers to specifically answer management questions 3, 4, and 5 in the SMMWP, as indicated in Table 1 below. Relevant to these questions is the fact that a more accurate sediment transport model will be able to more accurately assess sediment transport pathways and long-term trends throughout the Bay, including at key transects (e.g. GGB, Dumbarton, etc…) and offshore of marsh edges, thus enabling assessment of long-term erosion or accretion trends. As an example of how the modeling framework will give results better suited for decision making, despite estimates based on in-situ observations (Livsey et al. 2020, 2021), the annual sediment flux during past water years across the Dumbarton Bridge is known with very little confidence. The improved sediment transport model will be able to more accurately compute this flux because the sediment parameters will be calibrated to ensure minimal errors between the predicted and satellite-based surface SSC over much of the surface of the Bay including across the transect. It is reasonable to assume that the vertical structure of the SSC will be reproduced by the three-dimensional model if the simulated surface SSC matches the satellite-inferred data, Therefore, one can have greater confidence in the model prediction of the flux which will not only be closer to the true value but the uncertainty in the prediction will also be known.

This proposal focuses on the first step in developing the assimilated sediment transport modeling framework, which is to analyze satellite imagery to assess where and over what time scales it can be assimilated into the model. The focus will be on high-resolution Planet Cubesat imagery, although we will also study Landsat, Sentinel-2, and possibly other sources if relevant. Satellite imagery will be analyzed throughout SF Bay and validated where in-situ SSC data are available. This is particularly important given the need to relate the satellite-inferred turbidity to the surface SSC. The validated surface

SSC will be used to study long-term sediment trends and determine whether tidal dynamics can be deduced from daily Planet Cubesat imagery. Methods for approximating the depth-variability of the SSC (e.g., Rouse profile) will be assessed through comparison of previously collected bottom-mounted, in-situ measurements to the surface SSC derived from satellite imagery.

Table 1: Management and monitoring/modeling science questions from the SMMWP that will be addressed for this proposal (**indicated in bold**) and through the long-term goals of the proposed work (*indicated in italics*).

Management question	Monitoring/modeling science questions from SMMWP
MQ 3: What are the sources, sinks, pathways, and loadings of sediment and sediment-bound contaminants to and within the Bay and subembayments?	3.1: What is the flux of sediment through the Golden Gate and other Bay cross-sections? *Long-term goals: The long-term goal of this project is to compute accurate sediment fluxes and estimate uncertainties with the assimilated DFM sediment transport model. Another long-term goal is to estimate fluxes with the satellite imagery in combination with hydrodynamics from the DFM model (i.e., no sediment transport modeling).*
	3.3: What are the main sediment transport processes and pathways within subembayments? *Long-term goals: The assimilated DFM sediment transport model will be able to answer this question more accurately than existing models. The assimilated model will also be able to provide uncertainty bounds on the predictions.*
	3.4: Are marsh edges and shorelines undergoing net erosion or progradation? *Long-term goals: Modeling of marsh edge erosion is a difficult problem that will not be directly addressed by the proposed model without a specific effort to include marsh edge erosion processes. However, the assimilated DFM sediment transport model will be able to compute net sediment fluxes onto or offshore of marsh edges from deeper water.*
	3.5: What is the current sediment budget and how is the sediment budget changing? **This proposal: Sediment budgets can be estimated with satellite imagery although they require assumptions about the vertical structure of the SSC after inferring the surface SSC from the satellite imagery.** *Long-term goals: The assimilated DFM sediment transport model will be able to answer this question more accurately than existing models. The assimilated*

	model will also be able to provide uncertainty bounds on the predictions.
MQ 4: How much sediment is passively reaching tidal marshes and restoration projects, and how could the amounts be increased by management actions?	4.4: What are the accretion/erosion rates and fluxes between individual marshes, mudflats, and shallow subtidal shoals? *Long-term goals: The assimilated DFM sediment transport model will be able to accurately compute net sediment fluxes along with uncertainty bounds that will provide managers with information on sediment fluxes reaching tidal marshes.*
MQ 5: What are the concentrations of suspended sediment in the Estuary and its subembayments?	5.1 What are the predicted trends for suspended sediment concentrations, and how do they vary spatially and temporally around the Bay? **This proposal: We will focus specifically on analysis of satellite imagery to assess long-term (monthly to annual) and short (weakly to daily) trends in surface SSC throughout the Bay.** *Long-term goals: The assimilated model will be able to simulate the full, three-dimensional fields to relate the surface SSC to the distribution over the water column.*
	5.2 How does bed erodibility vary around the Bay? **This proposal: Surface SSC derived from satellite imagery in combination with estimated waves and currents from the DFD hydrodynamic model can be used to infer erodibility, although this is only a rough estimate**. *Long-term goals: The assimilated sediment transport model will be able to infer bed erodibility from the assimilation procedure.*
	5.3 How do flocculation processes and floc sizes vary throughout the Bay? *Long-term goals: This can be answered with the assimilated sediment transport model that will be able to infer flocculation processes and settling velocities from the assimilation procedure.*
	5.4 What are the concentrations and fluxes of suspended sediment in nearshore areas? **This proposal: Satellite-based SSC is less reliable in nearshore areas, although this will be assessed in the proposed work with algorithms that account for bottom reflectance.**

	Long-term goals: The assimilated DFM sediment transport model will be able to estimate nearshore sediment fluxes.

Approach

Satellite imagery will be analyzed following the well-documented methods to retrieve surface SSC from Landsat 7 by Adelson (2020) and from Planet Cubesats by Vanhellemont (2019, 2023). The accuracy of the surface SSC will be assessed through comparison to in-situ data and analyzed to understand both long-term and tidal trends in SF Bay. The research will be carried out through completing the following tasks.

Task 1: Database of in-situ datasets and surface SSC derived from satellite imagery

We will create a database listing details of available in-situ SSC datasets throughout SF Bay along with lists of times at which satellite imagery overlaps these data. Data sources will include, among others, the USGS San Francisco Bay water quality database (Cloern and Schraga 2016, Shraga and Cloern 2017, Shraga et al. 2018), monitoring stations from the USGS National Water Information System (waterdata.usgs.gov/nwis), and USGS data collected as part of the Lacy and Thorne RMP Special Studies in 2021-2023. This database will inform the selection of satellite imagery for assessing its accuracy in reproducing the in-situ observations. The imagery will be analyzed following the methods outlined in Adelson (2020) and Vanhellemont (2019, 2023). Specifically, we will apply the algorithms needed to compute the surface turbidity including atmospheric corrections and implementation of a machine learning algorithm for pixel classification. The pixel classification algorithm of Vanhellemont (2019) automatically distinguishes between clear water, non-water, turbid water, and mixed (i.e., non-water and turbid water).

The surface SSC will be computed from the surface turbidity with existing relationships from in-situ data (e.g. Bever et al. 2018) or through direct calibration where in-situ measurements of SSC overlap with the satellite data. Errors between the satellite-inferred surface SSC and the in-situ measurements will be assessed in relation to various sources, including but not limited to the time difference between image and measurement, depth of in-situ measurement, pixel classification algorithm, and cloud shadows. The method of Li et al. (2022) will be used to include the effect of bottom reflection in inferring the surface turbidity from the satellite imagery in shallow, nearshore areas. Because some in-situ measurements are not at the surface, we will use methods to infer the surface SSC based on in-situ measured or modeled currents and waves (Adelson 2020), which can then be compared to the satellite imagery. The focus will be on creating datasets of satellite-based surface SSC that will enable full-bay data assimilation in follow-on work. We will also seek datasets that allow us to study the flux at specific cross sections in follow-on work such as at the Golden Gate (Anchor QEA, L.L.C. 2021) and Dumbarton (Livsey et al. 2020, 2021) bridges.

Task 2: *Evaluating trends in satellite-based surface SSC*

We will use the satellite-based surface SSC to evaluate trends in SF Bay including seasonal and annual variability or possible decadal (depending on the satellite) declines in SSC in different embayments. Adelson (2020) evaluated trends in SF Bay using satellite-based SSC, although the long visit times of Landsat 7 (16 days) limited the number of satellite images that overlapped with the in-situ data. We will take advantage of the daily revisit times of Planet Cubesat satellites to increase the number of images that can be compared to in-situ measurements and to understand high-frequency variability in the suspended sediment dynamics. The daily revisit time of Planet Cubesat-based measurements is not sufficient to study tidal variability of the surface SSC, since that would require hourly imagery or better. Nevertheless, because the same phase of the semidiurnal tide arrives roughly one hour later each day, satellite imagery from the same time of day can be used to reconstruct a semidiurnal tidal signal by stitching together daily images over 12 days. We will assess whether this reconstructed tidal signal of surface SSC can be observed with satellite imagery while factoring in spring-neap variability and other processes that could impact the daily variability of the surface SSC such as wind-waves and tidal currents, which will be obtained from the SFEI DFD model.

Task 3: Write up and submit a publication and final report

A postdoc working on the project will write a paper that discusses the different satellite products in SF Bay and the accuracy and reliability of the remotely sensed surface SSC. This paper will also discuss observed trends in the SSC throughout the Bay as well as whether it is possible to infer tidal variability from daily Planet Cubesat images. The paper will serve as the final report submitted to the Sediment Workgroup. The working group will review the report and provide feedback in preparation for presentation at the RMP Sediment Workgroup meeting.

Task 4: Presentation to RMP Sediment Workgroup

The results will be presented at an RMP Sediment Workgroup meeting in 2026.

Budget

The Stanford budget will support a postdoc for one year who will be responsible for the deliverables. Funds are included for 1% of Fringer’s time (the minimum effort required for Stanford sponsored research projects) to advise the postdoc. Funds are also included for the postdoc to purchase a laptop and attend a national conference like AGU. The USGS budget includes funds for Samantha McGill to help with in-situ data requisition and analysis. All salaries include benefits and overhead and other amounts include overhead costs.

Stanford	
Fringer salary	2,556
Postdoc 1 year salary	119,919
Laptop + travel	5,000
Stanford Total	127,475
USGS	
McGill salary	8,000
USGS Total	8,000
Grand total Stanford + USGS	135,475

<u>In-kind and leveraged contributions</u>

Lacy's time will be provided as an in-kind contribution.

Two Ph.D. students funded by other sources will join Fringer's group in fall 2024 and will be working on projects that are closely aligned with the long-term goals of the proposed work. One Ph.D. student will be working on the data assimilation scheme in the SFEI DFD model. A second Ph.D. student will be working with Fringer and David Senn (SFEI) on a project to predict harmful algae blooms (HABs) in SF Bay using modeling, remote sensing, and machine learning. That project will also employ the SFEI DFD model with an emphasis on using remote sensing of SSC to predict the light field for accurate predictions of HABs.

Reporting

Remotely sensed surface SSC data will be posted on Stanford data repositories within six months of publication of related paper(s). The final report will be a draft paper for submission to a peer-reviewed journal in winter 2026. The report will be provided to the RMP Sediment Workgroup for review before presentation at an RMP Sediment Workgroup meeting in spring 2026.

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Special Study Proposal: Napa-Sonoma Sediment Loads

The SedWG has completed its planning and recommended fixed-station stormwater monitoring for sediment in the Napa River and Sonoma Creek watersheds in its 5-year San Francisco Bay Sediment Modeling and Monitoring Workplan (McKee et al., 2023). Based on the WDM (Zi et al., 2022), Napa River and Sonoma Creek watersheds together are estimated to provide in excess of 15% of the local watershed supply to the Bay, but suspended sediment data collected in Napa and Sonoma during WY 2018, a very dry year, were deemed insufficient for WDM calibration. A few more years of monitoring data during different hydrologic conditions are needed to support a robust model calibration for these two major North Bay streams. This project will address these key sediment data gaps by funding the USGS to monitor wet season suspended and bedload sediment for Napa River (station number USGS 11458000) and Sonoma Creek (11458500). Although this study is envisioned to be the first of 4 years, if a very wet year occurs and data are deemed sufficient to describe the sediment transport processes for these watersheds, monitoring resources will likely be redirected to other locations of interest such as Walnut Creek, Petaluma River, or San Francisquito Creek. This project would directly address monitoring needs described in the RMP SedWG Monitoring and Modeling Workplan and support the work of the WRMP in the following ways:

1) Improve the estimate of sediment supply to the Napa-Sonoma Baylands and to the Bay;
2) Support local and regional WDM calibration for current suspended sediment supply;
3) Support the ability to model predicted future sediment supply under a changing climate; and
4) Support the potential to analyze marsh elevation sustainability under various watershed and Bay connection scenarios.

Estimated Cost:	$142,040/year (for the two locations combined)
Oversight Group:	SedWG, SPLWG
Proposed by:	Lester McKee (SFEI), Andy Watson (Ukiah USGS CA Water Science Center)
Time Sensitive:	No - but there are a number of projects that use the WDM sediment outputs

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	Due Date
Subcontract with USGS and install monitoring equipment	Fall 2024
Complete wet season monitoring	April 30th of each year
SedWG reporting and decision making	May of each subsequent year
Publication of data on USGS NWIS	May of each year

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Special Study Proposal: Bay Sediment Budget Update

The San Francisco Bay sediment budget changes dynamically in relation to trends in watershed supply, dredging and dredge disposal, and sand mining, the largest terms in the budget. A 2005 RMP-funded effort found that the Bay had a net deficit of 1.8 Mt/y for the period 1995-2002 (Schoellhamer et al., 2005). However, there were uncertainties about bathymetric change and sand and mud were lumped. Recently, a new sediment budget was completed for a 20-year period (2001-2020) that addressed these weaknesses (McKee et al. 2023). Although providing new information, this new sediment budget does not address the effect of human alterations at smaller spatial scales and did not separate out sediment mass associated with the erodible sediment pool (ESP). The budget also used an empirical relationship between bed texture and dry bulk density from another estuary. This project aims to address these weaknesses. Specifically, this project will update the budget with bathymetric change data sand dredging and mining areas (Fregoso et al., et al., 2023), a local bed texture-dry bulk density relationship (McGill and Lacy in preparation), and a conceptual understanding of the ESP has further developed (McKnight et al., 2023). This project will provide the RMP stakeholders with:

1. improved overall confidence in the mass balance and directional fluxes at the subembayment boundaries and between the Bay and Pacific Ocean,
2. estimates of sand and mud mass in the erodible sediment pool,
3. increased spatial resolution to separate out the sand mining areas from the rest of the budget to better reveal the influences of sand mining on the Bay.

These improvements have immediate applications including further improvement of our conceptual understanding about how the Bay works, a basis for revised pollutant budgets for the Bay for any particulate pollutant, and a better understanding of the influences of mining and dredging on the sand and mud budgets.

Estimated Cost:	$50k
Oversight Group:	SedWG, SPLWG
Proposed by:	Lester McKee
Time Sensitive:	No

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	Due Date
Complete data analysis	April 30, 2025
Draft report for review	June 30, 2025
Final report uploaded to SFEI publications page	August 31, 2025

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Special Study Proposal: Shoreline Change in San Francisco Bay

Understanding shoreline change is crucial for addressing sediment budgets at the local level and comprehending bayland dynamics at the embayment scale. This project aims to tackle pressing questions about which wetlands and mudflats are most vulnerable to loss due to sea level rise and how we can strategically manage these changes to achieve desired future states. Past efforts in San Pablo Bay (Beagle et al. 2015) have laid a solid foundation of methods for understanding shoreline dynamics and evaluating geomorphic change. This proposal seeks to build on that knowledge and provide foundational data to address priorities identified by the Sediment Workgroup, such as understanding sediment transport processes (MQ#3.3), assessing erosion or progradation of marsh edges (MQ#3.4), and evaluating changes in sediment budgets under varying climatic and land use conditions (MQ#3.5).

By leveraging readily available data (NOAA) and utilizing improved automated techniques (Farris et al. 2019), this study will create a more comprehensive dataset covering the major rivers/bay-fronting shorelines of San Francisco Bay from 1850 to 2020, with an emphasis on shorelines of the past 15 years. Recognizing that different shoreline edge typologies (scarp, ramp, etc: Beagle et al. 2015) require unique mapping techniques for accurate change detection, we propose creating a vector dataset of the modern shoreline that classifies these marsh edge types. Key tasks will include compiling historical NOAA T-Sheet-derived shorelines (1850's-1980's), creating a shoreline typology dataset, deriving shorelines from recent aerial imagery using automated techniques, and completing a technical methods report.

This work is envisioned as the initial phase in a broader collaborative effort with the Wetlands Regional Monitoring Program (WRMP) to understand and manage shoreline changes across the Bay. The methodologies developed and lessons learned will inform and improve future iterations of shoreline mapping. Each task will be coordinated with the WRMP technical advisory committee. The outcomes will provide crucial data to address the question: what have been the shoreline position changes over the past 150 years? Ultimately, the project will produce vector datasets showing major river/bay-fronting shorelines of the whole Bay encompassing the last 150 years, and a modern shoreline dataset classifying the type of shoreline edge to enable more accurate delineation and contextual analysis of shoreline variability.

Estimated Cost: $80,000
Oversight Group: Sediment Workgroup
Proposed by: Alex Braud, Lester McKee, Jeremy Lowe, and Scott Dusterhoff
Time Sensitive: No

Proposed Deliverables and Timeline:

Deliverable	Due Date
1. Historical Shorelines Data Package	Spring 2025
2. Shoreline Typology Data Package	Summer 2025
3. Recent Past Shoreline Data Package	Winter 2025
4. Technical Methods report submitted and presented to Sediment Workgroup	Spring 2026

References:

Beagle, J., Salomon, M., Baumgarten, S., Grossinger, R., 2015. Shifting shores: Marsh expansion and retreat in San Pablo Bay. Prepared for the US EPA San Francisco Bay Program and the San Francisco Estuary Partnership (A Report of SFEI-ASC's Resilient Landscapes Program No. SFEI Contribution #751). San Francisco Estuary Institute, Richmond, CA.

Farris, A.S., Defne, Z., Ganju, N.K., 2019. Identifying Salt Marsh Shorelines from Remotely Sensed Elevation Data and Imagery. Remote Sensing 11, 1795. https://doi.org/10.3390/rs11151795

National Oceanic and Atmospheric Administration (NOAA), 2024. NOAA Historical Surveys (T-Sheets). https://shoreline.noaa.gov/data/datasheets/t-sheets.html

Special Study Proposal: Suspended-Sediment Flux Measurements at Richmond-San Rafael Bridge, California

This proposal is to expand upon an already funded project to collect cross-channel transects using an acoustic doppler current profiler (ADCP) to measure both velocity and acoustic backscatter (ABS) at Richmond-San Rafael Bridge cross-section (RIC) in water year (WY) 2025. We request further funds to install an additional continuous water-quality sensor at the RIC transect location to collect high-frequency data during the study period. The exact location and/or type of additional sensor is not yet determined, and preliminary transects are currently being done to decide what would be most useful. The sensor would be either 1) a turbidity sensor deployed at the western shoal or eastern channel at the bridge to be used as a surrogate for suspended-sediment concentration (SSC); or 2) an ADCP mounted at one of the bridge platforms. This additional sensor data will be used to help supplement the transect data, along with the existing real-time station at RIC (USGS station #375607122264701), to better understand how sediment flux varies temporally during the study period. The collection of this additional sediment data will supplement the transect data we will collect by adding an additional continuous data location to monitor cross-sectional variations between boat based ADCP measurements. This work will directly address SedWG modeling/monitoring question 3.2 which pertains to sediment flux at key Bay cross-sections.

This budget includes the collection of additional data during the cross-channel transects in the form of surrogate optical turbidity to calculate SSC and/or ADCP velocity data. Preliminary transects will be completed in May 2024 to determine what equipment, location(s), and deployment methods are best to support transecting. Additional equipment used during study will be project owned and no new equipment will be required, but any equipment that is requested to stay on site long term will need to be funded for purchase.

Estimated Cost: Cost for additional supplemental station for study:
$15,000 per additional sensor and to process data for publishing (CY2025)

Cost to keep ADCP on site past study period:
$40,000 for ADCP + $16,000 servicing (annual)

Oversight Group: RMP Sediment Workgroup
Proposed by: David Hart, U.S. Geological Survey - California Water Science Center

Proposed Deliverables and Timeline

Deliverable	Due Date
Data release including all new project data including ADCP transects and velocity-integrated point-SSC samples	December 2025
Model archive summary detailing the ABS-SSC empirical model to convert ADCP transects to sediment flux measurements	December 2025
Presentation to the RMP Sediment Workgroup	May 2026

Special Study Proposal: Spatial variability of sediment accretion in San Francisco Bay restorations: Expanded coverage

One of the key sediment management questions for San Francisco Bay is whether available sediment is sufficient for planned marsh restoration sites to attain suitable elevations for vegetation establishment and to keep pace with sea-level rise. Although large-scale restoration has been taking place in San Francisco Bay for decades, measurements of decadal-scale rates of accretion within areas where tidal exchange has been restored are limited. We propose to investigate accretion rates for a range of marsh restoration sites and estimate the volume of sediment deposited in those sites since being restored. This work will build upon an ongoing 2024 RMP Special Study by expanding the number of restoration sites included in the study from five to eight, adding coverage across the Napa River and South San Francisco Bay based on SedWG feedback during a March 2024 meeting. Our overall objectives are to: 1) investigate the amount of accretion that has occurred within each marsh restoration; 2) investigate the sediment characteristics in the restorations; 3) produce datasets for testing numerical models of sediment transport between the Bay and marsh at eight restoration marsh sites; and 4) determine the provenance of sediment in each restoration; 5) Analyze results to identify potential factors that contribute to sediment delivery and retention. Results will be useful for prioritizing future marsh restoration sites, understanding Bay-wide sediment budgets, and understanding sediment accretion in restorations region-wide, and their resilience to sea-level rise.

Estimated cost: $115,000
Oversight group: RMP SedWG
Proposed by: Karen Thorne, Kevin Buffington (USGS WERC), Jessie Lacy, Dan Nowacki (USGS PCMSC)
Time sensitive: Yes - a proposed add-on to a current RMP study

[1] USGS Western Ecological Research Center, Davis CA 95616, kthorne@usgs.gov
[2] USGS Pacific Coastal and Marine Science Center, Santa Cruz CA 95060, jlacy@usgs.gov

Proposed Deliverables and Timeline

Based on 12-month project: April 2025 to March 2026 [same timeline as ongoing project]

Deliverable	Due Date
Data release: soil properties	September 2025
Data release: digital elevation models and RTK GPS data	September 2025
Date release: sediment provenance	March 2026
Report (draft paper):	March 2026
Final Presentation and Report to RMP	May 2026

Special study proposal: Sediment dynamics in a fluvially influenced salt marsh

Salt marshes provide essential protection against storm impacts to coastal communities but are severely vulnerable to sea-level rise and other hazards. Determining their level of resilience is crucial to predicting their future evolution. Syntheses of measurements made in salt marshes over the past 20–30 years have produced metrics that indicate marsh health or vulnerability (Nowacki & Ganju 2019). Most of these metrics have been derived in microtidal marshes not subject to direct river inputs and without management interventions. Although these metrics are hypothesized to be universal across salt marshes, they have not yet been rigorously tested in fluvially influenced, restored marsh environments. Such research is aligned with the RMP's interest in the importance of local watersheds as a marsh sediment source. It also can inform the RMP Sediment Workgroup's monitoring/modeling science question 4.4 which addresses accretion rates and fluxes in marshes, mudflats, and shoals in relation to waves and local sediment supply.

We propose to assess sediment fluxes in a mudflat–salt marsh environment adjacent to the Petaluma River known as Gray's Marsh which was recently restored through an unintentional breach. This proposal will leverage work at the proposed site already funded by the RMP in 2024 to assess the decadal-scale physical response of marshes to restoration. We will deploy instrumentation for two deployments of 2–3 months each during wet and dry seasons to measure waves, currents, suspended-sediment concentration, and suspended-sediment flux within the river and in channels of the mudflat–marsh platform. We will also measure mudflat and marsh sediment deposition along three transects following similar methods to the study by Lacy & Thorne funded by the RMP in 2021. We will collect topo-bathymetric elevation data to determine the tidal and seasonal physical and sedimentary dynamics of this system, which is both fluvially influenced and recently restored. We will also test sediment-provenance approaches to determine the originating watershed of the sediment accumulating in the marsh. By measuring sediment flux and accretion during the wet and dry seasons, we aim to determine the relative importance of fluvial- vs. Bay-derived sediment to long term rates of accretion in this restored marsh. This work will also contribute to our understanding of how sediment transport and accumulation in marshes are influenced by site-specific attributes such as fluvial influence, which will help inform future marsh restoration prioritization and methods.

Estimated Cost: $121,500
Oversight Group: RMP Sediment Working Group
Proposed By: Daniel Nowacki & Jessie Lacy (USGS PCMSC), Karen Thorne (USGS WERC)
Time Sensitive: Potentially yes (site may be slated for dredge disposal in the future)

Proposed deliverables and timeline

Deliverable	Due date
Data release: salt-marsh and Petaluma River time-series data (PCMSC)	9/2026
Data release: deposition and accretion (WERC)	9/2026
Presentation to RMP and at selected conferences	5/2027
Report (draft paper) investigating the dynamics of sediment exchange between the salt marsh and its fluvial source and sediment accretion on the mudflat and marsh submitted to RMP	6/2027

References

Nowacki, D.J., Ganju, N.K., 2019, Simple metrics predict salt-marsh sediment fluxes, Geophysical Research Letters 46, doi:10.1029/2019GL083819.