Appendix D – Study Scopes and Supporting Documents

This Appendix includes information establishing the context for the San Francisco Bay Sand Mining Studies, including the management questions prepared by the Independent Science Panel and Sand Studies Technical Advisory Committee, the study scopes of work, and Memoranda of Understanding describing the study setting and relationship of various entities to one another in the combined effort.

Documents include:

- Sand Mining Management Questions
- Study Scopes of Work
- Memorandum of Understanding for the Selection and Contracting of a Study Coordinator

MEMORANDUM

From: San Francisco Bay Sand Mining Technical Advisory Committee (SFB Sand Mining TAC)
Date: July 17, 2018 -Annotated MQ revisions from 12/17/20 ISP recs for revised study scopes
Subject: Final Draft Management Questions from the Sand Mining TAC

The following questions regarding sand mining activities and their potential impacts to San Francisco Bay and Outer Coast sand transport were developed by the Physical Process Technical Advisory Committee (STAC). They are intended to guide the Independent Science Panel in recommending appropriate studies or research that would inform future management of mining activities. The STAC recognizes that this is not an exhaustive list of questions, nor can all of the questions included here be researched or addressed with the current funding or time available, and that prioritization and leveraging of studies will be necessary.

TIER 1 MANAGEMENT QUESTIONS:

1) Is sand mining at existing lease areas, at permitted levels, having a measurable or demonstrable impact on sediment transport and supply within San Francisco Bay or the outer Coast?

2) What are the anticipated physical effects of sand mining at permitted levels on sand transport and supply to San Francisco Bay and the outer coast?

3) Are there other feasible sand mining approaches to consider in San Francisco Bay?

TIER 2 SCIENCE AND MANAGEMENT QUESTIONS:

1) **Is sand mining at existing lease areas, at permitted levels, having a measurable or demonstrable impact on sediment transport and supply within San Francisco Bay?**

   a) Does sand mining influence sand transport through SF Bay?

      i) How does sand mining impact the volume or characteristics of sand supplies to the beaches (In-Bay and Outer Coast)?
      ii) Does sand mining change the way sand moves from subtidal shoals to intertidal flats, marshes and beaches?
      iii) Does sand mining influence sand waves and their contributions in transport processes?
      iv) Has sand mining altered the grain size distribution of in-bay or outer coast sand resources?
      v) Does sand mining result in sand sinks and resultant changes in flux to the Outer Coast?

   b) What is the source of mined sand in the lease areas? Is it “relic” sand, or “new” sand transported into the system?

      i) What is the ratio of relic to new sand found in mined sand?

      ii) How much of what’s available is being mined?

      iii) Is it better for the physical environment to mine “relic” sand or “new” sand?

c) What is the relationship between bathymetric change trends and sand mining intensity trends, recognizing the possible lag between stimulus and response?[1] Do we have the appropriate information for this evaluation?

d) Does sand mining alter the geomorphology of the Bay floor beyond the mining location such that sand transport/supply are significantly impacted?

e) Do both mining areas (Central Bay and Suisun) have the same effects on sand transport pathways and associated impacts? Should these areas be examined separately?

2) **What are the anticipated physical effects of sand mining at permitted levels on sand transport and supply within San Francisco Bay and the Outer Coast?**

a) Is there regional uplift/subsidence or other factors that would confound evaluation of sand mining effects?

b) Is there a seasonality to sand transport?

c) What is our current technical ability to model sand transport to and from the Bay?

d) What are the key uncertainties associated with measuring and modeling the relationship between sand mining in SF Bay and erosion of outer coast beaches? To what extent do the studies designed to answer the management questions presented here contribute towards reducing this uncertainty?

e) What monitoring and modeling efforts are required to significantly reduce uncertainty associated with quantitatively defining the relationship between sand mining in SF Bay and erosion along the outer coast?

f) Under currently permitted mining levels, would erosion be measurably influence sand transport to Ocean Beach or north of the Gate over a 10, 20, 30 and 50-year time horizon? By how much? What would quantitatively or qualitatively be the long-term effects ?

3) **Are there other feasible sand mining approaches to consider in San Francisco Bay?**

a) Are there areas within the current leases or other potential areas in the Bay where sand mining could feasibly occur that would minimize or avoid impacts to sand transported supply, as compared to existing mined areas?

b) Is there a "better" time period to mine sand so that the impacts to the physical processes are minimized while balancing economic realities, market demands and job impacts?

c) What scenarios should we model to judge the likely impacts associated with management actions (e.g. increase/reducing in mining intensity, rotation of lease areas, establishment of new lease areas)?

[1] Bathymetric surveys and change analysis are permit requirements that will be addressed by sand miners, and this data/information will be provided to the ISP.

SFEI Sand Budget and Transport

Task 1: San Francisco Bay Sand Budget, Information Collection and Synthesis

Introduction and General Approach

Our overall approach with this task is to improve information on sand sediment science for the Bay. For elements of the sand budget where we deem existing methods the best, or equal to the best available, we will update the information to include the most recent data and years for which computations can be completed (WY 2019 at the time of this proposal) adding improved estimates of uncertainty and climatic variability.
Where new data or new computational methods are deemed to allow the use of a superior method for the computation of some elements of the sand budget, we propose an improved method. An example of this circumstance is the use of a numeric model for estimating sand supplies from the local tributaries in the nine counties around the Bay. Where new sand budget elements can be added, we will clearly identify the rationale, the data availability, and how those elements will better address the key management questions.

Task 1.1 Literature review and synthesis

In this task we will update existing literature reviews and databases to include relevant literature, reports and databases up to 2020. We will build from the recent literature reviews relevant to Bay sand sediment science (Barnard et al., 2013; Schoellhamer et al., 2018) and gather, review, and synthesize subsequent research and information regarding sand transport within San Francisco Bay, from major tributaries and with the outer coast, with the focus on the mined areas and their linkages. In this subtask we will:

a) Solicit input from the Independent Science Panel (ISP) and STAC, and other local scientists and regulators for their literature suggestions and latest white and grey papers,
b) Search our local newsletter (IEP newsletter) and journal (San Francisco Estuary and Watershed Science) for key recent articles on sand sediment science of the Bay-Delta
c) Use standard techniques for building the literature and information database including forward searching the authors of key documents (cited reference search) as well as searching by subject using Google Scholar and the Science Citation Index via the Web of Science, and
d) Include meta-descriptions of key data sources and links.

Subtask Deliverable:
We will write an **annotated bibliography** related to the generation of an updated sand budget for the Bay that includes transport into San Francisco Bay from the Central Valley via the Delta, the tributary watersheds, between Bay segments, and out to the nearshore coast.

Task 1.2 Central Valley watershed sand supply

In this task we will, based on the more recent data, generate new estimates of sand load entering the Bay from the Delta for the period water year (WY) 1995 to at least WY 2019.We will also estimate sources of error which could be refined with additional data or measurements in the future. Our steps:

a) Update and refine estimates of suspended sand at Mallard Island using the larger data set and explore a refinement of the methods to either apply a flow based proxy to

estimate the proportion of sand in suspension or further revise the estimate of average proportion of sand (previously 3%)

b) Incorporate more recent (WYs 2011-2019) stream gage data, bed-material samples, and multibeam bathymetry data to reanalyze bedload sediment leaving the Delta using the similar methods as in the WYs 1997-2010 estimates
c) Improve the quantification of sources of error in these estimates and recommended any further possible improvements

Subtask deliverable:
A short metadata report that includes revised annual estimates of sand supply from the Central Valley to the Bay via the Delta beginning 1995 through to at least 2019.

Reference to a "**short metadata report**" in this document here forward means a brief report with final report ready text sections, tables and graphics to support methods and results, estimated uncertainties, climate variability and recommendations for future improvements.

Task 1.3 Local tributaries watershed sand supply

In this task we will provide an improved set of spatially and temporally resolved estimates of sand supply to the Bay from local tributaries in the nine counties for the period WYs 1995 to at least 2019.

Our steps:

a) Extend the modeling analysis range to include WYs 1995 to at least 2019;
b) Separate sand from the total suspended sediment simulation based on grain size distribution and focus on the process of sand erosion, transport, and settling, to estimate the supply of sand;
c) Extend the bedload production estimation to the whole nine county area with the previously developed rating equations, monitoring data, and the simulated shear stress in channels from the regional watershed model;
d) Update the sand supply estimates to the Bay with consideration of the management of flood control channels using the modeled sand fluxes at the head of flood control channels and the sediment removal records (see the subsequent subtask 1.4).

The results from this task will be combined with the storage and removal data (subtask 1.4) to estimate sand supply to the Bay with high temporal and spatial resolution. The results will be a major step up for supporting receiving hydrodynamic/sediment transport models (e.g. Delft3D discussed in the Sand Transport Task) to better simulate sand transport in the Bay.

Subtask deliverable:
A short metadata report with the revised annual sand supply to the Bay from the local tributaries for WYs 1995 to at least 2019.

Task 1.4 Quantify net sand storage and removal from flood control channels

In this task we will update the 2013 database (SFEI-ASC, 2017) on sand sediment removal and storage for 33 Bay Area flood control channels to include data through to at least 2019 to support improved estimates of sand supply to the Bay. We will repeat the methods previously developed and implemented by SFEI (SFEI-ASC, 2017):

a) Contact and coordinate with channel managers from the local flood control districts, counties, cities, to collect and collate data for each of the 33 channels for the period 2014 to at least December 2019, or later if additional data are available, including volume removed, location, date, cost, grain size, and in-channel deposition estimates.

b) Perform quality assurance on the data and work with the database team to archive the data for transference to BCDC and the CA Coastal Conservancy.
c) Work with the subtask 1.3 (Local tributaries watershed sand supply) team to make improved estimates of sand supply into the Bay.

The results from this task will be combined with the results from subtask 1.3 (local tributaries watershed sand supply) to estimate sand supply to the Bay with high temporal and spatial resolution.

Subtask deliverables:
An updated database on sand sediment removal and storage of key Bay Area Flood Control Channels for the period WY 1995 to at least 2019; A short metadata report.

Task 1.5 Within Bay sand sources and sinks

A sand budget for the San Francisco Bay system is not complete without including terms that account for sand made available by erosion of Bay sediment and sand sequestered by deposition in the Bay. In this subtask, we will make new estimates of sand supply from net erosion within the Bay based on recently available bathymetric data, combined with grain size data from sediment cores taken about 30 years ago.

Our steps:
a) Construct bay-wide 3D subsurface sand model from published and unpublished core data
b) Calculate sand volumes from the 3D sand and bathymetric change models following the mercury remobilization volume methodology (Foxgrover et al., 2019)
    i) The volume of sand released/sequestered is the sum of the products of subsurface sand percent and erosion (+)/ deposition (-) volume at each grid cell. We anticipate that existing data will support a resolution of 10 cm in the vertical and 50 m in the horizontal for both the sand and bathymetric change models.
    ii) The model extent is the entire Bay extending below the sediment surface to the core length, which is typically 2-3 m.
    iii) Interpolations and extrapolations of sand percentage in subsurface sediment from core locations will be based on USGS's knowledge of sediment transport in San Francisco Bay, existing surface grain size data, geomorphology, bathymetry, and locations of tributary inputs.
    iv) Sand volumes released by erosion will be calculated using the cores collected in 1990 and 1991.
    v) Sand volumes sequestered by deposition will be calculated from cores collected during the past five years and surface grain size data.
c) Conduct an uncertainty analysis using differing assumptions for the 3D subsurface sand percentage and error in bathymetry.
d) At core locations where erosion has occurred, determine the age of the sand eroded using the Bathychronology Tool (Higgins et al., 2005; Higgins et al., 2007) that reconstructs time horizons in subsurface sediment by tracking erosion and deposition using a series of bathymetric surveys.

To support the decadal scale sand sediment budget task (1.6), one of the tables we will provide will contain information on net erosion or deposition of total sediment and the sand portion for each sub-embayment. We will also provide bathymetric change information for relevant surveys to the Anchor QEA team working on this project for use in their model validation.

Subtask deliverables:
A 3D model of subsurface sand percentage; map of the distribution of within Bay sand sources and sinks; volume of sand released from remobilization by erosion; volume of sand captured by

deposition; a description of the methodology employed; uncertainty analysis on sand volumes. These deliverables will be provided in the form of a USGS Data Release (3D model of subsurface sand percentage).

Task 1.6 Complete and reconcile a revised sand sediment budget for the Bay

There are a number of challenges to completing and reconciling a revised sand sediment budget for the Bay. As is common with sediment budgets, there are often mismatches in the time periods of the data sets that support individual elements of the budget. Data quality varies prior in earlier years, so this task will collect, collate and assure the quality of data from 1995-2019 using the following:

a) Data on sand losses (sinks) from in-Bay-Delta channel dredging focusing on those removals that occur in sand shoal areas (Suisun Bay Channel, Pinole Shoal, Phillips 66 Rodeo and Tesoro Marine Terminals, and the San Francisco Marina Sand Trap). The smallest of these (Tesoro) removed an average of 5,000 CY per year (Perry et al, 2015) previously considered worth quantifying in the sand budget, therefore we will also reassess if other dredging projects for navigation in the Bay to see if any may approach this magnitude. These include the ports of Oakland and San Francisco, and the Marina at Crissy Field, which are all known to have some sandy areas.
b) Data on sand losses (sinks) from in-Bay-Delta sand mining lease areas located in Suisun Bay within the main channel west of the federal navigation channel and at Middle Ground Shoal, and in Central San Francisco Bay between Alcatraz Island, Angel Island and the Golden Gate Bridge.
c) Data on sand deposited within the tidal limits of the Bay during beach and wetland restoration. We have included this task as an optional task in the budget since it will likely be a very small term in the sand budget for the Bay.
d) Mass and volume data generated in the other subtasks (1.2: Central Valley watershed sand supply; 1.3: Local tributaries watershed sand supply; 1.4 Quantify net sand storage and removal from flood control channels; and 1.5: Within Bay sand sources and sinks), and in key cross-sections (Task 2: Sand Transport study) and convert masses to volume using appropriately vetted conversion factors.
e) Revise the sand sediment budget for San Francisco Bay based on the draft sand budget (Attachment D - SF Bay sand budget Appendix A; Perry et al., 2015). The period for the budget will likely be the period with the best available data for the largest budget terms (either 1995- or 2000-2020) but final decisions about that period will not emerge until all the data have been compiled and until we have consulted with the ISP and STAC.
f) Collaborate with the Anchor QEA team to compare the decadal Golden Gate sand flux estimate to the Anchor QEA model estimates (wet year/dry year).

Subtask deliverables:
A graphic box and arrow diagram that includes key supply, storage, and loss terms for a decadal scale annual sand budget for the Bay and if data support it, sand budget for a selected wet and dry year to illustrate climatic variation.

Task 1.7 Draft and final sand budget and transport report

To support difficult resource decisions in the next decade, the information gathered and generated through this project will be synthesized to answer management questions specific to sand transport and the sand budget within the Bay and to the nearshore outer coast. Specifically these questions as described in Attachment D of the RFPQ are:

1. Is sand mining at existing lease areas, at permitted levels, having a measurable or demonstrable impact on sediment transport and deposition within San Francisco Bay or the outer coast?

    1.b. What is the source of mined sand in the lease areas? Is it “relic” sand, or “new” sand transported into the system?

1.b.ii. How much available sand is being mined?

2. What are the anticipated physical effects of sand mining at permitted levels on sand transport and deposition within San Francisco Bay or the outer coast?

To answer these questions, we will use the literature compiled along with the revised sand budget and information gained from Task 2 (Sand Transport). We will prepare a concise report that will:

a) Clearly define the temporal and spatial boundaries of the budget.
b) Present an updated sand budget based on the draft sand budget presented in 2015 by BCDC staff (Perry et al., 2015).
c) Discuss the factors that will likely influence sand transport, such as natural processes (e.g. hydrodynamic patterns, rain fluctuations/seasons) and management actions (e.g. navigation and flood protection dredging).
d) Discuss the climatic variability, uncertainties, and assumptions associated with each of the sand budget terms.
e) Describe the logical basis of any estimates used in the budget (where data are sparse, weak, or highly uncertain).
f) Identify data gaps and methods that may be completed in the future for addressing these gaps.
g) Contain a section devoted specifically to responding to the key management questions.

This task will produce a concise report (<30 pages of main body text) plus appendices that will include the short metadata reports written for each subtask that describe the methods and results of each.

The report will synthesizes the literature, presents the revised sand budgets, and describes the interplay of processes that influence sand transport in relation to the sand budget including climate and anthropometric factors, current informational weaknesses, and proposed ways of addressing these.

The report and all its appendices will be internally reviewed and then offered to SCC, BCDC, the ISP, and the STAC for external peer-review. Upon receipt of external peer-review comments, we will prepare a response to reviewers to be included in the final report submission.

Subtask deliverables:
A draft and a final sand budget and transport report.

Task 2: Sand Transport Study

The objectives of the Sand Transport Study are to describe sand transport in the vicinity of the sand mining lease areas in San Francisco Bay and describe the effect of sand mining in San Francisco Bay on sand transport.

Task 2.1 Inventory, Summarize and Interpret Recently Collected Bathymetric Data

The primary objective for this task is to investigate the implications of sand mining on bedforms and sediment transport. To achieve this objective, we propose to analyze the bedform measurements in and around the mining site. Bathymetry surveys conducted between 2008-2019 will be included - four for Central Bay, three for Suisun Channel, and two for Middle Ground Shoal.

The Bedform Toolbox will be employed for a systematic evaluation of the bedform characteristics (e.g. height, length, asymmetry) in each of the 9 available multibeam datasets. Through a 2D correlation analysis of the repeated measurements (2008, 2014, 2018, and 2019) transport directions and migrational patterns and rates can be discerned for the various types of bedforms

and sandwaves. The difference between sand mining areas and non-mined areas provides a direct indication of the mining effects.

Subtask deliverable:
A short report on bedform characteristics and methodology of the analysis, information also to be included in the summary and synthesis report (Task 2.3).

Task 2.2 Mining Area Volume Analysis

This task focusses on a reanalysis of the mining area volume changes. The task includes the following:

a) Volumetric analysis of the 2008-2014 and 2014-2018 datasets will be performed using the mining area boundaries and buffer area (ring) to reproduce the eTrac results.
b) Normalize data and further investigation of the analysis and findings of the eTrac 2019 memo to better understand potential sand transport implications;
c) Analyze bathymetric change and volumes mined with particular focus on the 2018 - 2019 period, other areas and periods not included in the preliminary work, and/or other variables determined to provide additional information on sand transport implications;
d) Analyze, if possible, of sand recovery rates in mined areas compared to mining rates; and
e) Conclusions regarding sand capture in the depressions and implications on transport to other areas.

Subtask deliverables:

A database developed for analysis in usable format (ArcGIS and/or Excel) that includes: Volume change data, estimates of topographic and volumetric uncertainty; volumes of sand mined during the intervening time periods; rates of recovery over and any interannual variation that can be discerned; a short report, information also to be included in the summary and synthesis report (Task 2.3).

Task 2.3 Synthesis

As a final task we will prepare a summary and synthesis report to provide insights as to whether the sand mining is influencing sand transport, including specifically whether the changes in bedforms can inform us about transport, and whether mining activities play a role in that effect. In this report the research findings are discussed in relation to the research and management questions and existing literature and knowledge. This report will include:

a) A summary and synthesis of the technical memos and analysis.
b) A discussion of research findings in relation to the research and management questions.
c) A comparison and discussion of the research findings with existing studies, research and knowledge.
d) A summary of assumptions, uncertainties, and identification of data gaps.
e) Recommendations for future data collection, data analysis, and implications for sand management.
f) Hypothesis on the functioning of the San Francisco Bay sand transport system and the effects of sand mining on this system.

Subtask deliverable:
A summary and synthesis report.

Task 3: Information Management

The objective of this task is to support the delivery and communication of information related to the other tasks within this proposal.

Task 3.1 Data Delivery

The project will deliver a range of data, reports, and other materials. The data will take many forms, from geodatabases to modeling inputs/outputs and scripts. We can anticipate that the synthesis products will benefit from proper highlighting, organization, and priority within the constellation of materials. For other target audiences, however, the raw data might be paramount.

With the three participating organizations, there is a need for data and information coordination among all active data producers. The teams will leverage USGS's ScienceBase, a data catalog, to manage technical exchanges of data and facilitate availability among team members. In addition, the project team will contribute labor to help facilitate data exchanges to "fill the gaps" left by the use of ScienceBase. Examples of such work might include generating maps to illustrate areas for bathymetric analysis or providing access to technical tools for use in generating modeling outputs. This work is designed to complement the tasks enumerated elsewhere in this proposal.

Subtask deliverable:
Delivery of well organized data, with metadata where applicable (geodatabases, modeling inputs, modeling outputs, scripts, and reports).

Task 4: Project Coordination and Management

SFEI will regular project team coordination and meetings to meet grant reporting requirements, such as carefully tracking expenditures, project outcomes, and task progress, and adhering to robust contract and invoice management protocols.

Task 4.1 Bimonthly Team Coordination Meetings

Bimonthly meetings with the project team will be coordinated to ensure the project deliverables are completed on time and within budget and to facilitate the technical exchanges of information as required. Estimated costs are based on 12 one-hour meetings over the project period that will include the full SFEI, USGS, and Deltares team. We envision the Project Manager needing 2 hours of prep time before each meeting to coordinate with the project team and assemble materials.

Task 4.2 Quarterly Coordination Meetings with BCDC/SCC

Quarterly team meetings with the project team the ISP, STAC, BCDC and SCC staff will be scheduled to provide progress updates and an opportunity for technical advice and review of products. Up to four of the quarterly meetings will also include SFEI and UT Austin and serve as the project kickoff, interim, and wrap-up meetings. Estimated costs are based on 8 two-hour meetings that include the Principal Investigators, Project Manager, and task leads from SFEI, USGS, and Deltares.

Task 4.3 Develop Subcontracts

SFEI will develop subcontracts and set-up the project in the accounting system to track the project's expenditures.

Task 4.4 Prepare Invoices and Progress Reports

SFEI will submit quarterly invoices and progress reports to the Coastal Conservancy.

Subtask deliverables:
Invoices and progress reports.

Schedule and Deliverables Table

Task No.	Task Name	Deliverable	Start Date	End Date
1.0	**Sand Budget**			
1.1	Literature review and synthesis	Annotated bibliography	3/15/2021	6/30/2021
1.2	Central Valley watershed sand supply	A short metadata report that includes revised annual estimates of sand supply from the Central Valley to the Bay via the Delta beginning 1995 through to at least 2019	6/1/2021	11/30/2021
1.3	Local small tributaries watershed sand supply	A short metadata report with the revised annual sand supply to the Bay from the local tributaries for WYs 1995 to at least 2019	6/1/2021	11/30/2021
1.4	Quantify net sand storage and removal from flood control channels	An updated database on sand sediment removal and storage of key Bay Area Flood Control Channels for the period WY 1995 to at least 2019; A short metadata report	4/1/2021	11/30/2021
1.5	Within Bay sand sources and sinks	A 3D model of subsurface sand percentage; map of the distribution of within Bay sand sources and sinks; volume of sand released from remobilization by erosion; volume of sand captured by deposition; a description of the methodology employed; uncertainty analysis on sand volumes.	5/1/2021	8/31/2022
1.6	Complete and reconcile a revised sand sediment budget for the Bay	A graphic box and arrow diagram that includes key supply, storage, and loss terms for a decadal scale annual sand budget for the Bay and if data support it, sand budget for a selected wet and dry year to illustrate climatic variation.	1/1/2022	9/31/2022
1.7	Draft and final Sand Budget and Transport report	A draft and final sand budget and transport report.	2/1/2022	10/31/2022
2.0	**Bathymetry and Sand Transport**			
2.1	Inventory, Summarize and Interpret Recently Collected Bathymetric Data	A short report on bedform characteristics and methodology of the analysis, information also to be included in the summary and synthesis report (Task 2.3)	3/15/2021	7/31/2022
2.2	Mining Area Volume Analysis	A database developed for analysis in usable format (ArcGIS and/or Excel) that includes:Volume change data, estimates of topographic and volumetric uncertainty; volumes of sand mined during the intervening time periods; rates of recovery over and any interannual variation that can be discerned; a short report, information also	6/1/2021	9/30/2022

		to be included in the summary and synthesis report (Task 2.3)		
2.3	Synthesis	A summary and synthesis report.	9/1/2021	11/30/2022
3.0	**Information Management**			
3.1	Data Delivery	Delivery of well organized data, with metadata where applicable (geodatabases, modeling inputs, modeling outputs, scripts, and reports).	3/15/2021	12/31/2022
4.0	**Project Coordination and Management**			
4.1	Bimonthly Team Coordination Meetings	-	3/15/2021	12/31/2022
4.2	Quarterly Coordination Meetings with BCDC/SCC/ISP	-	3/15/2021	12/31/2022
4.3	Develop Subcontracts	-	3/15/2021	5/1/2021
4.4	Prepare Invoices and Progress Reports	Quarterly invoices and progress reports	6/1/2022	12/31/2022

SCOPE OF WORK

Task 1 Perform Sediment Transport Modeling

The UnTRIM Bay-Delta model will be used to model sediment transport under a range of conditions. The model grid and bathymetry will be revised in the vicinity of the sand mining leases based on the bathymetric surveys. The volume of mined sand will be used to develop a model bathymetry representative of bathymetric conditions assuming the sand mining had not taken place. To develop the model bathymetry representative of conditions without sand mining, the model bathymetry with sand mining will be adjusted based on the mined sand volumes to fill holes or low spots in the bathymetry that appear to be the result of sand mining, or to adjust the bathymetry in areas of known mining activity. The exact bathymetric dataset, mined sand volumes, and areas of bathymetry adjustment used to develop the model grids will be determined after coordination with SFEI on the bathymetric datasets and mined sand volumes. Surface grain size data available in Attachment H: 2018 Benthic Study will be incorporated into the more than 1,300 observed surface grain size distributions used to specify a model initial sediment bed.

The UnTRIM Bay-Delta model will then be used to simulate hydrodynamics, waves, and sediment transport for four scenarios. The scenarios will include two different water year types, both using observed bathymetry representative of conditions with sand mining and using the adjusted bathymetry representative of conditions assuming sand mining had not taken place. Model scenarios will span 1 year to fully capture seasonal changes in winds, waves, tides, and Delta outflow, which all impact sediment transport in San Francisco Bay.

The exact time periods of the model scenarios will be determined based on the available bathymetric data, our understanding of the San Francisco Bay, and discussion with the Independent Science Panel or State Coastal Conservancy (SCC). One possible simulation period is the time between the 2018 and 2019 bathymetric data collection, which would allow for validation of the model results versus observed bathymetric changes. It is assumed observed bathymetric changes would be provided by SFEI.

Both bedload and suspended load sand transport will be simulated by the UnTRIM Bay-Delta model and be evaluated separately to predict the transport rates and directions for bedload, suspended load, and total transport. Differences between scenario results using bathymetry representative of with and without sand mining will be used to predict the effects of sand mining on transport and deposition/erosion. Model scenarios will be examined spanning from Suisun Bay through the Golden Gate to evaluate the areas of the sand mining leases in the context of the predicted Bay-wide sand transport. Findings from the two years will be examined to evaluate how differences in conditions between years affects sand transport.

Maps will be generated to efficiently and concisely summarize the predicted sediment transport and effects of sand mining, and for comparison to maps of bedload transport direction from Barnard et al. (2013). The sediment transport model does not include mass wasting processes for predicting sloughing into the mined area. However, sloughing was not indicated in the preliminary work by eTrac.

Task Deliverables:

1. One technical memorandum detailing methods, results, and findings
2. Maps of predicted bedload and suspended load transport rates and directions under a variety of conditions
3. Maps of predicted deposition or erosion resulting from sand mining

Task 2 Develop and Deliver Findings Report

This task will include a detailed review of previous research on sand transport in the Bay. The review will include peer-reviewed publications and technical reports that are publicly available or available through SCC or other agencies. The sediment transport modeling findings from this study will be evaluated in the context of the previous research to develop a comprehensive understanding of sand transport in the Bay. We will confirm, revise, or expand previous conceptual models and graphics of sand transport in the Bay based on the synthesis of previous work and the findings of this study. Emphasis will be placed on conceptual models and graphics that can be used to succinctly address the Management Questions and are interpretable by a wide audience.

The posed Management and Research Questions will then be evaluated based on the developed comprehensive understanding of sand transport. A detailed synthesis report will be developed as part of this task that describes sand transport in the Bay and addresses the Management Questions to the fullest extent possible. Comprehensively addressing the Management Questions using previous research and sediment transport modeling will provide information to inform future management of sand in the Bay.

The synthesis report will include, but not be limited to, the deposition/erosion near the mining leases, sediment transport patterns from Suisun Bay through the Golden Gate, and the effects of sand mining on sediment transport and deposition. Report graphics will be based on the overall synthesis of previous GIS analyses and GIS analyses performed by SFEI as part of the San Francisco Bay Sand Study, sediment transport modeling, and review of previous research. Assumptions in the analyses from this study and previous research, uncertainties, and data gaps will be clearly explained. Recommendations for future data collection and further analyses will be provided.

Task Deliverables:

1. Presentation of findings to the Independent Science Panel, State Coastal Conservancy, Bay Conservation Development Agency, and the Sand Technical Advisory Committee during the last quarterly meeting.
2. Draft Findings and Synthesis Report
3. Final Findings and Synthesis Report

Task 3 Coordination and Sediment Flux Analysis

This task will include coordination with SFEI at the beginning of the project, during the transfer of bathymetric data, sand mining volume analyses results, and estimated Golden Gate sand flux, and at the end of the project. The transferred information will be used to develop the model bathymetry representative of without sand mining conditions in Task 1, which will be necessary for the modeling task to begin. This task, Task 3, will include collaboration with the SFEI team to compare the decadal Golden Gate flux SFEI will estimate by summing other sand budget components with the modeled Golden Gate sand fluxes during both wet and dry water years.

In addition, key members of the Anchor QEA team will attend up to 4 quarterly meetings with SFEI, the Independent Science Panel, Bay Conservation & Development Commission, State Coastal Conservancy, and the Sand Technical Advisory Committee throughout the course of the project.

Task Deliverable:
There are no specific deliverables as part of this task.

Timeline

Task Number	Task Title	Deliverables	Estimated Start Date	Estimated Completion Date
1	Perform Sediment Transport Modeling	Technical Memorandum Maps of transport rates Maps of deposition and erosion	05/01/2021	03/31/2022
2	Develop and Deliver Findings Report	Draft report Final report	03/01/2022	12/31/2022
3	Coordination and Sediment Flux Analysis	NA	03/15/2021	01/30/2023

SCOPE OF WORK

Task 1 Bathychronology and core selection

Subtask 1.1

USGS subcontract: Use the bathychronology tool to determine which existing cores are most advantageous for completing the research objectives.

Task Deliverable(s): Brief progress report on the Bathychronology and core selection, invoices for the Bathychronology work.

Task 2 Core Sampling

Cores selected based upon the Bathychronology analysis will be further processed and subsampled for provenance analysis and further age dating where necessary.

Subtask 2.1

Travel. This includes airfair (CA/TX), a rental car, lodging, and per diem for 3 people over 7 days,

Subtask 2.2

Scanning and subsampling of all cores. If necessary and depending on availability, selected cores can be scanned on the new XRF and CT core scanner facility at the USGS, Santa Cruz.

Subtask 2.3

Time spent transporting core samples from Menlo Park to Santa Cruz lab facilities for sampling

Task Deliverable(s):

Brief progress report on the samples collected and upcoming work/analysis, invoices for travel and sampling costs

Task 3 Sample Processing and Analysis

This task includes laboratory sample preparation and the collection of new, raw data for fingerprinting the characteristics of sediment moving through SFO Bay.

Subtask 3.1

Sample processing for analysis; includes heavy mineral separations, sediment geochemistry preparation, and wet sieving. This technique will include more time-intensive loss-less heavy mineral separation so that mineral concentrations can be accurately quantified. All samples have to be

conditioned, measured, and mounted (in most cases) before they are ready for analysis.

Subtask 3.2
Sample analyses: Major task is detrital zircon geochronology analyses by Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICPMS). This stage will also include some external lab analysis such as whole rock XRF or ICPMS sediment geochemistry.

Task Deliverable(s):
Brief progress report on the data collected, invoice for data analysis, and copies of the datasets and initial observations.

Task 4 Synthesis and Interpretation
This task will bring together all new bathychronology and analytical datasets in conjunction with a review of previous work to interpret sand sources and dispersal patterns in SF Bay. These interpretations will be presented in the context of implications for SF Bay sand mining.

Subtask 4.1
Synthesis of all data collected, maps, and quantitative modeling of datasets

Subtask 4.2
Final interpretations of new bathychronology, sand provenance and depositional chronology data to provide a framework understanding of SF Bay sand sources, dispersal patterns and changes thereto through time. These interpretations will be presented in the form of written reports that include a full outline of methods and raw data results.

Subtask 4.3
Attendance to up to three key coordination meetings, based on the timing of the work that is being conducted, with the Independent Science Panel, the Sand Technical Advisory Committee, the Conservancy, the Commission and other sand research teams. A sand study coordinator will be hired to coordinate and facilitate these meetings and information sharing. These meetings will include a initial coordination meeting at the start of the studies in 2021, and a final wrap-up meeting after the end of the studies in late 2022 or early 2023.

Task Deliverable(s):
Final report of the analysis and interpretation, final invoices, datasets, etc.

Fringe Benefits
Fringe benefit rates for the salary base employee is 0.306. The rate for a student employee is 0.0568.
No deliverables.

Indirect
Indirect rate is 0.15 for all direct costs, including up to 25K for subcontractors.
No deliverables

Timeline

Note some dates (particularly travel/sampling) are pending COVID-19 restictions.

Task Number	Task Title	Deliverable	Estimated Start Date	Estimated Completion Date
1	**Bathychronology**	**Progress Report and Invoices**	**Contract start date**	**08/01/2021**
1.1	Reconstruct core chronology for cores in areas of interest		Contract Start Date	08/01/2021
2	**Core sampling**	**Progress Report and Invoices**	**07/01/2021**	**12/01/2021**
2.1	Travel (TX/CA)		**07/01/2021**	**12/01/2021**
2.2	Sampling/imaging of cores		**07/01/2021**	**12/01/2021**
2.3	Transporting samples (Menlo Parl/Santa Cruz)		**07/01/2021**	**12/01/2021**
3	**Sample processing and analysis**	**Progress Report, Invoices, and copies of datasets and initial observations**	**10/01/2021**	**12/01/2022**
3.1	Sample processing and preparation		10/01/2021	09/01/2022
3.2	Sample analyses		9/01/2022	12/01/2022

4	**Data synthesis and interpretation**	**Final report, invoices, and copies of datasets**	**07/01/2022**	**12/31/2022**
4.1	Data synthesis and results interpretation		07/01/2022	11/01/2022
4.2	Report		10/01/2022	12/31/2022
4.3	Quarterly Meetings		Contract start date	1/30/2022

MEMORANDUM OF UNDERSTANDING FOR THE SELECTION AND CONTRACTING OF A STUDY COORDINATOR

The California State Coastal Conservancy ("Conservancy"), San Francisco Bay Conservation and Development Commission ("Commission"), Lind Marine, Inc. ("Lind"), and Hanson Marine Operations, Inc. ("Hanson") (referred to individually as "Party" and collectively as "Parties"), agree as follows:

WHEREAS, under the provisions of the McAteer-Petris Act and the Suisun Marsh Preservation Act, as amended, the Commission is charged with the management of San Francisco Bay resources, including the Suisun Marsh, and its adjacent shorelands;

WHEREAS, Lind and Hanson ("Permittees") currently harvest sand commercially from the San Francisco Bay and the western Delta (the Bay-Delta estuary). Hanson and Lind harvest sand from specified areas leased from the California State Lands Commission ("SLC") and a private party. Marine sands are used primarily for construction activities within the greater San Francisco Bay area;

WHEREAS, On April 16, 2015, the Commission approved three permits: BCDC Permit Nos. 2013.003.00 for Lind to mine up to 100,000 cubic yards (cy) of sand annually from Middle Ground Shoal; 2013.004.00 for Hanson to mine up to 1.1412 million cy of sand annually from Central San Francisco Bay; 2013.005.00 for Suisun Associates (a joint venture between Lind and Hanson) to mine up to 185,000 cy of sand annually from Suisun Channel. Through these permits the Permittees are authorized to mine cumulatively 1.426 million cubic yards (mcy) annually, and a peak of 1.73 million cy of sand in any year if the full volume was not mined in previous years, over a ten-year period ending in 2025.

WHEREAS, the 2015 permits require the Permittees to fund and participate in certain scientific studies in order to increase the understanding of the physical and biological systems, and the potential impacts of sand mining on them. With regard to the physical system related to sand transport and availability, the Commission's Executive Director, in consultation with the Permittees and others, appointed a Sand Studies Technical Advisory Committee ("STAC") and Independent Science Panel ("ISP") to guide the physical science studies to completion. The 2015 Permit provides that the STAC will consist of the Permittees' representative, regulatory and resource agency representatives as appropriate, and an independent study coordinator (study coordinator). The STAC identified management questions to be addressed by ISP, which developed scopes of work for the physical science studies. The STAC and ISP agreed upon the proposed scopes of work and study proposal selection and will monitor study progress and results. As required in the permit, the ISP consists of independent scientists with expertise in the studies being considered, and will be supported by the study coordinator. The ISP has recommended the type and scope of studies needed to address the management questions, and has reviewed the study proposals for their ability to address the management questions. The ISP also provided recommendations for selection of the final studies, which were reviewed and confirmed by the STAC. The ISP will monitor and review the studies' progress, and participate in quarterly meetings with the three study contractors, the study coordinator, and the STAC to review and discuss the studies

progress and status. When the three studies are complete, the study coordinator in consultation with the ISP will write a concise summary of the outcomes from each study. The ISP will review and assess the three individual study reports/data and the summary document from the study coordinator; discuss together the integrated information gained from all three studies; and will provide their scientific input as to how well the integrated data from the studies addresses each management question. The study coordinator will draft a summary document of this ISP input and provide to the STAC and the Commission. This is one document among other relevant documents that will be used by BCDC in their review of future sand mining activities and permit recommendations to the Commission.

WHEREAS, the Commission permits require a study coordinator to work collaboratively with the ISP and STAC to provide study results, conclusions, and a summary of scientific input to the Commission, and work with the Conservancy to coordinate information dissemination and document development;

WHEREAS, the STAC has been appointed and has completed its responsibility to develop management questions and agreed upon the appointed ISP members. The STAC will continue to meet and coordinate with the ISP to review study progress and outcomes. In consultation with the ISP, the Conservancy, Commission, and Permittees have engaged outside firms to conduct the individual studies;

WHEREAS, the Conservancy has assumed a significant role in managing and contracting for the studies and taking other steps to carry out the scope of work, and additional funds provided by the Permittees would help in carrying out the management duties under the original permit conditions; and

WHEREAS consistent with the Commission's permit condition applicable to all of the permits, the Parties desire to hire a new study coordinator to facilitate communication and dissemination of information to the STAC and ISP about the physical sand transport system science studies and coordinate future meetings and work with the ISP and STAC to develop documentation of study findings.

I. Statement of Mutual Benefit and Interests

The purpose of this MOU is to provide a framework and a funding mechanism for selecting and contracting a new qualified study coordinator to support and coordinate work conducted by the STAC and the ISP, which the Parties agree would be beneficial to completing the science studies and documenting the study results, conclusions, and scientific input from the ISP as to how well the integrated data from the three studies addresses each management question (discussed verbally by ISP and summarized into a concise written summary by the study coordinator).

II. Purpose

In order to increase the understanding of the physical sand transport system in the Bay and the potential impacts of sand mining, the Commission permits for sand mining require that the Permittees contribute up to $1.2 million towards creation of the STAC and ISP and to implement physical scientific studies to increase the understanding of: (a) the San Francisco Bay sand budget; (b) sand transport into the Bay from the Delta and local tributaries and to the outer coast (San Francisco Bar and Ocean Beach); (c) the amount and type of sand available for use; and (d) the impacts of mining on the sand resource. The STAC, in consultation with the ISP, identified specific management questions that are to be addressed by the scientific studies. In turn, the Commission's permit conditions call for appointment of a study coordinator to support the STAC and ISP, to finalize study plans collaboratively with the ISP, and to work with the Conservancy to contract for and manage the studies.

This MOU assures the supplemental resources needed for the selection and work performed by the study coordinator in support of the STAC and ISP. These supplemental resources are above and beyond the $1.2 million already deposited by the Permittees. The Conservancy shall contract with a study coordinator to provide administrative services, meeting development and facilitation, and coordination of the STAC and ISP. The study coordinator will work with the ISP to develop documentation of study outcomes, and of ISP and STAC discussions on the implications of the studies for the physical system, sand mining, and resource management. The use of a study coordinator will allow the Commission's staff to focus on review of the conducted studies rather than administrative tasks.

III. Advanced Funds to be Provided to the Conservancy

The Permittees agree to provide up to $50,000 to the Conservancy in a one-time advance payment for services provided consistent with this MOU and the contract to be entered by the Conservancy with the study coordinator. This one time advance payment will not be made until after SCC has received study coordinator cost estimates from at least three entities, and discusses and confirms the preferred contractor and cost with the Permittees and the Commission staff. The Conservancy agrees to refund Permittees any unpaid funds not owed to the contractor for work performed pursuant to the contract developed through this MOU. Neither the Conservancy nor the Commission has an obligation to provide funds for the Study Coordinator beyond those funds provided by the Permittees for this purpose. The Permittees' responsibility shall not exceed $50,000. However, additional funds may be distributed to the Conservancy at the sole discretion of the Permittees.

IV. Selection of Study Coordinator

No study coordinator shall be selected and placed under contract by the Conservancy until the Parties agree in writing that the proposed study coordinator is mutually acceptable to all Parties and the proposed study coordinator has agreed to perform work in the manner described in this MOU and accompanying Scope of Work (Exhibit A). The Conservancy's Executive Officer, or delegee may accept a proposed study coordinator who demonstrates, to the Executive Officer's satisfaction, knowledge and experience necessary to successfully complete the coordinator responsibilities in **Exhibit A: Sand Study Coordinator Scope of Work.** After soliciting proposals, the Conservancy shall provide information regarding three proposed study coordinators to the Commission and Permittees with a recommendation for a preferred study coordinator. If the

Commission or Permittees disapprove all three proposed study coordinators, Conservancy shall select another study coordinator for consideration consistent with the procedure outlined in this section.

V. Management of and Payment to the Study Coordinator

The study coordinator will be managed by the Conservancy. The study coordinator will prepare regular invoices and submit them to the Conservancy with a copy to the Permittees in time for the regularly scheduled bi-monthly calls with the permittees. Payments to the study coordinator will be mailed in accordance with the Prompt Payment Act. Each invoice shall contain time entries with detailed descriptions stating the date, time spent (including fractions of an hour), work performed, and describing the tasks accomplished as provided in the contract to be entered between the Conservancy and the study coordinator. The Permittees' responsibility for payment to the study coordinator shall not exceed $50,000. If the proposals exceed $50,000, then the parties will meet and discuss a potential increase in the funds available for this study coordinator contract, or make the necessary adjustments to the scope of work.

VI. Duties of the Study Coordinator

The study coordinator shall perform the scope of services listed in **Exhibit A: Sand Study Coordinator Scope of Work** at the direction from the Conservancy and Commission staff, in consultation with the Permittees**.**

VII. Role of Permittees

Permittees will participate, along with the STAC, in reviewing all work product and documents produced by the study coordinator via discussions at meetings and commenting on circulated documents. Permittees shall work collaboratively and transparently with the study coordinator, the Conservancy, and the Commission to fulfill the STAC permit conditions. To ensure full transparency, discussions with the study coordinator outside of scheduled meetings shall include the Conservancy and Commission staff.

VIII. Role of Commission

The Commission is the permitting agency and is responsible for ensuring satisfactory permit condition implementation and compliance. In collaboration with the Conservancy, it managed the STAC and its development of a 2019 study coordinator scope of work. In coordination with the Conservancy, the STAC, and previous study coordinator assisted with forming the ISP, worked with the ISP to develop and finalized study scopes, and the physical science studies selection. The Parties worked together to develop this MOU and Study Coordinator Scope (Exhibit A) included herein.

Regarding this study coordinator contract, the Commission shall not be responsible for any payments to the study coordinator. The Commission shall continue to work collaboratively with the STAC (including the Permittees), ISP, Conservancy, and study coordinator. To ensure full transparency, discussions with the study coordinator outside of scheduled meetings shall include the Conservancy staff and Permittees.

IX. Role of Conservancy

To date, the Conservancy has been participating in the STAC, assisted with forming the ISP, guided the process scopes of work finalization, physical science studies selection, developed and managed contracts with the researchers, and helped develop the scope of work for the study coordinator proposed herein. The Conservancy shall manage the study coordinator contract, review and pay invoices, and oversee the study coordinator work, including completion of tasks, development of work products, and communications with researchers, the ISP, and the STAC. The Conservancy shall ensure full transparency and freely share with the Parties all communications with the study coordinator and drafts of work product produced.

X. Ownership and Control Over Study Coordinator Work Product

Upon submittal of any draft or final document intended for public review (if any), the Commission shall have complete ownership and control of such document(s), which shall be considered public documents available for review by any member of the public who satisfies the Commission's procedures for requesting review of public documents. The Commission shall also be free to use the documents and the information in them in any manner that it sees fit.

XI. Information Sharing

Each Party shall have the right to examine any of the other Party's communications to another Party or to ISP and STAC, including documents or other records (including, without limitation, records contained on electronic media) relating to the performance of that Party's obligations pursuant to this MOU, except for a Party's communications within its own organization and those documents that are confidential or otherwise privileged by operation of law. This requirement does not require record retention beyond those business practices normally utilized by the Parties.

XII. Responsibility for the Objectivity and Completeness of the Science Studies

To carry out the STAC permit conditions, the study coordinator will work collaboratively with the Conservancy to: (a) finalize any summary or documentation of study results and conclusions, and (b) support the ISP in its review of those results and conclusions. The study coordinator shall help ensure that information is summarized and presented in a transparent and objective manner. The ISP, as the scientific experts, will review the studies and ensure that the studies were conducted in accordance with the assigned methodologies and with appropriate scientific integrity. The Conservancy and BCDC (in consultation with the ISP and STAC) shall ensure that the researchers have completed the tasks set out in the research proposals and that the research is presented in an objective fashion.

1. Effective Date and Term. This MOU shall become effective as of the date of the last signature and shall remain valid and effective until such time the Commission and STAC have completed their review of any study results and determined them "final" or December 31, 2023, whichever occurs first. The term may be extended by the written consent of all Parties. Notwithstanding the foregoing, any Party may withdraw from

this MOU by providing thirty (30) days' prior written notice to all Parties. If one or more Permittees withdraws from this MOU prior to completion of the work under the scope of work, the coordinator contract may be terminated and any unused funds will be returned to Permittee(s).

2. Further Review and Amendments. Modifications to this MOU may be necessary. On behalf of the Commission, the Executive Director is authorized to make amendments or other minor modifications in writing upon the mutual consent of the Parties.

3. Counterparts. This MOU may be executed in counterparts.

The Parties hereto have duly executed this Memorandum of Understanding.

San Francisco Bay Conservation and Development Commission

By: Larry Goldzband

Name: Larry Goldzband

Title: Executive Director

Date: 7/7/2021

Hanson Marine Operations, Inc.

By: T. R.

Name: Thorsten Rotter

Title: Vice President and General Manager

Date: 7/1/2021

Lind Marine, Inc.

By: William H. Butler

Name: William H. Butler

Title: Vice President, Regulatory Affairs

Date: 7/11/2021

California State Coastal Conservancy

By: Mary Small

Name: Mary Small

Title: Deputy Executive Officer

Date: 7/7/2021

EXHIBIT A

INDEPENDENT STUDY COORDINATOR SCOPE OF WORK

These professional services shall be provided by an environmental consultant – which can include a sole proprietor or an employee of a consulting firm or public entity.

A. Background

In 2015, three Bay Area sand mining companies, Hanson Marine Operations (Hanson), Lind Marine Incorporated (Lind) and Suisun Associates (Suisun), a joint venture partnership between Lind and Hanson, obtained permits from the San Francisco Bay Conservation and Development Commission (BCDC) to mine up to an average of 1.426 million cubic yards (mcy) of sand annually, over a ten-year period ending in 2025. As a condition of these permits the companies have contributed funds to support studies and research on the impacts of sand mining, its sustainability in the Bay, and its effects to the outer coast offshore from San Francisco Bay.

BCDC's permits resulted in the formation of a Sand Studies Technical Advisory Committee (STAC), an independent study coordinator (study coordinator), and an Independent Science Panel (ISP) to guide this research and analysis. The STAC consists of mining companies' representatives, regulatory and resource agency representatives, and appropriate stakeholders. The roles of each of these committees are described in the **Memorandum of Understanding** between BCDC, SCC, and the sand mining companies. The STAC identified three overarching Management Questions for the ISP and science studies to address that included additional further refined management questions. These three overarching management questions are:

1. Is sand mining at the existing lease areas, at the permitted levels, having a measurable or demonstrable impact on sediment transport and supply within San Francisco Bay or the outer Coast?
2. What are the anticipated physical effects of sand mining at the permitted levels on the sand transport and supply to San Francisco Bay and the outer coast?
3. Are there other feasible sand mining approaches to consider in the San Francisco Bay?

Each management question has multiple tiered questions from the STAC included in **Attachment A**.

In 2018-19, the previous study coordinator, the ISP, consisting of experts in the fields of sediment transport and coastal engineering including Bob Battalio, P.E., Dr. Craig Jones, Dr. John Largier, Dr. David Schoellhamer, and Dr. Paul Work, have reviewed these questions, reference documents, the proposed scopes of work, and are reviewing the proposals and the products produced.

The key research questions were largely focused on the three spatial scales representing the potential levels of influence that sand mining may have:

1. **Individual Mining Events:** What happens to the seafloor when an area is mined? How fast does sediment accretion occur after a mining event? Is the effect limited to the

depression? Does the depression trap more sand than present before the mining? Does the sand grain size distribution change? Does the hydrodynamics in the area change? Does side-casting of sand bycatch greater than 0.5-inch grain size sand armor the site or create an area of courser grain size sand. Could armoring of the bed change the sand transport mechanism and recovery time?

2. **Lease and Shoal Areas:** What are the sand transport pathways through and within the lease areas? What are the boundary conditions including direction of near bed velocities and shear stresses on each side of the lease areas? How do the bedforms affect the sand transport mechanisms for different grain sizes of sand? How does the volume of sand mined compare with the volume of transport through each lease area?
3. **Regional Study Area:** How are the regional sand budgets influenced by sand mining in the lease areas? What is the volume of sand bedload transport along various pathways in San Francisco Bay and to the outer coast?

Scopes of work were developed by the ISP to address the overarching Management Questions 1 and 2, and the tiered questions, and the research questions to the extent possible, recognizing that multiple studies would be needed to answer these questions.

The three identified study topic areas include:

1) San Francisco Bay Sand Budget, Information Collection and Synthesis
2) Sand Transport Study
3) Stratigraphy and Sand Resource Availability

Requests for proposals were solicited by the to the State Coastal Conservancy (SCC) (the agency managing the funds), and responses to the request were submitted on October 19, 2020. The STAC, ISP, BCDC and the SCC have reviewed and scored the proposals, discussed any fatal flaws or highlights of the proposals, and selected of the studies with some modifications. The selection took into consideration the SCC contracting procedures and the groups scoring of the proposals. The selection was finalized with the consent of the STAC, BCDC, SCC, and ISP in February 2021. Work proposed has been contracted by the SCC, and began in April 2021 and be complete by December 2022. See **Attachment B** for final proposals from the SFEI/Deltares/USGS team (Sand Budget and Transport), Anchor QEA (Sand Transport Modeling), and University of Texas at Austin (Stratigraphy).

In order for the study information to be available for BCDC's next permitting process, it is important that the science studies are completed by December 2022 and that the study coordinator summarizes ISP's review of the studies by June of 2023.

B. Scope of Work.

The contractor, acting as the independent study coordinator (study coordinator), will conduct the work described in this scope of work. The study coordinator will be contracted, and therefore managed by SCC with guidance from BCDC and the STAC. The study coordinator's role is to facilitate communication and information sharing, ensure full and timely review of the

studies, and develop meeting summaries, and draft and final reports.

The period of this scope is August 2021 through June 2023. Studies are anticipated to be complete by December 2022. The study coordinator will facilitate review of the studies by the ISP and STAC, draft the ISP findings and recommendations of the ISP for Commission review.

Responsibilities that the study coordinator would fulfill include the following:

1. *Facilitate Communication*: Throughout the research period the coordinator will work with SCC to facilitate information sharing and updates from the research among STAC, BCDC, ISP, and SCC. The study coordinator will gather and disseminate information and maintain a shared online document filing system (Dropbox or similar system) that allows participants to share and access information.
2. *Progress Report Calls*: The study coordinator will schedule short (half hour) progress report calls with SCC, BCDC, and the Permittees (subset of the STAC group) that are bimonthly. The study coordinator will prepare the meeting agendas, facilitate the meetings, take notes, and provide brief written meeting summaries.
3. *Quarterly research update meetings*: Schedule and coordinate up to 8 quarterly meetings with the researchers and the STAC, BCDC, ISP, and SCC. Develop meeting agendas in collaboration with SCC and BCDC with input from the STAC, prepare a facilitation (lead/run) agenda with details on timing, methods, and outcomes for each item. Collect or prepare and distribute meeting materials. Take meeting notes, develop meeting summaries, and distribute to the STAC and ISP as appropriate.
4. *ISP scientific review and documentation*: Develop a schedule for ISP review and discussion of the studies outcomes and integrated information gained from all three studies. The study coordinator will plan up to 4 meetings with the ISP to discuss how well the integrated data from the studies address each a management question, and summarize their input. The study coordinator will provide a draft report to the ISP for review and concurrence that the document accurately captures their findings and interpretations. The draft report will be shared with the STAC as will iterations of the report until final for transparency.
5. *Post-Research discussions*: The study coordinator will schedule, coordinate, and facilitate up to 2 meetings with the STAC, BCDC, ISP, and SCC to discuss implications of the studies' findings regarding the physical system, resource management, and mining. The discussions may include ISP draft recommendations and facilitated opportunity for clarifications and additional considerations. The study coordinator will document the discussion, comments and considerations from the meetings.
6. *Final Report*: The final report should include study outcomes, the ISP perspective on the implications of the studies for the physical system, sand mining, and resource management. This report may include "minority findings" or additional considerations from the STAC perspective.

D. Qualifications

A successful candidate will have the following qualifications:

a) Excellent project management skills, including time management, organization, communication (oral and written), and coordination skills;
b) Excellent remote and in person meeting facilitation skills;
c) Relevant experience providing administrative and project management services for environmental and/or scientific investigations; and translating scientific data to inform management decisions
d) Ability to understand complex scientific information (ideally regarding sediment processes), fluidly converse with scientists and managers, and the ability to communicate technical information to a lay audience;
e) Relevant project facilitation work experience within the last three (3) years;
f) Minimum of five (5) years of recent work experience in Environmental Consulting or other Science or Technical Coordination related service; and
g) Ability to legally enter into contracts and be qualified to do business in the State of California.