



**RMP**  
REGIONAL MONITORING  
PROGRAM FOR WATER QUALITY  
IN SAN FRANCISCO BAY

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# Bay RMP Sediment Workgroup Management Questions 1 & 2 Update and Workplan

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CONTRIBUTION No. 1335 / September 2026

Suggested Citation:

Foley, M.M., Dusterhoff, S., and McKee, L. 2026. Bay RMP Sediment Workgroup Management Questions 1 & 2 Update and Workplan. SFEI Contribution No. 1335. San Francisco Estuary Institute, Richmond, CA.

Acknowledgments:

Thank you to the Bay RMP Sediment Workgroup members, advisors, and special guests for coming to meetings, contributing to discussions, reviewing drafts, and providing many helpful edits and suggestions to the management question revisions and workplan.

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# Glossary

**Benefit:** positive effects on species or habitats from dredging or dredged sediment placement.

**Direct placement:** beneficial use technique whereby dredged sediment is placed directly at a restoration site or an existing marsh (i.e., elevation augmentation, including thin-lift placement and marsh spraying). For the purposes of these management questions, the focus is on direct placement of sediment on existing marshes, but this method is also used in the San Francisco Estuary to fill diked polders to restore wetland habitat.

**Impact:** negative effects on species and habitats from dredging or dredged sediment placement.

**In-Bay disposal:** placement of dredged sediment at any of the approved in-Bay disposal sites.

**Indirect placement:** beneficial use technique whereby dredged sediment is placed outside the restoration site and natural mechanisms, such as tides, waves, or currents, transport sediment from the placement location to the nearby restoration site. Examples include water column seeding and nearshore strategic placement.

# Introduction and Purpose

The Sediment Workgroup (SedWG) of the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP) was formed in 2018 in recognition of the need for sediment-focused studies to inform a range of management needs in the coming years. When the SedWG was formed, regional sediment management needs largely fell into two categories: 1) increasing the amount of dredged sediment being used for beneficial uses (e.g., tidal wetland restoration; LTMS 2013); and 2) understanding the potential effects of decreased sediment loading from the Delta (Schoellhamer 2011) on suspended sediment concentration in the Bay, decreased sediment delivery to tidal wetlands, and increased occurrence of algal blooms. The Nutrient Management Strategy, created in 2014, focuses on monitoring, modeling, and synthesis studies to inform management decisions related to the interplay between nutrients, sediment, and algal blooms (Wren et al. 2025).

The SedWG developed five management questions (MQs) to guide prioritization and funding of sediment-focused monitoring, modeling, and synthesis studies. MQs 1 and 2 focus on the effects of dredging and dredged sediment placement in the Bay; MQs 3 and 4 focus on sediment and sediment-bound contaminant transport into and within the Bay and onto tidal marshes; and MQ 5 focuses on suspended sediment concentration in the Bay (Table 1).

**Table 1.** Original Sediment Workgroup management questions.

|                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| MQ 1: What are the acceptable levels of chemicals in sediment for placement in the Bay, baylands, or restoration projects?                          |
| MQ 2: Are there effects on fish, benthic species, or submerged habitats from dredging or placement of sediment?                                     |
| MQ 3: What are the sources, sinks, pathways, and loadings of sediment and sediment bound contaminants to and within the Bay and subembayments?      |
| MQ 4: How much sediment is passively reaching tidal marshes and restoration projects, and how could the amounts be increased by management actions? |
| MQ 5: What are the concentrations of suspended sediment in the Estuary and its subembayments?                                                       |

Special studies conducted by the SedWG from 2018 to 2021 were spread across all five MQs. For MQs 1 and 2, studies predominantly focused on synthesis efforts to inform updates to sediment bioaccumulation and testing guidelines for dredged sediment. Examples include assessing contaminant concentrations in dredged areas (Yee and Wong 2019), evaluating sediment bioaccumulation results (Lin and Davis 2018; Mendez et al. 2022), analyzing contaminant data in dredged sediment using alternative statistical methods (Yee and Wong 2023), and identifying options for updating current beneficial reuse sediment screening

guidelines (Foley et al. 2020). The RMP supported studies on the effects of dredging on benthic communities (e.g., De La Cruz et al. 2017) and development of a benthic macrofaunal index (e.g., Thompson and Lowe 2008) prior to the Sediment Workgroup being formed. Starting in 2020, no special studies related to MQs 1 and 2 were proposed or funded; instead, all special study funds were used to support studies related to MQs 3-5, which were determined to be higher priorities by the SedWG.

As part of the governance process for the RMP, MQs are reviewed regularly to determine if changes are needed based on information and management needs. In 2022, a subgroup of the RMP Steering Committee met to discuss the need for updating SedWG MQs 1 and 2. The group decided to hold off on any revisions and review the decision in 1-2 years. Attention was instead focused on MQs 3-5, which were revised in 2022 as part of the development of the Sediment Monitoring and Modeling Work Plan (McKee et al. 2023). While there are some connections between MQs 3-5 and MQ 1 and 2, the SedWG prioritized updating MQs 3-5 because of greater regional needs to advance the monitoring and modeling of sediment movement into and within the Bay.

The RMP Steering Committee subgroup met again in 2024 and recommended updating MQs 1 and 2 as a high priority for the SedWG based on evolving management needs for dredging and a new understanding of the importance of beneficial reuse for marsh resilience. In 2021, a report from SFEI (Dusterhoff et al. 2021) quantified the amount of sediment needed to support marsh resilience in the face of sea level rise by the end of the century. That report showed a significant shortfall in sediment supply to marshes from natural inputs, and highlighted the importance of beneficially reusing dredged sediment for marsh restoration to address some of the shortfall. Dusterhoff et al. (2021) helped catalyze five dredging-related management actions in need of additional monitoring and modeling data: 1) the Long Term Management Strategy (LTMS)—the Regional Dredging Team for San Francisco Bay—began discussing the implications of increasing the in-Bay dredged sediment placement allocation to keep more sediment in San Francisco Bay, rather than disposing of it outside the Bay at the deep ocean disposal site; 2) the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) started trialing permit conditions that make allowances for different dredging methods in exchange for beneficial reuse of dredged sediment; 3) the US Army Corp of Engineers (USACE) piloted nearshore strategic placement—a type of indirect placement beneficial reuse—of dredged sediment from the Port of Redwood City near Eden Landing; 4) the Bay Conservation and Development Commission (BCDC) started the process to amend their Bay Plan to support more beneficial reuse of sediment; and 5) beneficial reuse of dredged sediment was designated a priority for funding by the EPA San Francisco Bay Program Office.

Given these regional dredging-related priorities and the need for information to support future decisions, the SedWG recommended the MQ update also develop science questions (detailed research questions associated with each management question) and a workplan to guide the development of special studies that support the revised management questions, which are linked to the five regional priorities listed above.

The goal of this update and workplan is to document the process used to update MQs 1 and 2 and develop science questions, as well as articulate a 5-year workplan the SedWG can use to prioritize and fund special studies that contribute to our understanding of the impacts and benefits of beneficially reusing dredged sediment for marsh resilience in the San Francisco Estuary. The priorities outlined in this workplan are more extensive in scope and budget than can be funded by the RMP alone but are included to provide a full picture of the regional priorities for advancing techniques and applications of beneficially reused dredged sediment and help spur collaboration.

## Revised Sediment Workgroup Management Questions

The SedWG stakeholders and additional regional partners involved in dredging or sediment placement permitting were invited to participate in three virtual meetings to update MQs 1 and 2. The first meeting focused on identifying the management and information needs associated with dredging and sediment placement, both at designated in-Bay disposal locations and potential future beneficial reuse sites. SFEI staff synthesized the input and revised MQs 1 and 2 based on the responses. The second meeting focused on attendees providing feedback and suggested changes to the draft revised MQs. The third meeting was used to develop science questions (SQs) for each of the MQs. Follow-up surveys were used to prioritize the SQs and inform high-level updates to the 2026 Bay RMP Multi-Year Plan. The finalized workplan will be used to update the 2027 Bay RMP Multi-Year Plan.

The input received during this process led to the revision of MQ1 and the splitting of MQ2 into three subquestions (Table 2). For MQs 1, 2a, and 2c, terminology was added to acknowledge the tradeoffs between the impacts and benefits of beneficially reusing dredged sediment to prevent marshes from drowning—both in the short- and long-term—that will need to be assessed.

**Table 2.** Original and revised Sediment Workgroup Management Questions 1 and 2

|                                                                                                                                     |                                                                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Original MQ 1: What are the acceptable levels of chemicals in sediment for placement in the Bay, baylands, or restoration projects? | Revised MQ 1: What are the acceptable chemical levels in dredged sediment that minimize ecological impacts and maximize benefits of sediment placement in the Bay or baylands?                                                           |
| Original MQ 2: Are there effects on fish, benthic species, or submerged habitats from dredging or placement of sediment?            | Revised MQ 2a: What are the short- and long-term impacts and benefits of direct or indirect placement of dredged sediment on aquatic species and habitats?                                                                               |
|                                                                                                                                     | Revised MQ 2b: What are the impacts of hydraulic dredging on aquatic species and habitats compared to mechanical dredging practices?                                                                                                     |
|                                                                                                                                     | Revised MQ 2c: What are the short- and long-term impacts and benefits on aquatic species and habitats of allowing more in-Bay disposal in exchange for increasing the amount of dredged sediment being used for beneficial use projects? |

## Revised Management Question 1: What are the acceptable chemical levels in dredged sediment that minimize risks of ecological impacts and maximize benefits of sediment placement in the Bay or baylands?

MQ 1 was revised to reflect the SFBRWQCB's interest in reviewing the sediment screening guidelines for beneficial reuse through a risk-based lens compared to the current ambient condition and effects-based approach. The suitability of dredged sediment for placement at designated in-Bay or ocean sites is currently determined using a weight-of-evidence approach that compares sediment contaminant concentrations in dredged sediment to ambient sediment in the open Bay (i.e., deep areas near the shipping channel), placement site conditions, total maximum daily loads for specific contaminants, and bioaccumulation triggers (San Francisco Bay Dredger's Handbook 2021). Sediment screening guidelines for the beneficial reuse of dredged sediment were developed in 2000 to determine the suitability of dredged sediment for wetland restoration projects, either as foundation or surface material (SFBRWQCB 2000). The guidelines for metals and organic chemicals are based on ambient conditions measured by the Bay RMP in the open Bay, Water Quality Objectives (SFBRWQCB 1995), and biological effects thresholds (Long et al. 1995).

The Bay RMP and the SedWG have conducted multiple studies to determine if changes to the weight-of-evidence approaches used for in-Bay, ocean, and beneficial reuse, particularly the bioaccumulation triggers and contaminant concentrations, are supported by dredging and ambient sediment data. In 2011, the LTMS recommended a change in mercury bioaccumulation testing as part of an update to the programmatic Essential Fish Habitat agreement. Using sediment contaminant and bioaccumulation testing data, the LTMS was able to show that sediment mercury concentration was not correlated to organisms' mercury concentrations, suggesting that the mercury in Bay sediment was not bioavailable (LTMS 2012). As a result, bioaccumulation testing was no longer required if sediment mercury concentrations were below the maximum TMDL concentration, as measured by the Bay [RMP Status and Trends sediment monitoring](#). The SedWG supported a similar study on PCBs, but the data did not show a statistically significant relationship between sediment concentration and bioaccumulation testing results (Mendez et al. 2021). As a result, bioaccumulation testing for PCBs is still required for concentrations above the bioaccumulation trigger and below the maximum TMDL concentration. For both mercury and PCBs, no in-Bay disposal or beneficial reuse is allowed if sediment concentration exceeds the maximum TMDL concentration. In 2015, the Bay RMP expanded sediment monitoring to include the Bay margins (1 foot above MLLW) (Yee and Wong 2024). Ambient concentration calculations now include results from both open Bay and margin areas, which will likely increase ambient concentrations because mercury and PCB concentrations tend to be higher in the margins than the open Bay (Yee and Wong 2024).

In 2019, the RMP hosted an expert workshop to review the screening guidelines and identify potential alternative methods for evaluating dredged sediment suitability for beneficial reuse projects (Foley et al. 2020). One of the recommendations from the expert panel was to redo the floating percentile analysis that was conducted in 2002 using additional paired data for toxicity and sediment chemistry from San Francisco Bay. The analysis resulted in no changes to the sediment contaminant thresholds, and in some cases lowered threshold concentrations, which would make the screening guidelines more restrictive (Yee and Wong 2023). The expert panel also recommended using the hazard quotient method to examine sediment thresholds based on the exposure concentration compared to the effects threshold. The hazard-quotient approach for beneficial reuse sediment screening guidelines was not pursued by the SedWG as a special study, but was recently incorporated into the revision of the upland sediment screening criteria at the Don Edwards National Wildlife Refuge (DENWR).

The DENWR, in collaboration with the SFBWQCB and other regulatory agencies, recently developed a risk-based evaluation approach as part of their quality assurance project plan (QAPP) update for upland sediment being beneficially reused as wetland surface and foundation material (DENWR 2024). The revised approach for upland sediment screening criteria for the DENWR uses three lines of evidence for non-metal contaminants for wetland surface material, including: 1) existing wetland surface screening criteria, 2) 95% upper confidence limit of the arithmetic mean, and 3) cumulative weighted average. For metals, a fourth line of evidence—the mean hazard quotient—is also used, except for mercury evaluation because of its bioaccumulative nature. Using multiple approaches to compare the sediment testing data against the upland sediment screening guidelines allows for a broader evaluation of

the data and adjusting the risk of impacts in a systematic way. The DENWR QAPP is now being used as a model for the region and all future upland sediment QAPP updates; the Eden Landing QAPP is currently being updated to incorporate this methodology.

A similar approach could be taken to evaluate sediment testing data for dredged sediment. In both cases, the risks of using contaminated sediment for wetland restoration projects that benefit habitats and species is being weighed against the risk of not having enough sediment to sustain wetland habitats and species as sea level rises. While these updates are needed because of changing conditions, it is important to highlight that most dredged sediment meets the current sediment guidelines for beneficial reuse (99% in 2024 for either foundation or surface material; DMMO 2025). However, if dredged sediment exceeds wetland cover acceptance criteria but not foundation criteria, beneficial use becomes more limited and potentially expensive because Montezuma is the only project site currently accepting material. The increased cost associated with beneficial reuse compared to in-Bay or ocean disposal remains one of the biggest hurdles of using more dredged sediment for beneficial reuse in the region.

The Bay RMP can support the SFBWQCB's exploration of risk-based approaches for assessing sediment suitability for beneficial reuse projects by reviewing the literature and beneficial reuse screening guidelines used in other locations, evaluating how previous testing data would be interpreted using a risk-based approach, and assessing the amount of additional sediment that would be available for beneficial reuse if the guidelines are updated.

## Revised Management Question 2a: What are the short- and long-term impacts and benefits of direct or indirect placement of dredged sediment on aquatic species and habitats?

To make it easier to develop and track monitoring and modeling questions associated with MQ 2, the original question was split into three subquestions that separately focus on dredged sediment placement and dredging. MQ 2a focuses solely on the placement of dredged sediment outside of the already designated in-Bay disposal sites, and explicitly calls out direct and indirect placement methods. Most wetland restoration projects to date have used direct placement methods to fill formerly diked baylands with dredged sediment, but the recent USACE pilot project at Eden Landing demonstrated the potential for indirect placement of dredged sediment to augment natural sediment supply to existing and restored wetlands via natural sediment transport processes. The original MQ2 focused on impacts, so "benefits" was added to MQ2a in recognition that it will be increasingly important to consider both the impacts and the benefits of sediment placement as sea level continues to rise and more wetlands are at risk of drowning. Similar to risk assessment for MQ 1, MQ 2a highlights the need for data that support weighing the tradeoffs between impacts and benefits when making decisions about where dredged sediment could be placed to increase marsh and mudflat resilience (outside of designated

aquatic in-Bay disposal sites). The final addition to this question includes the consideration of temporal (short- vs long-term) impacts and benefits. This terminology was added in recognition that there may be tradeoffs between impacts and benefits that occur in the days to weeks after sediment placement versus those that occur months to years after placement.

There are multiple ongoing efforts in the region outside the RMP that can help answer this management question. The USACE is currently conducting multiple projects with particular relevance to indirect placement: 1) ecological modeling for the shallow areas of the Bay to inform the potential impacts and benefits on aquatic species and habitats from indirect placement; 2) sediment transport modeling to identify potential locations for indirect placement; 3) extensive monitoring to assess the impacts and benefits of the Eden Landing indirect placement project; and 4) economic benefits risk mitigation modeling for wetlands. The USACE is actively exploring additional opportunities for indirect placement projects, including modeling at Emeryville Crescent and Ryer Island, that will continue to inform this MQ.

The Wetlands Regional Monitoring Program (WRMP) is conducting region-wide monitoring that measures the regional health of wetlands and tracks wetland restoration projects. While this monitoring is not set up to detect the effects of beneficial reuse specifically, some metrics will capture the benefits from beneficial reuse. For example, the Baylands Habitat Map (BHM), which is updated every five years, tracks the extent of and change in amount of existing and restored baylands habitat over time. The BHM and wetland assessment surveys (i.e., the California Rapid Assessment Method, CRAM) can be used to assess short- and long-term changes to wetland health and inform future restoration efforts. The WRMP's Project Tracker Tidal Wetland Restoration Restoration Map ([PTTWRM](#)) shows completed, in progress, and planned wetland restoration projects around the Bay and includes data on which projects used dredged sediment. In addition, future special studies may contribute to measuring the short- and long-term impacts and benefits of direct or indirect dredged sediment placement on wetland species and habitats, particularly birds, fish, and native vegetation.

The SedWG is supporting a modeling project in 2026 and additional benthic sampling and bathymetric surveys in 2027 that will further investigate the results of the Eden Landing indirect placement project. Additional Eden Landing modeling will result in a sediment transport modeling framework based on monitoring and modeling data that can be used for future indirect placement projects. While this project was funded as a priority for SedWG MQ 4.4 ("What are the accretion/erosion rates and fluxes between individual existing marshes, mudflats, and shallow subtidal shoals"), this study overlaps with MQ 2a because understanding sediment transport is necessary to evaluate the impacts and benefits of sediment placement on aquatic species and habitats. The benthic sampling aligns with MQ 2a and provides data on the longer-term effects of sediment placement on benthic habitats, including changes to food web dynamics.

The Bay RMP can help answer this management question and augment efforts by the USACE and WRMP by leading monitoring and modeling efforts that address key knowledge gaps not already covered by other regional programs. For example, the USACE is unlikely to be able to

fund multi-year monitoring efforts and synthesize the physical and ecological data collected before and after indirect placement projects. The Bay RMP could add value by supporting these types of targeted studies. The Bay RMP could also fund studies that compare the impacts and benefits of placement studies to our conceptual models and update them accordingly to inform future dredged material and wetland management and restoration permitting decisions.

## Revised Management Question 2b: What are the impacts of hydraulic dredging on aquatic species and habitats compared to mechanical dredging?

MQ 2b focuses on the impacts of dredging, specifically hydraulic dredging, a technique that is currently used sparingly in SF Bay in favor of mechanical dredging but that has the potential to be used more in the future. The dredging community is interested in using hydraulic dredging—both cutterhead and hopper methods—in more locations because it is typically more time and cost-efficient than mechanical (e.g., clamshell) dredging, particularly when dredging a large area. Hydraulic dredging has been used in a limited capacity in SF Bay primarily due to concerns for higher risk of fish entrainment than mechanical dredging. Hydraulic dredging has been used in SF Bay where the risk to fish—particularly threatened and endangered species—was considered low compared to the benefits, especially when the decreased cost of dredging allowed more sediment to go to beneficial reuse. For example, the SFBRWQCB recently permitted a hydraulic dredging project in Oakland Harbor with the stipulation that a majority of the sediment go to beneficial reuse. The dredging community is interested in exploring additional projects where hydraulic dredging could be used in exchange for placing dredged sediment at beneficial reuse sites. The USACE Regional Dredge Material Management Plan (RDMMP) lays out a regional approach for using hydraulic dredging in key locations as a means to increase beneficial reuse by bringing the annual cost of dredging and sediment placement equivalent to the current federal standard (i.e., lowest cost), which is currently defined predominantly by mechanical dredging and ocean disposal (USACE 2024). This part of the RDMMP will go into action in FY2027 or 2028 for the Oakland and Richmond channels.

The USACE currently conducts monitoring during hydraulic dredging activities in SF Bay, most notably to collect data on fish entrainment. Fish monitoring being conducted by Drs. Levi Lewis and James Hobbs for the WRMP could help to identify important areas for sensitive fish species. The Bay RMP can play a role in synthesizing monitoring data collected by the USACE and WRMP and providing information that can be used to update the ecological model assessing the potential impacts of hydraulic dredging and inform future permitting decisions and RDMMP updates.

## Revised Management Question 2c: What are the short- and long-term impacts and benefits on aquatic species and habitats of more in-Bay disposal in exchange for increasing the amount of dredged sediment being used for beneficial reuse projects?

MQ2c was added to help inform management decisions made by the Long Term Management Strategy (LTMS)—an interagency collaboration between the USACE, SFBWQCB, US Environmental Protection Agency (EPA), and Bay Conservation and Development Commission (BCDC)—regarding future limits on the amount of dredged sediment that is placed at designated in-Bay disposal sites in SF Bay. The current annual limit for in-Bay disposal set by the LTMS, which went into effect in 2012, is 1.25 million cubic yards (MCY). When the limit for in-Bay disposal is reached, sediment tends to be taken to the deep ocean disposal site (DODS) rather than going to beneficial reuse because ocean disposal is less expensive. However, ocean disposal removes sediment from the SF Bay system altogether, which is not desirable given the estimated deficit in sediment needed to make tidal wetlands more resilient to climate change (Dusterhoff et al. 2021) and the overall sediment deficit in the Bay Sediment budget (McKee et al., 2025). Extensive sediment transport modeling at the designated in-Bay disposal sites in San Pablo Bay showed that these sites are generally dispersive, but little to none of this sediment is expected to reach the baylands (i.e., mudflats and wetlands) (Bever et al. 2014). However, even if sediment does not reach the baylands in the short term, there is an assumption that leaving sediment in the Bay is advantageous in the long term to removing it completely from the system and dumping it in the ocean. The USACE, the largest dredger in San Francisco Bay, recently completed an RDMMP that outlines how increased in-Bay disposal combined with alternative dredging methods results in less sediment going to ocean disposal and more to beneficial reuse (USACE 2024; Alternative 2). This preferred alternative is cost-neutral compared to the No Action Alternative/Future Without Project scenario, allowing the revised plan to be considered equivalent to the Federal Standard. Alternative 2 would increase the baseline of beneficial reuse to 20-30% and decrease ocean disposal to 0-10% of dredged sediment per year.

In order for the LTMS to determine if the in-Bay placement limit should be increased, decision makers need access to syntheses of historical studies as well as additional information from monitoring and modeling studies that quantify the site- and regional-scale impacts of additional in-Bay disposal (e.g., increased turbidity, navigation hazards, expanded zone of sediment deposition) compared to the benefits of maintaining and expanding mudflat and marsh habitat through beneficial reuse of dredged sediment. Many of these studies are beyond the available budget of the Bay RMP, but collaboration across the region and external funding could support generating this information.

# Sediment Workgroup Science Questions, Priorities, and Collaborations

As part of the MQ update, we developed Science Questions (SQ) to help translate the MQs into actionable studies that can be completed by the Bay RMP or in collaboration with regional partners (Table 3). The attendees at the three MQ update meetings provided input on the prioritization of the SQs for MQs 1-2 only. Priorities for MQs 3-5 were developed during the review and workplan development in 2022-2023. The prioritization for the full suite of SQs for MQs 1-5 has not been done but could be a focus of a future SedWG meeting or planning document.

**Table 3.** Bay RMP Sediment Workgroup Management Questions, Science Questions, priorities, and coordination with other regional entities.

| <b>RMP Sediment Workgroup Management Questions (MQ)</b>                                                                                                                | <b>Science Questions (SQ)</b>                                                                                                                                                                       | <b>Priority (H, M, L)</b> | <b>Coordination needs</b> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|---------------------------|
| MQ 1: What are the acceptable chemical levels in dredged sediment that minimize ecological impacts and maximize benefits of sediment placement in the Bay or baylands? | SQ 1.1: Which risk-based evaluation process is suitable for assessing the potential impacts and benefits of beneficially reusing dredged sediment for wetland restoration?                          | H                         | SFBRWQCB, LTMS, DMMO      |
|                                                                                                                                                                        | SQ 1.2: How much additional dredged sediment would be available for beneficial reuse projects if the sediment screening guidelines were revised or a risk-based evaluation process was implemented? | M                         | SFBRWQCB, LTMS, DMMO      |
| MQ 2a: What are the short- and long-term impacts and benefits of direct or indirect placement of dredged sediment on aquatic species and habitats?                     | SQ 2a.1: What is the magnitude, duration, and spatial extent of increased turbidity during indirect sediment placement events?                                                                      | M                         | USACE, NMS, USGS          |
|                                                                                                                                                                        | SQ 2a.2: How do frequency, magnitude, and spatial extent of direct or indirect sediment placement affect species and habitat recovery?                                                              | H                         | USACE, WRMP               |

|                                                                                                                                                                                                                           |                                                                                                                                                                                                                  |   |                                      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|--------------------------------------|
|                                                                                                                                                                                                                           | SQ 2a.3: Which existing wetlands are the highest priority for direct or indirect sediment placement projects?                                                                                                    | H | USACE, LTMS, WRMP                    |
|                                                                                                                                                                                                                           | SQ 2a.4: Which sediment placement methods minimize impacts and maximize benefits for existing wetlands?                                                                                                          | H | USACE, LTMS, WRMP                    |
| MQ 2b: What are the impacts of hydraulic dredging on aquatic species and habitats compared to mechanical dredging?                                                                                                        | SQ 2b.1: Which dredging areas have a lower risk of hydraulic dredging impacting fish and fish habitat?                                                                                                           | M | USACE, NMFS, USFWS, CDFW, WRMP, LTMS |
| MQ 2c: What are the short- and long-term impacts and benefits on aquatic species and habitats of more in-Bay disposal in exchange for increasing the amount of dredged sediment being used for beneficial reuse projects? | SQ 2c.1: Are there additional locations for in-Bay sediment placement that support sediment processes in the Bay in addition to the current deep Bay disposal sites and nearshore strategic placement locations? | M | USACE, USGS, LTMS                    |
|                                                                                                                                                                                                                           | SQ 2c.2: What are the spatial and temporal impacts to species and habitats caused by increasing the volume of dredged sediment at in-Bay disposal sites?                                                         | H | NMFS, USGS, LTMS                     |

Science Question 1.1 is the highest priority for MQ 1. While changing the sediment screening guidelines is unlikely due to federal rulemaking processes that would be required to update the Dredger's Handbook, the approach used by the SFBRWQCB to evaluate the risk of impact caused by contaminant concentrations can be updated so the potential impacts and benefits of beneficially reusing dredged sediment are properly weighted in the permitting process. Some members of the group suggested that SQ 1.2 should be answered before SQ 1.1 even though it was a lower priority. SQ 1.2 could be evaluated using dredging data from the Dredge Materials Management Office (DMMO), but SFBRWQCB staff familiar with testing data are confident that the sediment screening guidelines are not the limiting factor with regard to sediment being available for beneficial reuse; cost is currently the biggest driver of where sediment goes after dredging.

The SQs associated with MQ 2a were prioritized over nearly all other SQs for MQs 2b and 2c. In particular, the SQs aimed at quantifying the impacts and benefits of sediment placement—including different methods of sediment delivery—are of particular regional interest because additional efforts to improve marsh resilience need to start now before marshes begin to drown due to sea level rise. The data needed to answer these questions range from before-after-control-impact (BACI) studies that monitor impacts and recovery of aquatic species and habitats over time to monitoring water quality conditions before, during, and after sediment placement (Table 4). The one SQ for MQ 2b focused on hydraulic dredging on fish was given a low priority due to current permitting strategies being used by the SFBRWQCB that offset potential hydraulic dredging impacts with beneficial reuse projects. However, small dredgers are interested in being able to use hydraulic dredging for their projects, but discussions have predominantly focused on large dredgers. For MQ 2c, the highest priority is understanding the impact to aquatic species and habitats if in-Bay sediment disposal limits are increased to retain as much sediment within the Bay system as possible. The ecological modeling being conducted by the USACE could provide a starting point for this work. The timing of studies to support this SQ will be determined by the timeline for LTMS discussions about increased in-Bay disposal limits, which is still to be determined.

## Workplan and preliminary budget estimates

Table 4 highlights example monitoring and modeling studies that address the SQs associated with MQs 1 and 2, as well as the timing and estimated budget needs for those studies. The example studies included here are less detailed than those identified in the Sediment Modeling and Monitoring Workplan (McKee et al. 2023) associated with MQs 3-5 because specific project locations and scopes are still being developed. The timing of the studies is based on MQ priorities determined by the stakeholder group (Table 3), as well as the approximate timing of regional projects and management decision-making needs. The special studies will be incorporated into the 2027 Bay RMP Multi-Year Plan and refined annually based on stakeholder feedback as part of the SedWG annual meeting and Bay RMP Multi-Year Plan update.

**Table 4.** Proposed timeline and preliminary budget estimates for monitoring and modeling studies that address the Science Questions associated with Management Questions 1 and 2. High priority studies highlighted green; medium priority studies highlighted yellow.

| Science Question |                                                                                                                                                                                             | Example monitoring or modeling study                                                                                                                                                            | Cost (x \$1,000) |                                         |      |      |      |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-----------------------------------------|------|------|------|
|                  |                                                                                                                                                                                             |                                                                                                                                                                                                 | 2027             | 2028                                    | 2029 | 2030 | 2031 |
| 1.1              | Which risk-based evaluation process is suitable for assessing the potential impacts and benefits of beneficially reusing dredged sediment for wetland restoration?                          | Investigate whether alternate risk assessment methods are better suited than current methods to assess the potential impacts and benefits of using dredged sediment for beneficial use projects |                  | 50                                      |      |      |      |
| 1.2              | How much additional dredged sediment would be available for beneficial reuse projects if the sediment screening guidelines were revised or a risk-based evaluation process was implemented? | Assess whether current sediment screening guidelines are limiting the amount of sediment being used for beneficial reuse                                                                        |                  |                                         |      |      |      |
| 2a.1             | What is the magnitude, duration, and spatial extent of increased turbidity                                                                                                                  | Monitor turbidity during indirect sediment placement projects to better understand                                                                                                              |                  | Timing TBD<br>(variable cost based on a |      |      |      |

|      |                                                                                                                                                                                                                 |                                                                                                                                                                                  |     |                                                           |     |     |  |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----------------------------------------------------------|-----|-----|--|
|      | during indirect sediment placement events?                                                                                                                                                                      | the short- and long-term turbidity effects                                                                                                                                       |     | range of factors)                                         |     |     |  |
| 2a.2 | How do frequency, magnitude, and spatial extent of direct or indirect sediment placement affect species and habitat recovery?                                                                                   | Implement before- after-control-impact (BACI) monitoring studies for sediment placement projects (e.g., Emeryville Crescent)                                                     | 100 | 150                                                       | 150 | 100 |  |
| 2a.3 | Which existing wetlands are the highest priority for direct or indirect sediment placement projects?                                                                                                            | Use regional data, assessments, and plans to develop a list of priority beneficial reuse projects and a timeline for project implementation                                      |     | 150                                                       |     |     |  |
| 2a.4 | Which sediment placement methods minimize impacts and maximize benefits for existing wetlands?                                                                                                                  | Implement before- after-control-impact (BACI) monitoring studies for different types of sediment placement projects (e.g., marsh spraying, channel seeding, strategic placement) |     | Timing TBD<br>(variable cost based on a range of factors) |     |     |  |
| 2b.1 | Which dredging areas have a lower risk of hydraulic dredging impacting fish and fish habitat?                                                                                                                   | Conduct fish monitoring in navigational dredging areas where hydraulic dredging is feasible                                                                                      |     |                                                           |     |     |  |
| 2c.1 | Are there additional locations for in-Bay sediment placement that support sediment processes in the Bay in addition to the current in-Bay disposal sites and potential nearshore strategic placement locations? | Model sediment transport from additional key locations in the Bay (e.g., San Pablo sediment gyre; Allen et al. 2021)                                                             |     |                                                           | 100 |     |  |
| 2c.2 | What are the spatial and temporal impacts to species and habitats caused by increasing the volume of dredged sediment at in-Bay disposal sites?                                                                 | Model ecological impacts related to increased in-Bay disposal, including impacts from increased turbidity and burial                                                             |     | Timing TBD<br>(variable cost based on a range of factors) |     |     |  |

## Conclusions

As the region continues to identify creative solutions to the sediment limitations facing tidal marsh resilience to sea level rise, MQs 1 and 2 are being reprioritized by the Bay RMP and SedWG. This workplan describes the process and changes to the Management Questions that reflect management priorities and information needs. The workplan also articulates Science Questions and priority studies to support increased beneficial reuse of dredged sediment in the San Francisco Estuary. The revised MQs, new SQs, and example special studies provide a 5-year roadmap for monitoring and modeling work in the region. This workplan shifts priorities from studies focused on sediment quality and toxicity to those focused on measuring the impacts and benefits of directly and indirectly placing dredged sediment to support marsh accretion. This is a rapidly changing space, both in terms of opportunities and funding, so the workplan will be regularly reviewed and updated during the Bay RMP's annual multi-year planning process and SedWG meetings to reflect the regional priorities for this work.

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