Group A. Project Management and Information/Data Quality Objectives
A1. Title Page

Quality Assurance Project Plan for
Tracking Bay Health: Water Quality Science to Inform Management

Grant Number:
W9-97T22601

Prepared by:
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Prepared for:
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San Francisco, CA 94105

Date prepared:

03/24/2025

Period of Applicability:

10/01/2024 - 09/30/2029

A2. Approval Page

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QAPP Revision History

Version No.	Description of Changes	Author	Date
1	Original Version	Dan Killam Amy Kleckner	03/24/2025

A3. Table of Contents

Nutrient Management Strategy QAPP

Group A. Project Management and Information/Data Quality Objectives

A4. Project Purpose, Problem Definition, and Background

The project "Tracking Bay Health: Water Quality Science to Inform Management" will enhance nutrient monitoring to guide water quality improvements affecting San Francisco (SF) Bay. Our team and regional collaborators aim to collect and analyze data, empowering regulators and stakeholders to make informed decisions on nutrient load reductions that will influence the region's 37 wastewater treatment agencies in both the immediate (1-5 years) and extended future (5-20 years). This project greatly expands the SF Bay Nutrient Management Strategy (NMS) to provide comprehensive insights into nutrient trends and water quality while building monitoring capacity for the coming decades. The devastating 2022 harmful algae bloom (HAB), which resulted in widespread fish mortality and anoxic conditions in South SF Bay, emphasizes the urgency of this work. While discussions about wastewater upgrades were underway, events in 2022 and a smaller bloom in 2023 highlighted the need for load reductions and additional data to support those decisions. Overall 14 wastewater agencies have identified opportunities to optimize and develop projects that will collectively reduce nutrient loads to SF Bay by 30-40% by 2029. To that end, we will develop collaborations with other monitoring entities with the goal of integrating and optimizing monitoring efforts, expand the NMS's long-term monitoring network to fill high priority data gaps, assess water quality impacts of specific management actions, and model nutrient scenarios for different upgrade actions and mitigation against future blooms. The outputs of this project will directly inform multi-billion dollar investments in wastewater treatment.

Since 2014, the San Francisco Estuary Institute (SFEI) has served as the technical lead for the NMS, a management-driven, stakeholder-guided program serving to answer questions surrounding whether SF Bay is increasingly susceptible to nutrient-driven water quality impairment. This concern arose based on findings of the long-term monitoring program initiated in 1969 by the US Geological Survey (USGS), which detected trends indicating the risk of eutrophication had increased since that time - a testament to the essential value of rigorous long-term monitoring. Over the last decade, the NMS predominantly drew upon discharger funding to support monitoring and special studies. Concurrently, the USGS grappled with diminishing federal backing for its long-term monitoring of the largest estuary on the West Coast.

The Tracking Bay Health project leverages 10+ years of regional investments by the NMS and SF Bay Regional Monitoring Program (RMP) to directly inform unprecedented levels of investment in multi-benefit water infrastructure anticipated in the next decade. The tasks within this initiative promise to shed light on both imminent (1-5 years) and extended (5+ years) wastewater management strategies, carving a path for enhanced water quality in SF Bay. Moreover, the data harvested from this endeavor address pivotal management queries charted by the NMS. These include identifying potential bloom hotspots, gauging nutrient load reductions needed to mitigate future bloom hazards, instituting early-detection systems for timely management responses, and assessing if climatic shifts compound SF Bay's vulnerability to high nutrient loads.

A5. Project Task Description

There are multiple tasks within Tracking Bay Health that will employ data compilation, monitoring, and modeling to describe environmental processes and conditions to inform water quality management needs in San Francisco Bay. These tasks represent the natural extension of work initiated decades ago by the USGS and numerous partners to establish a sustainable long-term monitoring program, as well as provide advanced insight into nutrient management impacts at different spatial and temporal scales under variable environmental conditions.

This QAPP covers each of these elements as described below.

Task 1 - Sustain and Expand Water Quality Monitoring: Task 1 aims to expand the current monitoring regime in SF Bay through increased ship-based monitoring, both through additional high-frequency monitoring cruises on the under-studied shallow SF Bay shoals, and by adding new parameters to the ongoing channel-based monitoring, such as eDNA-based surveillance of HAB species presence. Additional parameters and stations also can be added to the existing SFEI mooring network (Figure 1). Expansions would also include biomonitoring of toxins in mussels and quantification of biomass of benthic grazers that form an important control on phytoplankton biomass and species composition. Remote sensing capacity can additionally be expanded, via new Bay-wide applications to quantify turbidity, cloud cover, and other controls on production.

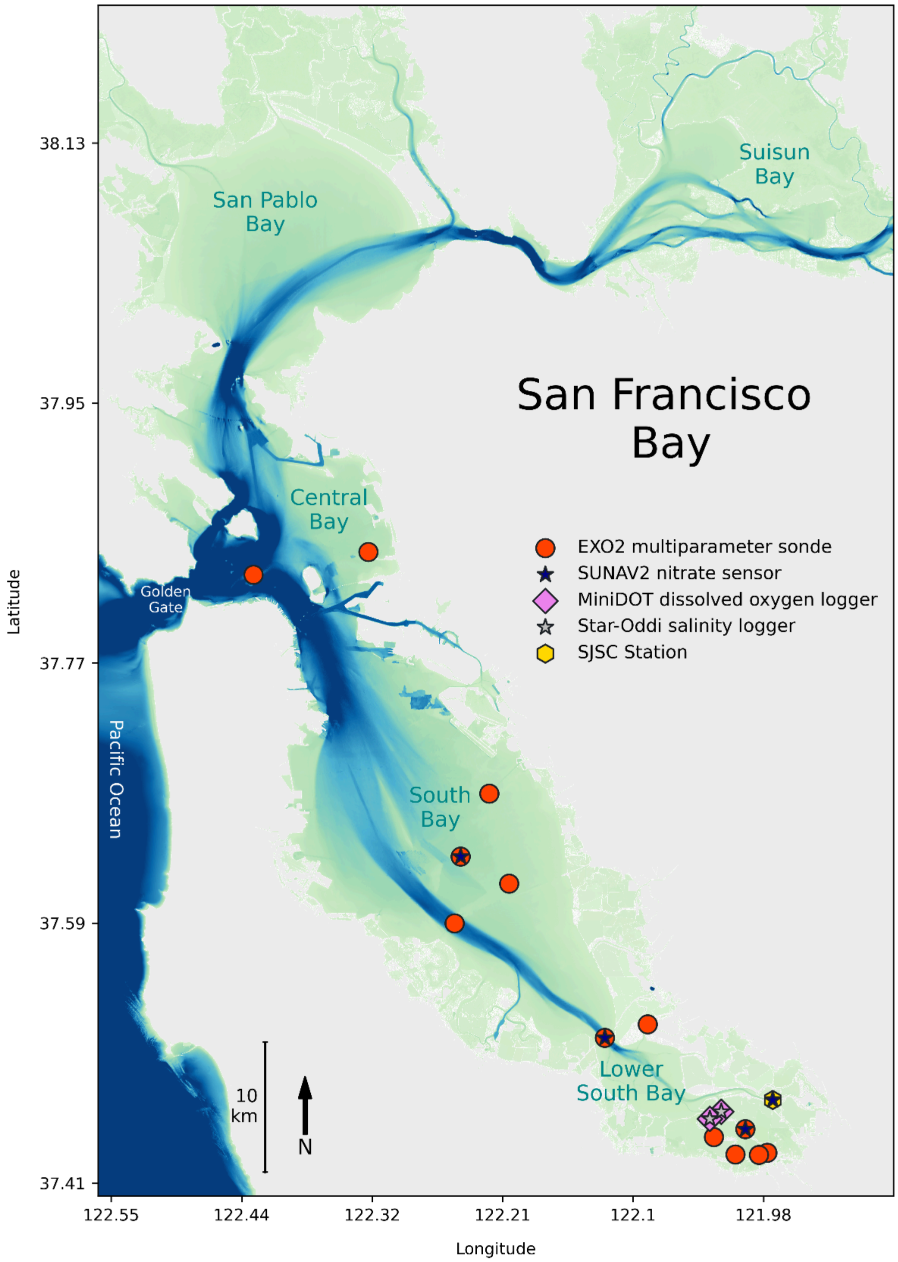

Figure 1: Diagram showing existing SFEI mooring network in SF Bay

Task 2 - Targeted Field and Lab Studies: Task 2 will involve 1-2 year projects undertaking targeted field-lab studies to fill longstanding, high-priority data gaps, undertaking 1-3 such studies per year. Study areas include intensive field or lab studies investigating the triggers of HAB toxin production, sourcing of the organisms, and observing their growth rate in controlled conditions. Additionally, efforts will be undertaken to quantify the exports of biomass from Lower South Bay salt pond environments to the open Bay through sloughs, and to estimate denitrification through time and space with greater granularity.

Lastly, field collection will help with testing and evaluating the performance of recently developed assessment framework indicators.

Task 3 - Data Analysis & Synthesis: Work will be undertaken to make data analysis and synthesis a higher priority, with 3-4 studies undertaken per year, increased from the present pace of 1-2 studies/year, structured as 1-year intensives. Broad themes for analysis include characterizing spacetime variability of key mooring and high-speed mapping data, and cross-comparison of that data with lower frequency sources of data such as biweekly channel cruises and satellite observations. The data will also be used to investigate management-relevant science questions such as unusual deviations from typical background conditions, and comparisons with assessment framework thresholds. Topics for synthesis priority will be identified via planning discussions with the NMS Steering Committee, as discussed in Task 5, to review summary State of the Science materials and iterate on new reprioritizations of effort, leading to a new technical synthesis report. Candidate topics for analysis include spacetime variability in molecular surveillance of HABs, using a 2015-2023 database of 18S and 16S metabarcoding data. Synthesis efforts combining ongoing moored sensor observations with 30 high-speed mapping surveys conducted 2021-present would also be a priority, and efforts to quantify long-term trends in productivity forcings such as suspended sediment via satellite observations. Refinement of assessment framework indicators for Lower South Bay and subtidal environments of the South Bay would be important deliverables for stakeholders.

Task 4 - Numerical Modeling: The data collected from Tasks 1, 2, and 3 will be used to fine-tune and validate the integrated hydrodynamic/biogeochemical model that has been a primary undertaking of the NMS in recent years. These models simulate SF Bay dynamics and biogeochemistry, facilitating the exploration of management challenges concerning nutrient transport and ecosystem response to nutrients, and pinpointing necessary management strategies to curb negative impacts. They will allow us to understand SF Bay's response to imminent management decisions and the evolution of wastewater treatment throughout the region.

Key subtasks include implementing recommendations from the Model Advisory Group, a team of external advisors, and assessing the performance of that data using high-frequency observations. Key priorities include developing techniques for nutrient source apportionment, and simulating the triggers and progression of major HAB events in the model. Close collaborators include Resource Management Associates (RMA) and Four Peaks Associates, who will undertake improvements to the Lower South Bay sector of the model, as well as general validation and design of the main whole-bay model. Improvements to the benthic grazing module will help account for controls of production by clams in Suisun Bay, and application of a new high-resolution model to the Lower South Bay will allow for assessment of the baywide impacts resulting from reconnection of salt ponds in that environment.

Task 5 - Program Support: NMS continues to meet with its pre-existing Steering Committee, Planning Committee and other subcommittees. As the breadth and complexity of NMS work increases, we will expand resources in Program Management, to ease tracking expenditures, developing contracts, invoicing, and providing oversight of program areas, assisting the Lead Scientist. We will also undertake a series of meetings with our Science Planning subcommittee, to solicit detailed feedback on both NMS core program research and the expanded work undertaken through this EPA work. We expect this steering work to be complete by April 2025, in terms of reviewing the state of the science, reallocating resources across projects based on consensus of program priorities, and also reaching out to new stakeholders previously not integrated into our steering committee, including deeper outreach to POTWs and the general public that are generally not part of our decision-making process.

Science communication will also be part of our priorities under this task, including biannual program updates and planning documents with high-level graphics, detailed but accessible summaries of results, and polished formatting. This will extend to the final report produced as part of reporting results to the EPA Project Officer.

A6. Information/Data Quality Objectives and Performance/Acceptance Criteria

This project will collect data and interpret data to yield insights relevant to informing nutrient management decisions in San Francisco Bay and protecting nutrient-related water quality. The main data quality objectives for the data collected through this project is to develop a clear picture of water quality trends in the San Francisco bay to better inform regulators and stakeholders to make informed decisions on nutrient load reductions in the immediate (1-5 years) and extended future (5-20 years).

To answer the question posed in this project the data used for analyses will be gathered through primary data collection, past data collected and potentially data generated from other agencies that have been quality controlled. To this end all primary and past data undergoes three levels of quality assessment including manual quality checks, which flags and filters any data that does meet quality standards. Data quality specificity can be found in section B.4.1 Any datasets used in analyses must meet standards for measurement accuracy, representativeness, completeness, and comparability. The standards are described in more detail below:

REPRESENTATIVENESS: Spatial and temporal data will be collected from diverse water quality monitoring programs or projects such as those implemented by federal, state and local government agencies, Tribes, universities, and private research entities. This will ensure the data collected is representative of many different locations and water quality conditions that span the whole Bay.

COMPARABILITY: Data collection methods and lab analysis methods from each of the datasets should have similar scientific standard practices already in use in the region. Comparable QA/QC practices should provide a level of uniformity across the various datasets. Any differences in data collection methods will be identified and clearly noted. The datasets may be analyzed for trends and anomalies to provide a clear understanding of the heterogeneity between the datasets.

COMPLETENESS: The completeness of the collected datasets will be assessed by evaluating the data's origin, spatial accuracy, database schema, attribute values, and methods used to generate the data. Based on the question at hand, datasets must provide enough temporal and spatial data to accurately represent the environment and given parameters. Datasets will be reviewed for missing, duplicated, or manipulated data. If completeness targets are not achieved, the dataset may be excluded.

ACCURACY: The precision and accuracy of datasets can be determined by comparing the dataset to external and past data sources for data validation. Several water quality datasets from the region have been peer-reviewed and will be used to validate the other datasets. For example, turbidity and sediment data collected in the course of on-the-ground work will be used to calibrate the remote-sensed estimates.

For Task 3, different criteria are listed related to Synthesis/Communication success including: COMPLETENESS, ACCURACY and IMPACT.
IMPACT: The produced communication materials should be widely available and in a format allowing accessibility to all applicable groups.

For Task 5, relating to program oversight, criteria of REPRESENTATIVENESS, COMPLETENESS and ROBUSTNESS
ROBUSTNESS: The described programs and management approach will be durable and able to persist long-term through future work.

	A. Questions to be answered, decisions to be made, action to be taken, or hypotheses to be tested	B. General categories of information needed to answer questions	C. Specific measurements/ observations needed to answer questions	D. Quantitative criteria (action level, decision threshold value, etc.) associated with each measurement/ observation needed to answer the question
Task 1	1) How do primary productivity and nutrient concentrations vary in under-studied regions of Central North San Francisco Bay, and what are the key drivers of these processes? 2) Expand sensor network, improving maintenance and data management pipeline 3) Conduct high-speed biogeochemical mapping, including extension to previously unmeasured regions, helping measure	1) Obtain and install new instruments on channel cruise ship (USGS Peterson). 2) Coordinate and new shoal cruises and install moored stations covering additional areas (North Bay, Central Bay) 3) Improved remote sensing capacity, translated to light attenuation coefficients and/or suspended sediment	1) Additional parameters added to USGS biweekly cruises 2) New data from additional sites in Central and Lower South Bays 3) New high-frequency cruises extending into Central Bay 4) Additional mussel toxin collections	Representativeness: Data coverage in Central, North and Lower South Bay cruises should be improved. Comparability: Additional parameters will allow us to assess whether correlated parameters (chl-a vs DO+pH, toxin vs HAB presence) are adequately capturing the correlated biogeochemical aspects.

	how water quality changes throughout San Francisco Bay in response to hydro-climate variability and human activities 4) How do suspended sediment concentrations and light attenuation vary spatially and temporally over time in the Bay? How does this influence primary production?	concentration, as well as cloud cover/fog		Completeness: Resolution of dataset should be improved by additional cruises, improving our temporal understanding of production Accuracy: We should have more coincident mooring, mapping and mussel toxin data close in space and time to improve cross-validation.
Task 2	1) HAB studies: triggers of toxin production, resident taxa, stimulatory parameters 2) Biogeochemical studies: Lower South Bay production and transport, denitrification, zooplankton grazing 3) Assessment Framework: field collection of assessment framework indicators, including fish metabolic needs	1) Culture studies, toxin and nutrient measurements at broad spatial scale across seasons 2) Molecular sampling relevant to zooplankton quantification, sediment or seawater incubations 3) Quantitative understanding of transport rates in Lower South Bay (LSB) sloughs	1) Measurements of biomass transport from Lower South Bay sloughs 2) Grabs of sediment and water for denitrification incubations, extraction and culturing of live harmful algae. 3) 18S metabarcoding measurements of phytoplankton filter samples to determine lineage/sourcing of harmful algal cells	Representativeness: Denitrification, esp. in LSB, can help explain why nitrate varies so dramatically on diel and seasonal scales. Assessment framework thresholds must be representative and field data can help tailor more applicable and efficacious thresholds. Studies on HAB toxin triggers must be representative of SF Bay (most prior work in other settings) Comparability: HAB molecular and toxin data provide

				two complementary views of the proportion of biomass contributing to HAB hazards. Completeness: Quantification of HAB taxa which we previously lack precise abundance measures for. Accuracy:Better quantification of triggers of HAB production based on numerical estimates rather than narratives.
Task 3	1) State of the Science: synthesis reports integrating science planning priorities into unified report 2) Reanalyze historical record of HAB abundance based on newly developed molecular approach 3) Relate these abundance patterns to hydrodynamic conditions 4) Search for long-term trends in HAB abundance vs environmental data.	1) Steering committee feedback on State of Science documents 2) Data from the prior permit (high frequency moorings, mapping surveys, toxin and phytoplankton data) 3) Hydrodynamic data from colleagues and modeling team	Summary datasets from other tasks are needed, packaged in repositories for open access publishing and further ongoing work.	Completeness: The reports will be comprehensive and provide stakeholders with a view of all possible projects and how they fit into different science priority topics Accuracy: The reports will be in line with the latest, best understanding of the data, to allow them to have lasting explanatory power. Impact: The reports will be published as technical reports on our internal repository, with report number and

				description in our index of products. Additionally, some reports will be published as manuscripts with open data, in open-access journals.
Task 4	1) Incorporate recommendations from Model Advisory Group 2) Simulate HAB events and/or future scenarios 3) Add benthic grazing and expand to Lower South Bay 4) Decide on topic and form of manuscript	1) Field data needed for ground-truthing/ validation 2) Information on source apportionment plans 3) Data on grazer composition needed for validating grazing module 4) Feedback from MAG needed to evaluate efficacy of improvements	1) Field data (cruises, satellite and moorings) needed to validate models 2) Nutrient data from managers 3) Modules for grazing 4) Biogeochemical data needed for validation in Lower South Bay, potentially at higher temporal resolution than present	Representativeness: Model should allow realistic assessment of implications of nutrient management decisions Comparability: Data should compare closely to real-world observations from moorings and cruises. Completeness: Model output should match closely with observational data. Accuracy: Grazing data should allow more realistic seasonal fluctuations of biomass to be modeled
Task 5	1) Program management role will allow for greater direction of resources, efficiency between projects 2) Stakeholder engagement through a series of steering and subcommittee	1) Committee will have access to high-level summary reports and state of the science documents (Task 3) 2) Information on committee	1) Surveys of committee opinions and sentiment about plans 2) Comments from committee members, followed by synthesis of their	Representativeness: Planning should adequately account for all committee member input and priorities Completeness:

	meetings. 3) Communication via high-level science summaries	member availability and provision of budgetary and planning documentation	feedback	Program plan must track all interconnected funds and identify opportunities for efficiencies Robustness: Program plan must be usable through the duration of this next permit (through 2029)

Table 1: Data Quality Objectives and Acceptance Criteria Summary by task

A7. Distribution List

The following is a list of organizations that will receive a copy of the approved QAPP:

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Pradeep Mugunthan
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Wenatchee, WA 98801

A8. Project Organization

SFEI maintains primary responsibility for ensuring the successful completion of the grant. SFEI oversees all project scheduling, progress, and deliverables, including progress reports that provide timely information on project outputs and outcomes. The roles and responsibilities of those involved in the implementation of tasks within Tracking Bay Health are described below.

SFEI Project Manager will be the responsible official for overseeing the overall project and budget, as well as tasking subawardees and contractors with work required to complete this project. They will communicate project needs to subawardees and contractors.

SFEI Project Task Manager will be responsible for ensuring each task is completed on time and according to the standards laid out in the QAPP. They will also be responsible for maintaining the QAPP. It is the responsibility of the task manager to prepare and maintain amended versions of the QAPP at the direction of the Principal Investigator and distribute them to the individuals listed in Section A7.

SFEI QA Manager will be responsible for reviewing and approving the QAPP. They may provide technical input on proposed sampling design, analytical methodologies, and data review. In collaboration with the Principal Investigator, the Science Director will determine if the QAPP needs to be updated.

SFEI Project Principal Investigator will be responsible for ensuring the deliverables produced by the grantee, subawardees, and contractors are coordinated and meet the goals of the project. The PI will also determine if the QAPP needs to be updated.

Subawardee Project Manager will have overall responsibility for assigning appropriate personnel to complete the tasks included in this plan. They will ensure that the project budget is adhered to and will communicate with the SFEI Project Manager on work accomplished in this plan and any problems or deviations that need to be resolved.

Title/Responsibility	Name/ Qualification	Agency Affiliation	Number/ email
EPA Project Officer/Oversees Direction of Project			
Grant Program Officer	Dana Michels	EPA	michels.dana@epa.gov 415-972-3400
Principal Investigator			
Principal Investigator	David Senn	SFEI	davids@sfei.org, 510-999-1105
Project Manager/Directs Day-to-Day Work of Project			
Senior Manager	Ariella Chelsky, Senior Scientist Will Geiken, Project Manager Jen Trudeau, Project Manager	SFEI	ariellac@sfei.org, 415-269-6752 willg@sfei.org, 408-314-5314 jent@sfei.org, 510-746-7347
Project QA Manager/Senior Manager			
QA Manager	Ariella Chelsky, Senior Scientist	SFEI	ariellac@sfei.org, 415-269-6752
Project Task Manager/QAPP Maintenance			
Project Task Manager	Dan Killam, Environmental Scientist	SFEI	dank@sfei.org, 510-746-7397
Project Task Manager	Katie Harding, Environmental Scientist	SFEI	katieh@sfei.org, 530-318-9564
Project Task Manager	Martin Volaric, Environmental Scientist	SFEI	martinv@sfei.org, 571-451-5865
Staff/Performs Project Tasks			
Moored sensor and other water quality data	Lucy Montgomery, Environmental Analyst	SFEI	lucym@sfei.org, 415-971-8928

QAQC			
Moored sensor and other water quality data QAQC	Katie Noland, Associate Environmental Scientist	SFEI	katien@sfei.org, 406-788-0985
Biogeochemical modeling	Farid Karimpour, Environmental Scientist	SFEI	faridk@sfei.org, 970-818-6069
Biogeochemical modeling	Allie King, Environmental Scientist	SFEI	alliek@sfei.org, 561-901-5446
Biogeochemical modeling	Jordyn Moscoso, Environmental Scientist	SFEI	jordynm@sfei.org 949-292-4623
Remote sensing data processing	Lindsey Sim, Environmental Scientist	SFEI	lindseys@sfei.org 510-746-7333
Biogeochemical modeling	Rachel Allen, Environmental Scientist	SFEI	rachela@sfei.org
Collaborators/Performs Project Tasks			
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Subawardee Project Manager	Timothy Elfers	USGS Pacific Coastal and Marine Science Center	telfers@usgs.gov, 831-460-7479
Subawardee Project Manager	Raphe Kudela	UCSC	kudela@ucsc.edu, 831-459-3290
Subawardee Project Manager	Jerry Frank	University of Maryland Center for Environmental Science	frank@umces.edu, 410-326-7252
Principal Investigator	Rusty Holleman	RMA	rusty@rmanet.com, 828-333-0183
Principal Investigator	Pradeep Mugunthan	Four Peaks	pmugunthan@fourpeaks

			env.com, 509-415-3480

Table 2: Project Organization and Personnel.

A9. Project QAM Independence

The Project Quality Assurance Manager (QAM) is independent of environmental information operations. The Project QAM's independence is ensured through separation of sections and reporting chains within the San Francisco Estuary Institute. The Project QAM has oversight authority and responsibilities for planning, documenting, coordinating, and assessing effectiveness of the QAPP. The QAM has authority to access and discuss quality-related issues with senior management outside of the direct supervisory chain as necessary. Ariella Chelsky is supervisor of the QAPP, while EIO is conducted by scientists Killam, Harding, and Volaric.

A10. Project Organizational Chart and Communications

Communications will be two-way between all parties in the organization chart below. Subawardees and Contractors will report to the Operations and Senior managers. The Operations and Senior managers will report to the EPA.

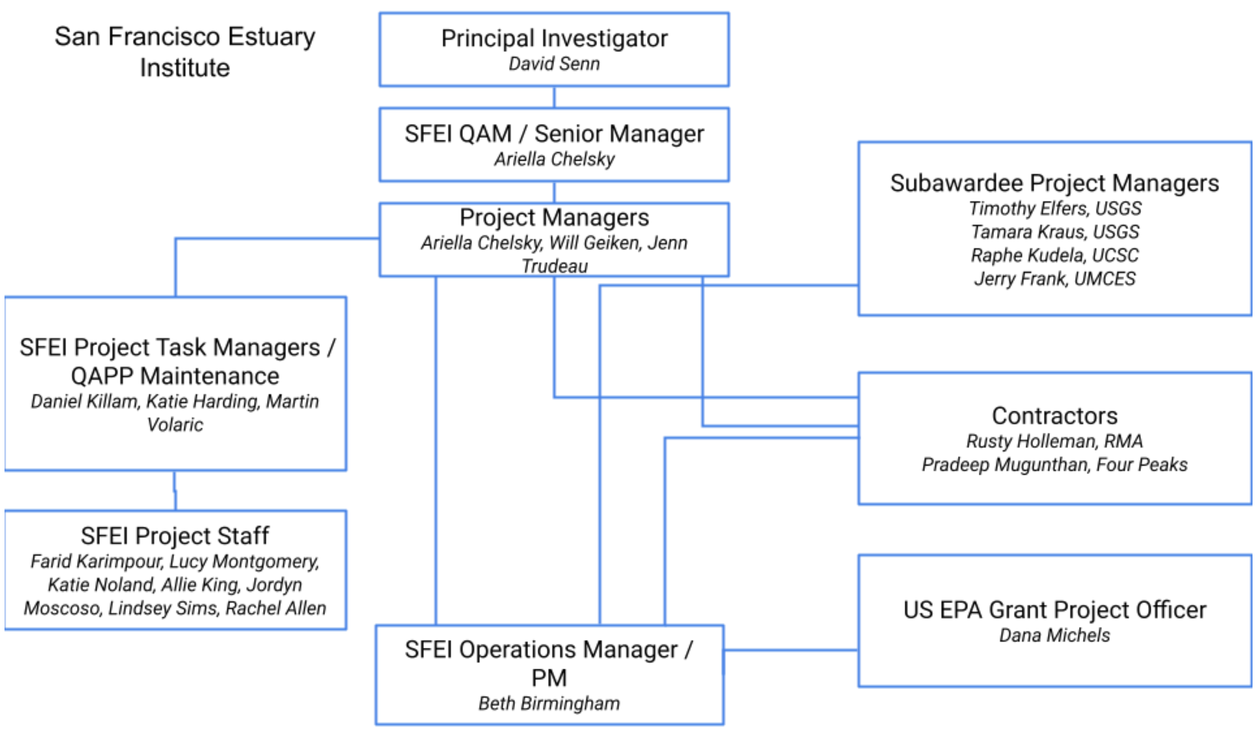

Figure 2: Organizational chart for NMS Tracking Bay Health

A11. Personnel Training/Certification

A11.1 Field Sampling and Measurements Personnel

No special training is required for field sampling and measurements. All staff participating in field work are trained by more experienced personnel and use the Health and Safety Manual for Fieldwork created by SFEI (Appendix A) as guidelines. Additionally, all fieldwork staff are required to complete a boating safety course and apply for a California boater card.

A11.2 Laboratory Personnel

There is no specific training for laboratory staff. Staff are trained by more experienced personnel on the protocol described for each task.

A12. Documentation and Records

Data

All data collected and data used for analyses will be documented in spreadsheets containing available metadata. Each level of QA/QC from raw to final data is saved as independent spreadsheets as backup and QA/QC tracking. Methods and technical details will be documented in project management documents. Data used for analyses and characteristics of each dataset will be documented in a spreadsheet to track adherence with the DQIs and to document metadata. Methods and technical details will be documented in project management tools and/or documents. All data and information will be preserved in the SFEI Data Center Repository. SFEI datasets will be stored in a database together with the metadata, and preserved via regular backups (a minimum of weekly) to an aggregated package, where they are mirrored for local replication and copied to a removable storage device for remote co-location. The removable storage devices are stored in a secure facility outside of the SFEI Data Center and rotated regularly to achieve industry standard security and preservation. Final reports and other communication materials will be publicly available through the WRMP website.

Shipping

Pertaining to Tasks 1 and 2. Each sample container with a unique sample identification is entered into a project-specific Microsoft Excel database for tracking. Chain of Custody forms (COC) are generated for each sample shipment to an analytical laboratory. COCs contain the following information: sample identification, analysis required, bottle size, bottle type, matrix, and any sample-specific comments (e.g. field filtered, field preserved). Samples that require cold temperature preservation and/or have short holding times are shipped on ice with next day delivery, to maintain appropriate temperatures (between 4-6°C for chilled samples; < 0°C for frozen samples).

Field Documentation

Staff will complete electronic field data sheets (Appendix B), sample container labels, and field sampling checklists in the field. All notes will be incorporated into the field data sheets while at the sampling site.

Field data sheets and checklists will be reviewed prior to leaving the sampling site for completeness. Sample container labels will also be cross-referenced with the field notes prior to leaving the sampling site. Staff always carry pencils, sharpies, directions to the nearest hospital, and important contact information into the field.

Labeling

Each sample container is pre-labeled with a unique sample identification, sample date, and analyte name. Labels are made of waterproof paper and pencil/sharpie is used for labeling. This method will ensure that no smudges occur in the field. Upon return from the field, a sample log is generated and checked against each container.

Chain-of-Custody Forms and Custody Seals

Chain of custody forms are generated by us and collecting partners such as USGS prior to shipment of samples to the analytical laboratory. A copy of the COC is sent along with the sample shipment and an additional copy is kept with the project records at the originating body (SFEI or USGS).

Reports

The QAPP for this project will be maintained and distributed by the staff listed in the table in section A.7.

The SFEI Project Manager is responsible for the preparation of quarterly reports that are submitted to the US EPA Grants Project Officer. Quarterly reports will be submitted 30 days after the end of each quarter, in January, April, July, and October.

The tasks within this project have either annual reports, technical reports and or technical memorandum. These reports will be drafted by the task project leads, reviewed by the senior manager and QAM and submitted to the EPA program officer by the dates noted in the work plan.

Group B: Implementing Environmental Information Operations

SFEI is the primary agency collecting field data and conducting modeling. The USGS will assist with the monitoring activities in Tasks 1 and 2. Task 1 remote sensing work will be done in collaboration with a university partner (UCSC). RMA and Four Peaks Environmental Science & Data Solutions, both engineering consulting firms, will contribute to the models developed in Task 4.

B1. Identification of Project Environmental Information Operations

Task 1 - Sustain and Expand Water Quality Monitoring and **Task 2 - Targeted Field and Lab Studies:** Data will be collected from various water quality monitoring programs or projects such as those implemented by federal, state and local government agencies, Tribes, universities, and private research entities.

The NMS and USGS established moored sensor networks are instrumental in evaluating the impacts of planned nutrient management actions. Continuous data from moored sensor stations will be collected via an array of monitoring instruments at new stations in the Central and North Bay. These data are needed to fill spatial gaps in Bay monitoring, like the USGS cruises, that do not include the shoals. The additional stations will increase the diversity of sampling locations and provide more observational data to fine-tune the biogeochemical models. Furthermore, the addition of telemetry will allow scientists and managers to observe water quality conditions in real-time and respond to potential HAB events.

The 37 stations monitored as part of the USGS cruise were identified based on the hydrodynamics of the Bay and key areas of interest. Discrete samples are collected at each station along with water quality data. Samples are analyzed for nitrate, phosphate, silicate, chlorophyll-a, suspended sediment, and plankton taxonomy. These data are needed to understand the temporal and spatial dynamics of nutrient, sediment, and chlorophyll concentrations in the Bay.

Task 3 - Data Analysis and Synthesis: Synthesis analysis uses a mix of open-source Python and R workflows, supplemented by QGIS. All relevant code is archived on Git repositories including Stash and Github, where contributions from collaborators are also archived with version control. Working datasets are saved in project folders. During manuscript submission, open data requirements for most journals mandate uploading those datasets to an open repository, such as Figshare or Dryad. Internal technical reports are also saved to an internal repository and assigned a permanent report number.

Task 4 - Numerical Modeling: For in-bay modeling, the project will use the existing D-Flow Flexible Mesh Hydrodynamic Model and D-WAQ water quality model, which are part of the suite of models built by Deltares (Figure 5). SFEI has used this model platform to develop hydrodynamic, water quality, and sediment transport models for San Francisco Bay, with the hydrodynamic and water quality models thus far set up and calibrated/validated for 10 and 8 years, respectively.

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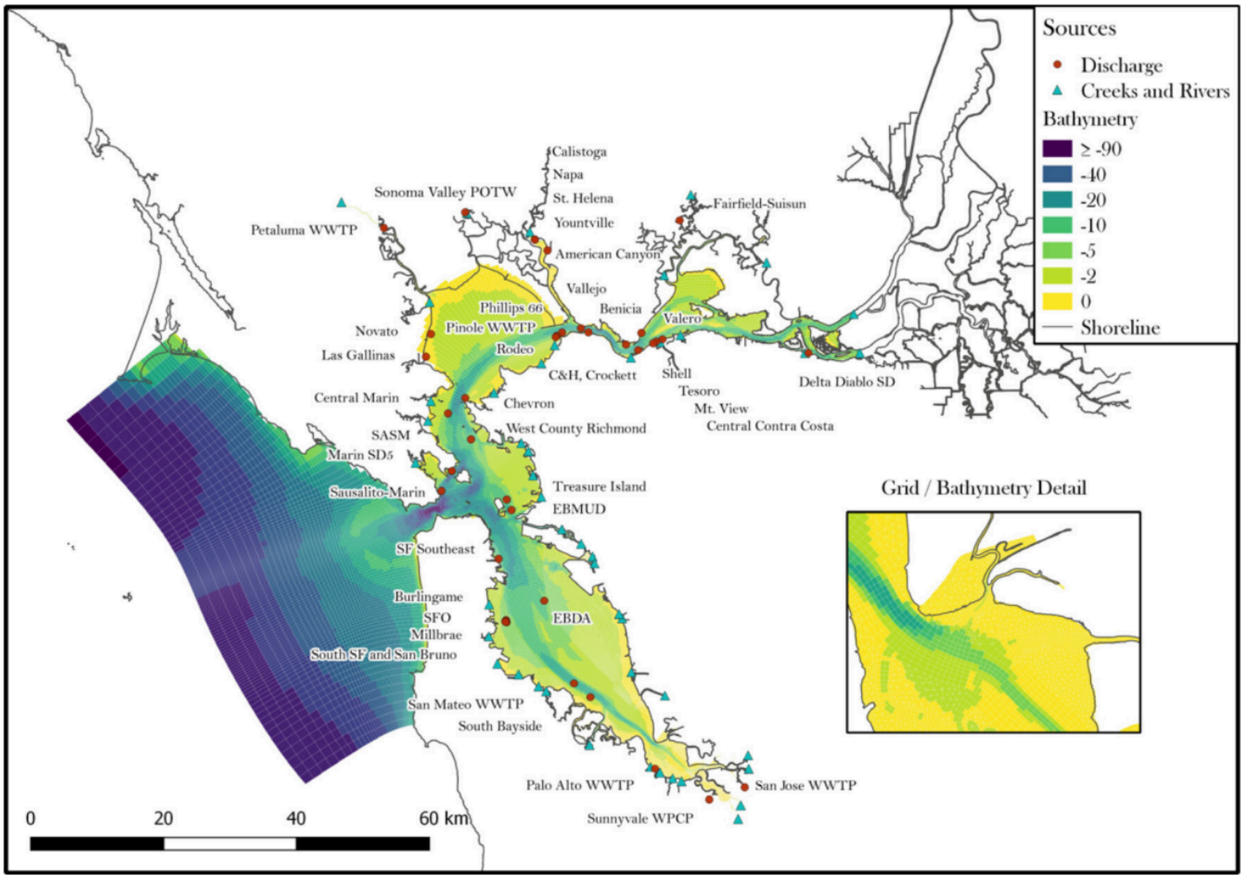

Figure 3: Map of the modeling grid used for SFEI biogeochemical model

Task 5 - Program Support: Does not apply.

B2. Methods for Environmental Information Acquisition

B2.1 Moored Sensors

Moored sensors are deployed in the San Francisco Bay which collect environmental parameters every 15 minutes. The instruments are multi-parameter sondes (EXO2s, YSI) are surrounded by copper tape and wrappings to minimize biofouling and automatic anti-fouling wipers clean the sensors periodically to remove any fouling before measurements. The sensors are serviced every 4 to 6 weeks. The entire sensor is either pulled from the water and replaced with a new sensor or the sensor is cleaned and calibrated on site. During servicing the data is downloaded and stored in the SFEI google cloud for QA/QC. The multiparameter sonde includes instrumentations to measure temperature, salinity, pH, chlorophyll-a and cyanobacterial accessory pigments, turbidity, dissolved oxygen and fluorescent dissolved organic matter. Additionally, at select locations outlined in this project there are nitrate sensors (SUNA, Seabird) that will be serviced at the same frequency and procedure as the EXO sondes. See table below for moored sensor SOPs.

B2.1.1 Field Equipment for sensor maintenance

List of Equipment Needed (Tasks 1 and 2):

- Hard copies of field data sheets
- Electronic device for field data sheets if applicable
- Pencil and permanent marker
- Map and spreadsheet of collection locations
- ISCO automated pump or peristaltic pump
- Remote sampler
- Stainless steel bailer
- Tubing
- Batteries of various sizes
- Zip-ties
- Wire snips
- Gloves
- KimWipes
- Sample collection containers
- Sampling pole
- Coolers with ice
- Labels for samples

#	SOP Title	Description of content	File	Author organization, date
1	Moored Sensor Program Operations Manual 2024-2025	Station Details and Station Maintenance	Operations Manual	SFEI, July 2024
2	2020_Field_Work_Checklist.docx	Preparations checklist for days prior to fieldwork	Field Work Checklist	SFEI, 9/19/2024
3	2020_How-To_Plan_Field_Trips	Logistics and timeline for successful field day	How to Plan Field Trips	SFEI, 1/3/2020
4	MSP Quick Guide - Field Work	Moored sensor site servicing SOP	MSP Quick Guide	SFEI, 2/28/2023
5	MSP Site Servicing Trip Packing List	Packing checklist for fieldwork	Servicing Packing List	SFEI, 7/15/2024

6	Salt Pond Servicing SOP	Packing needs and SOP specific to salt pond sites	Salt Pond SOP	SFEI, 8/13/2024
7	YSI EXO2 Sonde & Sensor SOP	Serving SOP for EXO and SUNA instrumentation	EXO2 SOP	SFEI, 2/16/2024
8	SUNA V2 Instrument Performance Verification (IPV) SOP_Version 2.0	Serving SOP for SUNA instrumentation	SUNA V2 SOP	SFEI, 11/25/2024

Table 3: List of field sampling SOPs

B2.1.2 Discrete Surface Water Sampling (Tasks 1 & 2)

Surface water samples in the Bay will be collected using a variety of approaches that are appropriate for the type of sample or analyte, including: a sampling pole with affixed collection container; Van Dorn water sampler or Niskin bottle; peristaltic pump; or the research vessel's pumped flow-through system. A high level of effort to avoid field contamination will be undertaken by the field staff, including: wearing clean gloves; thoroughly rinsing tubing or other sampling equipment prior to sample collection; using new sample containers or containers that have been cleaned following standard protocols, and when appropriate rinsing sample containers 3 times with site water; and tightly sealing labeled bottles and storing in coolers with ice for transport back to the laboratory.

More information on discrete sampling may be reviewed in Schraga and Cloern, 2017. Analytical procedure references may be reviewed in Table 8.

B2.1.3 Mussel toxin sampling

Mussel toxin samples will be collected from a series of eight floating marina docks bordering the Bay, as described in Peacock et al., 2014. Five mussels are collected from each station by staff wearing gloves, making sure to collect only one individual 2-3 inches in length from successive discrete clumps of individuals. The mussels are stored during the field day in ziplock bags in a cooler and frozen at -20 °C pending shucking at SFEI. Mussels are later thawed (within 2 months), shucked, and sent for analysis at UC Santa Cruz. Procedures for analysis are as mentioned in Peacock et al., 2014.

B3. Integrity of Environmental Information

B3.1 Moored Sensor Data

The sensors are serviced every 4 to 6 weeks. The entire sensor is either pulled from the water and replaced with a new sensor or the sensor is cleaned, checked for integrity and calibrated on site.

B3.2 Sampling Handling and Custody

For all samples, only trace contaminant-cleaned or trace contaminant-certified bottles, provided by the laboratory, will be used for sample collection, where applicable. See table below for information regarding sample containers, preservatives, holding times, and storage.

Analyte	Matrix	Preservative	Container	Hold time	Storage
Nutrients concentration	Water	None	Plastic (HDPE)	28 days	Frozen
Suspended sediment concentration	Water	None	Plastic (HDPE)	4 months	Chilled
Chlorophyll concentration	Water	None	Plastic (HDPE)	28 days	Frozen
Phytoplankton taxonomic identification, counts, and biovolume	Water	Lugols	Plastic (HDPE)	12 months	Chilled
Phytoplankton taxonomy and relative abundance	Water	Lugols	Plastic	1 day	Chilled
Mussel toxin	Tissue	None	Plastic	12 months	Frozen

Table 4: Overview of environmental sample collection, handling and storage procedures. High density polyethylene (HDPE).

B3.3 Disposal of residual materials

N/A

B3.4 Packaging and Shipment

SFEI has an extensive shipping protocol developed to ensure quality shipping and minimize sample destruction. USGS will ship most cruise samples, but SFEI will ship mussel tissue samples (to UC Santa Cruz) and some discrete samples collected during mooring servicing. A summary of of the shipping protocol is outlined below:

- ➢ All samples should be kept at target temperatures (chilled or frozen) between collection and delivery to the laboratory. When ice is used, use flexible rolls of blue ice or pack ice in double plastic zip-top bags (avoid wet ice and hard ice packs – these can break glass bottles during transit). If applicable, seal the drain plug of the cooler with duct tape to prevent moisture from leaking out of the cooler.

- ➢ Shipping glass and plastic bottles:
  - ○ Check screw caps for tightness.
  - ○ Ensure sample labels are securely fastened and legible.
  - ○ Place bottles in styrofoam shipping containers and create separation between bottles with cardboard. Plastic sampling containers can be shipped in regular ice coolers.
  - ○ Wrap all glass sample containers in bubble wrap / bubble bags to prevent breakage.
  - ○ Add ice packs between bottles.
  - ○ Add enough bubble wrap layers to the top of the box to ensure no movement of bottles during shipment.
  - ○ Enclose the appropriate COC(s) in a zip-lock plastic bag affixed to the underside of the lid.
  - ○ Wrap the box with clear packing tape to ensure that the lid stays closed.

For analytes with short holding times and labs nearby, driving the samples to the lab may be the most appropriate option to ensure this. Otherwise, a reliable commercial shipper, such as FedEx, should be used to transport the packed samples.

- ➢ To ensure that samples arrive within the acceptable temperature range, even if hold time is not a constraining factor, all shipments should be sent for next-day delivery. When shipping late in the work week, also ensure that the analytical laboratory is open to receive the samples should they arrive up to 1 day late.
- ➢ When shipping bottles containing acid, if you ship more than 30 ml of acid in a sample bottle or more than 500 ml total per package you are violating US Department of Transportation regulations and may be fined $50,000. For packages with bottles containing less than 30 ml of acid per bottle:
  - ○ "Each package must have an "Excepted Quantities" label, which must be placed on the outside of the package, be at least 100 mm (3.9 inches) x 100 mm (3.9 inches), and be clearly visible on the package.
  - ○ For transport by air, the air waybill must include the statement "Dangerous Goods in Excepted Quantities" in the "Nature and Quantity of Goods" space. Also indicate the number of packages being shipped.
  - ○ Each person who offers or transports excepted quantities of hazardous materials must read the requirements of 49 Code of Federal Regulations 173.4a (http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title49/49cfr173_main_02.tpl).
- ➢ The courier may require a "declared value" of the shipment, which represents the maximum liability of the courier in connection with a shipment of that package. The declared value for a shipment (equal to $50 per bottle in the shipment) should match the "customs value" of the shipment, applicable only for international shipments.
  - ○ For international shipments, a signed commercial invoice also needs to be included, consistent with other shipping documentation, along with 2 copies.

B4. Quality Control

B4.1 Data Quality Control

After data collection through methods described in B.2 the data undergoes several steps of quality assessment and quality control (QA/QC). The QA/QC step involves both automated and manual assessment by a QC reviewer on the project staff. Moored Sensor data is downloaded from moored instruments every 4 to 6 weeks and is QA/QC shortly after.

Prior to January 2025, data will be processed through a series of Python scripts that stitch the raw data files together, remove outliers, and other QA procedures. The QA/QC steps are outlined below.

L0	Automated	• Converts raw output files from instruments to CSV format with identical data columns
L1	Automated	• Removes data that fall outside set maximum and minimum thresholds for individual parameters • Removes data points that fall outside three standard deviations from the mean of a two-hour window centered around the point of interest • Removes data when instruments are out of water
L2	Automated	• Removes data that have a coefficient of variance in a 200 point window surrounding each data point that exceed set thresholds • Removes data when sensor depth is < 0.5 meters • Re-enters data during periods of heavy freshwater inflow
L3	Semi-automated	• Removes remaining false data that have been identified through manual review by an NMS team member • Re-enters data that were identified manually by an NMS team member as real but had been removed during automated processing • Observations of exponentially trending data indicative of instrumentation fouling is removed

Table 5: Current water quality QAQC steps

At the beginning of 2025, we will move to a new quality control pipeline utilizing Aquarius software. This software is also used by the US Geological Survey for their continuous sonde data quality control and visualization. The transition to this software will allow the aforementioned QA/QC steps to be followed in a trackable way, with the advantage of automatically applied metadata, version control and an interactive dashboard visualizing all applied data changes. It also serves as a secure data repository.

Below are the three levels of QAQC data review that will be conducted in Aquarius.

L0	• Confirms automated upload of raw data was successful including checking timestamps • Creates a note for each data gap greater than 12 hours
L1	• Removes data points that are visually observed as irregularly spiky or fouled • Removes data for periods when the sonde is out of water • Observations of exponentially trending data indicative of instrumentation fouling is removed • Applies drift corrections and offset corrections when identified • Applies a 'Grade' to data that is observed to be of lower data quality than regularly observed. A Grade of 'Poor' is applied to data that has minor fouling or periods of when the wiper has failed. A Grade of 'Unusable' is applied to data that is fouled beyond correcting capabilities or a confirmed sensor malfunction.
L2	• Completed by senior level staff. Provides final data review and guidance on periods with irregular data identified in Level 1. • Confirms drift correction and offset corrections completed accurately

Table 6: Quality assessment/quality control (QA/QC) steps for new Aquarius-based system.

B4.2 Field Quality Control Samples

B4.2.1 Assessment of Field Contamination (Blanks)

Equipment Blanks: Field blanks will be collected for nutrient and chlorophyll discrete samples and will provide estimates of overall field blank contamination.

Field Blanks: Field blanks will be collected with the same methodology as field sample collection. Field blanks will be collected at a frequency of at least 5% of the total sample number.

Trip Blanks: Separate trip blanks will not be collected. Field blanks will be collected and will provide estimates of overall field blank contamination.

B4.3 Assessment of Field Variability (Field Duplicate or Co-located Samples)

Field duplicate samples will be collected at a frequency of 5% of the total sample number. Field duplicate samples will be collected in the same manner and time as field samples. Describe the frequency of each type of QC activity, corrective actions, and how the effectiveness of the corrective action shall be determined and documented.

B4.4 Laboratory Quality Control Samples

This project will follow the guidelines established in the Regional Monitoring Program for Water Quality in SF Bay's QAPP for laboratory control measures (Yee et al., 2021). The QAPP requires all analytical laboratories to demonstrate capability continuously through:

1. Strict adherence to common QA/QC procedures. This may include measurement of the following:

- Analysis of certified reference materials
- Laboratory replicates
- Calibration checks

2. Regular participation in an on-going series of interlaboratory comparison exercises.

B4.5 Modeling Quality Control

Biogeochemical models are calibrated and validated through comparison to observational data at the same time and place (such as from cruises and moored stations described in Task 1 and 2). The model generated data and observational data can then be visualized together to determine residuals and statistical relationships, to assess further changes. Those changes can be iteratively tested to determine sensitivity of the model output to each parameter. The parameters can be varied in a controlled manner to determine the values that correspond closest to observational data, with those parameter values being reported as a median value and confidence interval. In addition, each model run and the associated parameters can be saved as a scheme for later reference, which at SFEI is done on the high-performance computer storage, along with associated metadata needed to interpret the data output.

B5. Instrument/Equipment Calibration, Testing, Inspection, and Maintenance

B5.1 Calibration of Field Equipment

For Tasks 1 and 2, multiparameter water quality sensors will be calibrated using reference standards prior to instrument deployment. Methods of calibration will be selected based on equipment manufacturer specifications and water quality monitoring common practices. If a calibration of a sensor fails, a new sensor will be used in its place or the proceeding field data measurements will be qualified. Calibration post-checks of the water quality sensors may be conducted after the equipment's use in the Bay. See SOPs 7 and 8 in Table 4 for instrument maintenance and calibration details.

B6. Inspection/Acceptance of Supplies and Services

B6.1 Analysis Narrative

Numerous water quality parameters or analytes may be tested for in this project, including but not limited to those in the following categories: nutrients, phytoplankton composition, chlorophyll, and suspended sediments. Analytes to be collected will be implemented in task 1 and task 2.

The following table provides the analyte category and the maximum sample number in each applicable task.

	Task 1 monitoring (# samples)	Task 2 monitoring (# samples)
Plankton taxonomy	240	180
Chlorophyll	240	180
Suspended sediment	240	180
Nutrients	420	240
Mussel toxin measurements	240	
Molecular samples (16S/18S metabarcoding)	240	120

Table 7: Analyte sample totals by task.

Reference material for analytical procedures are noted in this table:

	Laboratory	Procedure Standard Reference
Chlorophyll-a (high-frequency cruises)	UMCES Chesapeake Biological Laboratory	Reference: EPA 445.0, SM10200H.3
Chlorophyll-a (biweekly channel cruises)	US Geological Survey	Schraga and Cloern, 2017
Suspended sediment	US Geological Survey	Schraga and Cloern, 2017
Dissolved Inorganic Ammonium	UMCES Chesapeake Biological Laboratory	Reference: 4500-NH3 G-2011
Silicate	UMCES Chesapeake Biological Laboratory	Reference: SM 4500-SiO2 E-2011
Dissolved Inorganic Orthophosphate	UMCES Chesapeake Biological Laboratory	Reference: EPA 365.1 Rev. 2.0
Total Dissolved Phosphorus, Total Phosphorus	UMCES Chesapeake Biological Laboratory	Reference: #4500-P.B.5, #4500 P.E, and EPA Method 365.1

Particulate Carbon/Nitrogen	UMCES Chesapeake Biological Laboratory	Reference: EPA 440.0
Particulate Phosphorus	UMCES Chesapeake Biological Laboratory	Reference: EPA 365.1, Rev. 2.0
Dissolved Inorganic Nitrate plus Nitrite	UMCES Chesapeake Biological Laboratory	Reference: EPA 353.2, Rev. 2.0
Dissolved Inorganic Nitrite	UMCES Chesapeake Biological Laboratory	Reference: EPA 353.2, Rev. 2.0
Mussel toxin measurements (dinophysis toxin, microcystin, domoic acid, saxitoxin)	UC Santa Cruz	Peacock et al., 2018

Table 8: Procedures involved in discrete water and mussel toxin sampling

B6.2 Analytical Laboratory

USGS sample collection and management: The USGS Water Science Center will manage sample tracking and distribution or shipping of samples to the analytical laboratories below for the following analyses.

Tamara Kraus (Project Manager)
USGS Water Science Center
Placer Hall
6000 J Street
Sacramento, CA 95819
Phone: 916-278-3260
Email: tkraus@usgs.gov

Brian Bergamaschi (Project Manager)
USGS Water Science Center
Placer Hall
6000 J Street
Sacramento, CA 95819
Phone: 916-278-3053
Email: bbergama@usgs.gov

Suspended sediment: The USGS Sediments Laboratory will analyze sediment samples.

Stephen Lowe (Principal Investigator)
USGS Water Science Center
Santa Cruz Field Office
2885 Mission Street
Santa Cruz, CA 95060
Phone: 831-460-7500
Email: stephlow@usgs.gov

Nutrients and chlorophyll: University of Maryland Center for Environmental Science's Chesapeake Bay Laboratory will analyze nutrient and chlorophyll samples.

Jerry Frank (Manager - Nutrient Analytical Services Laboratory)
146 Williams Street, P.O. Box 38
Solomons, MD 20688
Phone: 410-326-7252
Email: frank@umces.edu

Phytoplankton using Microscopy: Contractors procured in alignment with Federal and EPA requirements will analyze water samples for phytoplankton abundance by microscopy.

Phytoplankton taxonomy and relative abundance Molecular/Sequencing Techniques (eDNA, qPCR): Contractors procured in alignment with Federal and EPA requirements will analyze samples using DNA-sequencing/molecular techniques, following standard protocols (e.g., SFEI 2020, SFEI 2021).

Mussel toxin measurements: UC Santa Cruz conducts toxin measurements using LCMS and/or ELIZA protocols

Raphe Kudela (Principal Investigator)
1156 High St.
Santa Cruz, CA 95064
Email: kudela@ucsc.edu
Phone: (831) 459-3290

B7. Environmental Information Management

Task 1 - Sustain and Expand Water Quality Monitoring and **Task 2 - Targeted Field and Lab Studies:** SFEI and USGS will collect records for sample collection, field analyses, and laboratory chemical analyses. Samples sent to analytical laboratories will include a Chain of Custody form. The analytical laboratories will maintain records of sample receipt and storage, analyses, and reported results.

SFEI maintains hard or electronic copies of field notes and measurements, as well as laboratory submitted documentation and results at the SFEI main office. The SFEI Data Manager is responsible for the storage and organization of information. Contract laboratories are responsible for maintaining copies of project documentation originating from their respective laboratories, with backup archival storage offsite where possible.

Copies of laboratory methods, standard operating procedures (SOP)s, and quality assurance (QA) plans are available by request from SFEI. Some laboratory methods and SOPs may be edited to exclude proprietary details about the analyses. Quality assurance documents are reviewed by the PI of the project and QAM or their designees.

Copies of all records will be maintained at SFEI and at the laboratory for a minimum five years after project completion, after which they may be destroyed, except for the database at SFEI, which will be maintained without destruction. All data will be backed up and secured at a remote location (i.e., separate from the SFEI office). As needed, data recovery can be initiated by contacting the back-up facility for restoration and this will be covered through SFEI overhead.

The data management procedures for the Bay monitoring tasks described in this section will also pertain to the data potentially collected for remote sensing purposes.

Processed data records will be available to stakeholders and the public upon request or included in the Task 1 website data dashboard as applicable. Sample data collected by USGS will be uploaded to the publicly available National Water Information System (NWIS) website after QA procedures have been completed.

Task 3: Data Analysis and Synthesis: All synthesis work is based on the versioned and quality controlled datasets described in Tasks 1 and 2. During analytical work, data is drawn down from the servers and saved as working datasets, with the Python and R scripts used to do so being saved in a local Stash Git repository managed by SFEI Environmental Informatics Staff.

Collaborators may be added and able to pull and push from the repository, and for some collaborators unable to use Stash, we will maintain mirrored repositories of that project code on Github.

All datasets, code and other supplementary information will be hosted on open access data repositories when manuscripts are submitted to relevant journals, also referring back to the local relevant repositories at SFEI's Stash.

Task 4 - Numerical Modeling: Secondary data collected as part of this project will be maintained electronically only. Key secondary data will be compiled from a variety of sources into a common database such as Microsoft Excel or kept as a set of cleaned input files (e.g., netcdf or csv format, depending on size of dataset). The database will be used to support model development. The modeling software to be used for this project is the DFM and D-WAQ models from Deltares. Description of the metadata, model parameterization and other supporting materials will be documented in a report. SFEI will maintain copies of data, model files in a task subdirectory (subject to regular system backups) and keep available upon requests after completion of the project.

Group C: Elements for Assessment, Response Actions and Oversight

C1. Assessments and Response Actions

Quality assessment for Tracking Bay Health includes regular review of the data and draft reports. The first step of data assessment with be done as the described QA/QC procedure in section (B.4.1) by the project staff. The QA/QC is done after data download from field station, approximately 1-3 months. The second level of data assessment will be done by the task project leads, through data analyses and synthesis work, making sure the data is within range of previous datasets which covers decades of data collection.

Quality assessment of draft reports will be done through reviews by peers and management. Reports are drafted by task project leads and will be assessed through review by peers (other task project leads) with input from project staff where relevant. After which the reports will be assessed by the Senior Manager and QAM through review and editing. Several reports are generated including quarterly progress reports and annual technical reports.

Short time frame quality oversight will be done through biweekly to bimonthly meetings which include project staff, task managers, senior manager and QAM where project progress and any issues are discussed. Issues that can be addressed directly are handled within the meeting. If a more complex issue is presented, a lead is assigned. The lead will identify the problem through further research of related information, contacting collaborators to collect information, analyze relevant data and then summarize the collected information and report back to the biweekly meeting with resolution options. Once a resolution is chosen as the best path forward, the lead or project staff will implement the resolution.

Summarized by task:

Task 1 - Sustain and Expand Water Quality Monitoring: Annual readme/data summaries of new data types will be drafted by the task project lead and reviewed by the senior manager.
In addition to the quality control (QC) measures used for the evaluation of lab and field sampling performance conducted by the project staff, data will be compared to data collected in other Bay water quality studies throughout the Bay Area by task project leads. For the potential remote sensing algorithm calibration, processed satellite data will be compared to ship-board data collected monthly throughout the Bay by task project lead and contractual colleagues.

Task 2 - Targeted Field and Lab Studies: In addition to the QC measures used for the evaluation of lab and field sampling performance by the project staff, data will be compared to data collected by water quality studies throughout the Bay Area by the task project leads.

Task 3 - Data Analysis and Synthesis: All resulting synthesis products will be subject to review by multiple colleagues including SFEI staff and external collaborators. Some projects will be overseen by advisory boards including unaffiliated members. All Git repositories will be shared between colleagues to ensure reproducibility and replicability between computers and users, in preparation for publication. Git commits are expected to be clearly written, and in code, objects must be clearly named and most lines commented to ensure the logic of the script is clear.

Task 4 - Numerical Modeling: Data management and reporting accuracy will be reviewed periodically throughout the project to confirm compliance with standards by the project manager. Progress reports ongoing throughout the project period within a month after each quarter will be produced by task project leads and the project manager and reviewed by the senior project manager. These reports will include content from all tasks.

Task 5 - Program Support: Not applicable.

C2. Oversight and Reports to Management

The SFEI Senior Manager and SFEI Project Manager will be informed at least quarterly on the status of the project, results of data quality evaluations, and significant quality assurance problems and recommended solutions. The SFEI Project Task Manager will provide updates and communicate back to project staff on actions to be taken.

In general reports are drafted and edited by the project task manager. The reports are then sent to the senior manager and QAM for final edits and approval before being sent to the EPA grant program officer.

Reports are listed by task below with a brief description, followed by the generator, editor and transmitter of each report.

Task 1:

Annual data summaries and readmes featuring new data types, deployments and datasets to expand monitoring, including new regions measured and new parameters collected. Generator: Daniel Killam, Editors: Katie Harding, Martin Volaric, Ariella Chelsky and Transmittor: Ariella Chelsky. Distributed to EPA program officer

Task 2:

Technical reports or manuscripts summarizing dataset, analysis and potential implication for management actions. Generator: Daniel Killam, Martin Volaric, Editor: Ariella Chelsky and David Senn, Transmittor: Ariella Chelsky. Distributed to EPA program officer

Task 3:

Synthesis documents including State of the Science documents, and final reports for HAB synthesis, spatiotemporal variability, long-term trends and Assessment Framework subtasks will be prepared by

Daniel Killam, Martin Volaric, Katie Harding. Editors: Ariella Chelsky and David Senn. Transmittor: Ariella Chelsky. Distributed to EPA program officer

Task 4:

Technical memorandum identifying recommended model scenarios for review by the NMS Model Advisory Group. Generator: David Senn, Editor: Ariella Chelsky and Transmittor: Ariella Chelsky. Distributed to EPA program officer

Task 5:

Quarterly progress reports which include invoicing, sub-contract development and management. Generator: Beth Birmingham, Editor: Daniel Killam and Ariella Chelsky and Transmittor: Ariella Chelsky. Distributed to EPA program officer

Final project report. Generator: Beth Birmingham, Editor: Daniel Killam and Ariella Chelsky and Transmittor: Ariella Chelsky. Distributed to EPA program officer

Technical report documenting model-based scenario results. Generator: David Senn, Editor: Ariella Chelsky and Transmittor: Ariella Chelsky. Distributed to EPA program officer

Group D: Elements for Environmental Information Review and Usability Determination

D1. Environmental Information Review

Task 1 - Sustain and Expand Water Quality Monitoring and Task 2 - Targeted Field and Lab Studies

REPRESENTATIVENESS: Conditions that are selected for measurement will include spatial and temporal variations of interest to best represent different tidal, nutrient, and phytoplankton growing conditions. The sampling and analytical methods were chosen in accordance with well-documented procedures used for previous water quality monitoring in the Bay. With sampling distributed over the entire year and tidal cycle, a representative characterization of the sampling sites and parameters investigated will be achieved.

COMPARABILITY: Methods used for sample collection and laboratory analysis will match those used in other Bay water quality monitoring efforts in the region.

COMPLETENESS: Completeness of measurements is evaluated as a percentage of usable measurements out of the total number of measurements desired. At least 80% of measurements should be usable. If a lower percentage is achieved for any sampling event or time period, the cause(s) shall be investigated and fixed where possible, through instrument maintenance, recalibration, repair, or replacement, and reanalysis of samples as needed. If completeness targets are not achieved, instrumentation and/or laboratory procedures and analytical methods shall be adjusted or changed to improve measurement reliability before the next sampling event or measurement period.

PRECISION: Precision of lab measurements is determined by repeated measurement of an analyte within a single sample (e.g., via lab replicates sub-sampling a homogenous collected sample), or by measurement of field replicates collected simultaneously, in rapid succession, and/or close proximity in a homogenous location. For evaluation of lab performance, lab replicates are preferable, as uncertainty introduced by heterogeneity in the environment by field replicates is minimized. However, for some matrices (e.g., hydrophobic organic compounds in water), low ambient concentrations and consequent large sample size requirements do not allow sub-sampling for lab replicates without loss of measurement sensitivity, requiring the use of separately collected field replicates for precision evaluation instead. In other cases where sample size and available material may be limited, other sample types may be used in place of locally field-collected samples as replicates. Such samples can include matrix or blank laboratory control spikes (LCS) spike replicates (at low levels within ~10x of those typically seen in field samples), larger field samples collected from other locations for other projects, and/or certified reference materials (CRMs) for similar matrices. General constraints for other sample types used for replicate analyses are that 1) the samples be taken through all the same analytical procedures (reagent additions, extractions, drying, etc.) and 2) that concentrations be similar in magnitude (at maximum 100x, preferably 10x or lower) to average project samples.

ACCURACY: Accuracy of lab measurements is evaluated by measurement of known standards or samples containing the appropriate analytes. Calibration standards and calibration-check samples establish the adequacy of instrument performance, but measurements of accuracy incorporating all preparation, extraction, and cleanup steps are required for evaluating the entire analytical process. When available, CRMs in an appropriate similar matrix and concentration range are most preferred, as the certified or reference values provide external confirmation of the expected concentrations for those samples.

Task 3 - Data Analysis and Synthesis
COMPLETENESS: We will assess if the reports are complete and rigorous through repeated iteration of all scripts by multiple users. Working datasets will be generated from the original quality assured datasets, with scripts shared to re-generate the dataset, in addition to the extracted and processed working dataset itself, to assure that all research is reproducible.

ACCURACY: Any subsetting of the data done in the course of generating statistics and models will be fully documented, with rationales for any such treatment. Where appropriate, regressions and models constructed using the data will be validated using subsamples of data set aside as controls. This will allow the determination of statistical model residuals from the data. All data on replicates will be displayed as confidence intervals on bar charts. All joins of related datasets will be cross-checked to ensure no unintended duplication of points.

IMPACT: The reports will be published as technical reports on our internal repository, with report number and description in our index of products. Additionally, some reports will be published as manuscripts with open data, in open-access journals. Statistics on the impact of resulting papers will be reviewed with the NMS Steering Committee to publicize the impact of this research.

Task 4 - Numerical Modeling
REPRESENTATIVENESS: For in-bay modeling, the project will use the existing D-Flow Flexible Mesh (DFM) Hydrodynamic Model and D-WAQ water quality model, which are part of the suite of models built by Deltares. SFEI has used this model platform to develop hydrodynamic, water quality, and sediment transport models for San Francisco Bay, with the hydrodynamic and water quality models thus far set up and calibrated/validated for 10 and 8 years, respectively.

COMPARABILITY: The performance of a model is commonly assessed by comparing model predictions with observations (see description of Precision & Accuracy below). Model-model comparisons can also be useful if comparable models are available (e.g., using comparable forcings, simulating same time periods). Model results often have different assumptions which can make comparability challenging. We will use the existing DFM as a base from which to expand the model for nutrients.

COMPLETENESS: The completeness of the model will be assessed based on the degree to which it includes equations/variables for simulating the most important/relevant processes and state variables, and also is used to simulate a sufficiently diverse set of conditions (e.g., multiple seasons, multiple years having different forcings and responses). The current model (DFM+D-WAQ) has the ability to simulate what are believed to be the most important processes; improvements/advancements to the model will be incorporated as needed. The DFM used as a base for this project is a completed model and is being used to inform water quality management in the region.

PRECISION & ACCURACY: The precision and accuracy of modeling efforts are subject to the accuracy of input data, model structure, and goodness of calibration. To assess model accuracy, we will compare model output with a diverse set of validation data, and evaluate model performance using widely-used model performance metrics (e.g., R^2 , RMSE, bias). Based on the work carried out thus, the accuracy of DFM and D-WAQ are suitable for this project's planned applications.

Task 5 - Program Support
REPRESENTATIVENESS:
Planning reports should adequately account for all committee member input and priorities, through a repeated process of input and surveying of committee member impressions. Solicited comments from the steering committee will be recorded both in meeting minutes and survey responses. Additionally, science plans should be representative of staff priorities, and so staff opinions will also be gathered in internal meetings as well as in unified steering committee meetings, to ensure maximum transparency and interchange of ideas. This will lead to a program plan that fully represents the best path forward as articulated by all participants.

COMPLETENESS:
The program plan must deliver the most complete understanding of Bay biogeochemistry possible, including all stakeholders in various subembayments. It must also be completed from the standpoint of presenting a realistic budget which balances the various costs while also delivering committee member organization priorities.

ROBUSTNESS:
The program must be usable throughout the duration of this next permit (through 2029). Creating plans with longevity, accounting for various contingencies, is a priority for NMS leadership. The 2022 harmful algal bloom event lead to a broad-scale reprioritization of NMS work. With this permit and work plan, we intend to build in capacity to respond to further such events, or to instead work on background conditions

and study recurrence intervals if rapid research response to acute bloom events aren't required before 2029. This will ensure a robust research program, proactively directed rather than reactively directed.

D2. Usability Determination

Task 1 - Sustain and Expand Water Quality Monitoring and Task 2 - Targeted Field and Lab Studies: All data that will be generated by the project will proceed through a rigorous QA process inline with what is outlined in SFEI's Regional Monitoring Program for Water Quality in SF Bay's QAPP (Yee et al., 2021). The USGS collected data will be processed through their own agency's data review requirements before being used by NMS or uploaded to NWIS. QC measures that will be used for evaluation of lab and field sampling performance include the following:

1. Calibration Standards: Calibration standards are used in the lab prior to instrument deployment to calibrate instruments between deployments.
2. Method and Field Blanks: samples of a clean or null (e.g., empty container) matrix taken through the entire analytical procedure, including preservatives, reagents, and equipment used in preparation and quantitation of analytes in samples; including the field sampling procedures for field blanks.
3. (Instrument) Replicates: replicate analyses of extracted material or standards that measure the instrumental precision.
4. Laboratory Replicates: replicate analyses of sub-samples of field samples, certified reference materials, lab reference materials, matrix spike samples, or laboratory control samples, taken through the full analytical procedure including all lab processes combined, used to evaluate overall measurement method precision.

Task 3 - Data Analysis and Synthesis: In addition to the above lab and field performance evaluation, data results will be compared to other relevant data collected in the Bay Area. This will serve as a QA check during the interpretation of the results.

For the potential remote sensing calibration, all satellite data will be processed and corrected/cleaned following widely-used approaches, and values for suspended sediment concentration and/or light attenuation coefficients will be estimated using (when possible) locally-derived calibrations (using paired samples with Bay data) or widely-used relationships demonstrated to be appropriate for conditions in the Bay. Researchers from UC Santa Cruz and SFEI will review the data through a rigorous QA process.

Task 4 -Numerical Modeling: Data incorporated into the models will have undergone QA checks through the RMP, NMS, USGS or other monitoring programs. Outputs generated by the model will be compared to regional values to determine model robustness.

Task 5 - Program Support: Not applicable

D2.1 Model Calibration and Quality Control

Task 1 -Sustain and Expand Water Quality Monitoring: Not applicable

Task 2 - Targeted Field and Lab Studies: Not applicable

Task 3 - Data Analysis and Synthesis: Not applicable

Task 4 - Numerical Modeling: This project will utilize an already calibrated version of the D-Flow Flexible Mesh (DFM) Hydrodynamic Model and D-WAQ water quality model for nutrients in the San Francisco Bay. As needed, those calibrations will be improved over the course of the project, including through the use of datasets collected or produced during this project.
For model development and software modifications, the following data review and quality control processes will be conducted.

- All modeling activities including data interpretation, load calculations, or other related computational activities are subject to audit or peer review. Thus, the modelers are instructed to maintain careful written and electronic records for all aspects of model development.
- A written record on where the data were obtained and any information on their quality will be documented in the final report.
- If a new theory is incorporated into the model framework, references for the theory and how it is implemented in any computer code will be documented.
- Any modified computer codes will be documented in the user's guides and technical memoranda supplements.

Task 5- Program Support: Not applicable

Tables, Figures, Appendices, Abbreviations

References

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Schraga, Tara S., and James E. Cloern. 2017. "Water Quality Measurements in San Francisco Bay by the U.S. Geological Survey, 1969–2015." Scientific Data 4 (1): 170098. https://doi.org/10.1038/sdata.2017.98.

Yee, D.; Wong, A.; Weaver, M. 2021. 2021 Quality Assurance Program Plan for the Regional Monitoring Program for Water Quality in San Francisco Bay. SFEI Contribution No. 1048. San Francisco

Estuary Institute: Richmond, California.
https://www.sfei.org/documents/2021-quality-assurance-program-plan-regional-monitoring-program-water-quality-san

Tables and Figures

Abbreviations

SF -San Francisco

NMS - Nutrient Management Strategy

SFEI - San Francisco Estuary Institute

USGS - United States Geological Survey

UCSC - University of California, Santa Cruz

RMP - Regional Monitoring Program

WRMP - Wetland Regional Monitoring Program

HAB - Harmful Algal Bloom

LSB - Lower South Bay

COC - Chain of Custody forms

HDPE - high density polyethylene

QA/QC - Quality Assurance / Quality Control

SOP - Standard Operating Procedure

NWIS - National Water Information System

LCS - Laboratory Control Spikes

CRM - certified reference materials

D-WAQ - Delft3D Water Quality

DFM - D-Flow Flexible Mesh

UMCES- University of Maryland Center for Environmental Science

CBL - Chesapeake Bay Laboratory

LCMS - Liquid Chromatography Mass Spectrometry

ELISA - Enzyme-Linked Immunosorbent Assay

qPCR - quantitative Polymerase Chain Reaction

DO - Dissolved Oxygen

Appendices

Appendix A: Health and Safety Manual for SFEI Field Work

Appendix B: NMS Moored Sensor Program Field Form

Appendix A: Health and Safety Manual for SFEI Field Work

Health and Safety Manual

For

SFEI Field Work

Prepared by
Nicole David of
the San Francisco Estuary Institute

June 2007
Updated July 10, 2007
Updated April 17, 2008
Updated November 1, 2008
Updated May 18, 2010
Updated September 22, 2011
Updated September 13, 2012
Updated July 11, 2014
Updated April 14, 2015
Last Updated December 14, 2015

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Table of Contents

The San Francisco Estuary Institute (SFEI) is responsible for the safety of all employees in the office and during field assignments. This document outlines the SFEI safety mission statement, multiple safety programs, and safety training. It includes lists of field equipment, handling procedures, protective gear, and emergency communication plans.

Health and Safety Mission Statement

SFEI's goal is to assure health and safety of staff and to protect them from risk of injury and exposure to illness. SFEI will instruct every employee to recognize and avoid all unsafe conditions in the field and train them to eliminate or control hazardous situations with equipment, sampling protocols, or at sampling sites. SFEI is committed to provide training and encourage continued improvement for health and safety procedures in the field to promote a safe workplace and preserve the environment.

General Guidelines for Field Work and Emergency Numbers

- Determine work environment hazards and wear appropriate protective gear to mitigate hazards. For example:
  - Wet weather: foul-weather gear and boots, etc.
  - Sunny weather: sunglasses, sunscreen, hat, etc.
  - Cold weather: warm jackets, hats, gloves, etc.
  - Areas with pests (ticks/mosquitoes): long sleeves and pants, insecticide if necessary.
  - Areas with poison oak/ivy or other vegetation hazards (e.g., nettles): long sleeves and pants, use Tecnu oil prior to exposure, shower after exposure with appropriate soaps to remove oils. Be aware of your surroundings as work hazards may change during the course of the day.
  - Areas with other potentially dangerous wildlife (mountain lions, bears, snakes, etc.): Be aware of your surroundings at all times. Take frequent brakes during your field work and assess your surroundings. Keep the truck close by if possible.
- Bring a first aid kit and safety kit every time you go out in the field.
- Bring emergency communication information and a map to the nearest hospital for your sampling site.
- Notify your supervisor and Administration staff when you are in the field, provide contact information (cell phone numbers of all staff in the field) and when you are expected to be back. It would be helpful to add to this information which vehicle you are using (license plate) and which boat you are using (license number).This rule needs to be observed especially for sampling in remote areas, in areas without cell phone coverage, and for night-time sampling.
- Bring the SFEI field phone or a phone that you can be reached at and keep it on at all times.
- You should not go out in the field alone.
- Prior to commencing field work, discuss the work to be conducted with field staff on-site, the potential work hazards, assure that field staff are wearing or using appropriate

protective gear, and make all field staff aware of emergency contact information and the first aid kit.

- At the site, initiate steps necessary to abate hazardous conditions promptly.
- Any accident, incident, or "near miss," no matter how slight the injury or damage, must be reported to the department supervisor immediately for appropriate action.
- The supervisor is responsible for taking appropriate follow-up action, including getting medical attention for the injured, completing an incident report (to be filed with HR and the Safety Officer) and recommending or implementing appropriate corrective actions.
- The primary purpose of the accident report is to identify the cause(s) of the accident, incident or "near miss" and take action to prevent a similar occurrence in the future. Additionally, it will provide a record for future reference in case of delayed medical needs or injuries. The form is located in S:\SFEI\SFEI SOPs\Safety.
- Emergency Response Numbers for Contra Costa County

Emergency Calls Only	**911**
Police	510-620-6655
Fire	925-933-1313
Poison Control	800-222-1222
Hazardous Materials	925-313-6587
SFEI staff:	
Anna de Lopex	510-746-7334
Meredith Lofthouse	510-746-7357

The field supervisor should provide each field worker with a description of the project, including the general location where work will be conducted, the anticipated weather, the tasks to be performed, and the specific clothes and gear the field worker must supply. The location of the first aid kit, cell phones (or nearest phone if there is no mobile phone reception), and emergency numbers need to be identified before field work starts.
The field supervisor should be trained in first aid and CPR.

Field Safety Equipment

Safety kits are required to be taken on each field trip that involves site reconnaissance or sampling. Each safety kit is equipped with a first aid kit, a rescue rope tied to a wooden bar, triclosan-free soap, a rescue blanket, and a copy of the field safety binder. Additionally, safety goggles, eyewash, gloves, disposable masks, sunscreen and insect repellent are provided in the field kit.

The rescue rope needs to be rolled up and stored in the safety bag neatly and dry (use Velcro straps if available). Otherwise it will get tangled up and will be of no use in an emergency situation. The bar can be thrown to a person that is in danger and pulled either by throwing the bowline at the other end of the rope over the truck hitch or around the rescuer's waist. The bowline knot makes a secure loop and will not slip.

Safety goggles and surgical masks should be worn on windy, dusty days working next to farm fields, especially when pesticide application is in process or has just finished (protection from spray drift and San Joaquin Fever).

Antibacterial soap should be used for cleaning hands in the field after sampling and before eating and drinking. If a bathroom is available, regular soap will work for removing pathogens and germs. Never drink untreated water and exercise caution to avoid contact with contaminated water or soil borne parasites (Giardia, tapeworms, etc.).

If a person has been exposed to water by slipping, falling, or flooded waders or shows in general signs of hypothermia, use the rescue blanket to wrap tightly around the body. It will assist in preserving the body temperature and prevent further loss of body heat.

Headlight can be used for nighttime sampling.

Driver Safety Policy

Every person using the SFEI truck has to be employed by SFEI and added to the list of employees covered through the SFEI insurance by Linda Russio. She takes care of this as soon as a person is added to SFEI staff, including paid interns. Unpaid interns and volunteers are not allowed to drive the truck.

In the event of an accident, make sure you and your passengers are okay first and move to a safe location. Seek help from a police officer and dial 911 if you require emergency services.

Things to remember:

- It is difficult to see out of the rear window of the truck with the top being permanently installed on the truck bed. The use of both side mirrors is necessary.

- The truck has a boat hitch attached in the back. Backing up and parking the truck leaves less space than it may appear from the driver's seat.

- Do not drive when you are drowsy, intoxicated, or are taking prescription medication that may affect your performance.

- Use caution when sampling in areas with high vehicular traffic. Use vests and cones when needed, and safely park your vehicle.

Fieldwork on or near navigable waterways

The Longshoremen and Harbor Workers Compensation Act or "LHWCA" is a statutory worker's compensation that covers certain maritime workers, including most dock workers and maritime workers not otherwise covered. In addition, Congress has extended the LHWCA to cover all employees who work on or near navigable waterways. Please remember to log the time you spend working close to or on navigable waters. The full definition is below.

The term "navigable waters" of the United States means "navigable waters" as defined in section 502(7) of the Federal Water Pollution Control Act (FWPCA), and includes:

(1) all navigable waters of the United States, as defined in judicial decisions prior to the passage of the 1972 Amendments of the FWPCA, also known as the Clean Water Act (CWA), and tributaries of such waters as;

(2) interstate waters;

(3) intrastate lakes, rivers, and streams which are utilized by interstate travelers for recreational or other purposes; and

(4) intrastate lakes, rivers, and streams from which fish or shellfish are taken and sold in interstate commerce.

Please log your work hours in the shared Google document and include a photo of the site on the S-drive.
https://docs.google.com/a/sfei.org/spreadsheet/ccc?key=0AtGyLFptyaxVdGtMbjdqYzdQOXZ3M1YzOFQ4SWE1dGc&usp=drive_web#gid=0

To log the portion of our field time that falls under this LHWCA appropriately, we interpret the term navigable waterway as any waterway (i.e.: river, bay, ocean) connecting to oceans, even if seasonally dry. Interstate waterways such as Lake Tahoe are covered under LHWCA. However most lakes and ponds, not immediately connected to an ocean, are not covered under LHWCA. If in doubt, please discuss with Nicole David.

Handling of Heavy Equipment

Heavy equipment is involved in many SFEI projects. The better you know the piece of equipment you are transporting or setting up, the easier handling will be.

Things to remember:

- Familiarize yourself with the equipment so you know which way to set it up, transport, or store it before you start lifting it.
- Do not handle heavy equipment when you are drowsy, intoxicated, or are taking prescription medication that may affect your performance.
- Do not stand on, or place yourself in, under, or directly adjacent to heavy equipment when it is set up or operating.
- Always lift with a straight back. Your feet should be about shoulder wide apart when lifting to give you the most stability.
- Avoid twisting at waste while lifting heavy equipment

- Set up work operations as ergonomically safe as practical.
- Ask for help when equipment seems too heavy to be lifted by one person.
- Wear proper hand and foot protection to prevent pinching or crushing injuries.

Fall Protection

Thinking about fall hazards before the work begins will help to manage fall hazards and focus attention on prevention efforts. If personal fall protection systems are used, particular attention should be given to identifying attachment points and to ensuring that employees know how to properly set and inspect the equipment.

Extra caution is required for stepping and walking on slippery surfaces (wet rocks, wet wood, surfaces covered by algae, mud, etc.). Appropriate, slip-resistant foot wear should be worn at all times when working on or around slippery surfaces.

Working on and around stairways and ladders is hazardous.
The following rules apply to *all ladders*:

- Maintain ladders free of oil, grease and other slipping hazards.
- Do not load ladders beyond their maximum intended load nor beyond their manufacturer's rated capacity.
- Use ladders only for their designed purpose.
- Use ladders only on stable and level surfaces unless secured to prevent accidental movement.
- Do not use ladders on slippery surfaces unless secured or provided with slip-resistant feet to prevent accidental movement. Do not use slip-resistant feet as a substitute for exercising care when placing, lashing or holding a ladder upon slippery surfaces.
- Keep areas clear around the top and bottom of ladders.
- Do not move, shift or extend ladders while in use.
- Use ladders equipped with nonconductive side rails if the worker or the ladder could contact exposed energized electrical equipment.
- Face the ladder when moving up or down.
- Use at least one hand to grasp the ladder when climbing.
- Do not carry objects or loads that could cause loss of balance and falling.

Handling of Boats and Boating Equipment (inc., photos for transport)

General boat safety recommendations

Avoid slipping and falling by being aware of conditions (icy, wet, etc.) and wearing slip resistant shoes. Keep at least one foot on deck at all times. Hold on to handrails or boats when moving around and hand off equipment before boarding or de-boarding. Use caution with hand and foot placement to avoid injuries through moving objects. Secure and tie down all objects properly. Keep hands and feet clear of the anchor line and brace for any sudden movement.

If you are concerned about sea sickness and are likely affected by drowsiness from sea sickness medication try ginger. Some doctors recommend that you take it 12-24 hours before, as preventing sea sickness is easier than curing it. Somewhere from 1 gram up to 4 grams per day of powdered ginger is recommended.

- Get an up-to-date weather forecast for the area where you plan to boat and obtain charts for waterways and tides.

  Weather http://www.nws.noaa.gov/
  Waterway Charts http://www.nauticalcharts.noaa.gov/mcd/Raster/
  Tides http://tbone.biol.sc.edu/tide/sites_uswest.html or http://tidesandcurrents.noaa.gov/ports.html
  Local Notices to Mariners (obstructions etc.) http://www.navcen.uscg.gov/Lnm/d11/default.htm
  Explanations for nautical charts are found in ***Chart 1*** on file cabinet outside Nicole's office downstairs
- File your Float Plan with Admin (Located in: S:\SFEI SOPs\Safety\Float Plan)
- Contact appropriate officials if working in navigation lanes or near bridges.
- Be aware of surroundings, have methods to warn oncoming boats if needed.
- Verify load limits of boat or vessel and weight of equipment to be loaded.
- Secure all gear firmly for boat transport and on the water.
- Bring boat box with flotation devices, emergency flares and sound producing device.
- Bring water proof bags for cell phones, marine radios, cameras, etc.
- Bring paddles/oars, throwable flotation and mooring lines.
- When fueling, do not lean directly over nozzle and use splashguard on nozzle if necessary. Do not top off. Always fill the gas can on the ground, never in the boat.

Boat Safety Instructions (metal dinghy)

This metal boat is strapped to a trailer which is then pulled by another vehicle. There are certain safety procedures to follow both in and out of the water.

a. Make certain that the boat is securely fastened to the trailer.
   i. There is one cinch strap that attaches to the trailer and is tightened perpendicular to the length of the boat. Make sure the strap is attached

to the trailer on both sides and that the metal fastener pulls the strap taught.

ii. There are 2 other cinch straps that attach the boat to the front end of the trailer. Make certain the cinch is tight and secure.

b. Make certain that the trailer is attached correctly to the vehicle.

i. Unlock the padlock and open the tow pin. Use the hand crank on the trailer to raise the trailer up high enough to fit over the truck hitch. Lower the trailer onto the tow hitch – you may have to pick up the trailer and drop it onto the hitch to make sure the trailer is securely on. Close the tow pin and relock the padlock.

ii. Plug the electrical lines on the trailer into the receiver on the truck. Check truck and trailer turn signals and brake lights.

iii. Don't leave anything in the boat or on the trailer that is not attached during transport.

c. Preparation for boating

iv. Make sure the drain plug is firmly in place – otherwise the boat will fill with water.

v. Be careful when lifting the boat engine into/out of the truck and on/off the boat. This is very heavy and awkward and could cause injury. If you don't feel that you're able to lift the motor – seek assistance. The engine carrier can be taken in the truck and used to transport the engine from the truck to the boat.

vi. Make sure the engine lies on the correct side when put into the truck – oil will leak out if engine lies on the wrong side. The engine is marked with 'this side up'.

vii. Make sure the gas canister valve is slightly open when transporting the canister in a closed space. Heating of the canister will cause it to expand. If the valve is completely tight, increased pressure will force gasoline to spill.

d. Launching the boat

i. Make certain all boat cinch straps are off before boat is backed into the water.

ii. Disconnect trailer lights from the towing vehicle

iii. Make certain that the engine is mounted at an angle and locked in place. Be careful when pulling the engine up and locking it that you don't get your fingers caught. When on shore, it is best to push the engine up and lock it from behind. When you're in the water you will have to pull the engine up and lock it when you pull the boat out of the water. Do not leave the engine in the vertical operating position when taking the boat in and out of the water. The propeller will drag along the ground if it is not lifted to an angle.

iv. Make sure the drain plug is placed in the drain hole.

v. Don't stand behind the boat when the boat is being backed down the launch ramp. The driver can't see that area as the boat is lowered.

vi. Once the boat is in the water slowly release the boat into the water using the winch. To use the winch hold tightly to the crank and release the winch brake. Let the winch out counterclockwise holding firm. To bring the boat back onto the trailer rotate the crank clockwise.

vii. Make certain you are holding the line to the boat when the boat is released into the water.

viii. Every person in the boat must wear personal flotation devices (PFDs) at all times.

ix. Make certain that the accelerator is on low when you start the engine. The engine must be in neutral when starting up – the engine will not start if the boat is in gear. The choke must also be pulled out when first starting the engine. Push the choke back in after engine is running. The valve on the gas canister must be closed when starting the engine – pressure is needed to create a vacuum.

x. Observe speed limits and go slowly when near boat traffic, docked boats, and shallow areas. No wake is allowed near docks and docked boats

xi. When motoring near tidal marsh or other wetlands, keep wake to a minimum. The wake can erode channel banks. This is a rule on many state and federal properties.

e. Retrieving the Boat

i. Back the trailer into the water so that approximately two-thirds of the rollers or bunks are submerged in the water. Set the parking brake of the towing vehicle and put it into park (or first gear for manual transmission).

ii. Drive boat onto the trailer far enough so that the winch line can be attached to the bow eye of the boat. Finish pulling the boat onto the trailer by cranking the winch.

iii. The strap or cable needs to be in excellent condition without any kinks or frays.

iv. Make sure no one is in direct line with the cable or strap in case it brakes or snaps back. If the winch is hand-cranked, be sure the ratchet is engaged. A runaway winch handle can break bones.

v. Shut off the engine and raise the outboard.

vi. While still at the landing remove and dispose of all weeds from the boat, anchor, and lines.

vii. Remove the drain plug and release bilge water.

viii. Reattach tie-downs and plug in the trailer lights. Checl light before departing.

Boating Safety Checklist
(one in each boat box)

Each time SFEI staff take out the motor boat, the lead boat person should be in charge of ensuring that everything on this list has been checked. **Only staff with boating experience who have taken a boating class can be the lead boat person.**

Items to bring in the boat

☐ Printout of tides, weather (including wind), and waterway charts for the day

☐ Boat bag (in storage room next to garage) including

- ☐ Fully charged marine radio
- ☐ acoustic and visual emergency signaling devices (flares, horn, and flag)
- ☐ navigation lights and spot light

    - small toolkit
    - extra boat plug
    - distress signals (laminated sheet)
    - waterproof small bags for phones and radios
    - extra oil for boat engine
    - bailer

- ☐ Life vests (in storage room next to garage) – one for every person
- ☐ Throwable floatation device (rescue cushion)
- ☐ Oars – at least two
- ☐ Anchor with rope attached
- ☐ Rope for tying the boat
- ☐ Stake to secure the boat in muddy areas
- ☐ Safety kit
- ☐ Stow any electrical equipment in waterproof bags (GPS, radios, phones, computers, etc.)
- ☐ Extra water for emergencies

<u>Towing the boat with the truck</u>

- ☐ The two front and one rear boat strap are securely fastened to the trailer
- ☐ Chains are fastened and crossing each other
- ☐ Hitch is securely fastened
- ☐ Winch hook is fastened
- ☐ Trailer support front wheel is in a horizontal position
- ☐ Trailer lights function after connecting the electrical wires to the truck

<u>Motor</u>

- ☐ Gas can has enough gas (Always remove portable tanks from boat or vehicle when filling them; they must be grounded)

☐ Gas can is vented during storage and closed during transportation, only occasionally purged during longer rides but then closed again

☐ Battery (needs to be tight down to wooden board); connect red cable first, then black

<u>Starting your trip on the water</u>

☐ Boat plug is in the boat

☐ Engine in neutral

☐ Throttle out or partly out

☐ Gas connected and gas bulb pumped

☐ Safety lock in and clip attached to boat operator

For more information on how to attach the boat trailer to the truck (including images), please check the Safety Manual for SFEI Field Work located in S:\SFEI SOPs\Safety

<u>Electrical Motor</u>

Charging

- Always make sure battery is fully charged prior to going out in the field
- Use grounding wire when charging
- Make sure charger is not plugged in when attaching or removing the battery leads
- Place battery on piece of wood to elevate off of cement (otherwise it will not retain its charge)

Use

- Make sure motor is tightly attached to motor mount
- Make sure handle is pointing to neutral/off (no numbers) prior to attaching battery – attaching the battery is the on switch
- Avoid laying saltwater soaked material (such as nets) across battery – you will get shocked
- Adjust up/down height of motor to avoid hitting rocks/sediment
- If you do hit something turn handle to off, raise motor or paddle away from obstruction, attempt to use motor again
- If wind is to your back consider if you will be able to make it back with a head wind
- Remember that winds tend to pick up in the afternoon
- Always bring paddles

General

- The battery is very heavy, be sensible when carrying and don't hurt yourself
- Rest motor on either side when transporting/storing, be conscious of where blades are and avoid putting weight on them

Carbon monoxide (CO)

- Carbon monoxide (CO) is a colorless, odorless, and tasteless gas
- Exposure to CO is harmful
- Symptoms include headache, irritated eyes, nausea, dizziness
- If you can smell engine exhaust, you are inhaling CO
- Stay off the back deck while the engines are running
- Do not confuse CO poisoning with seasickness and treat people rather for CO poisoning when in doubt
- Get the person affected by CO poisining into fresh air immediately

Navigation

Navigation Rules

When operating a power-driven vessel, you must give way to

- any vessel not under command
- any vessel restricted in its ability to maneuver (towing, conducting work on the water, etc.)
- a vessel engaged in commercial fishing
- a sailing vessel
-

Navigation Lights

- Positioning lights: Front: green-starboard (right); red-port (left)
- All-around white light in the back.
  When anchored at night, all around white light. No day signals necessary if anchored away from shipping traffic.
- Yellow-indicates towing, stay away as far as possible. Big freighters can be towed with lines that are over 1 mi long.
- Use lights and fog horn in restricted visibility and reduce speed.
- Sound warning signals: 1 prolonged blast (5-6 sec) when coming around a blind bend, in thick fog etc. Five or more, short, rapid blasts (1-2 sec) are used to signal danger or to signal that you do not understand the other boater's intentions.

Marine Radios

VHF (very high frequency) marine radios have channels reserved for distress calls that are continuously monitored.

Channel 16: International Distress, Safety and Calling for recreational boat traffic.
Channel 9: Is back-up for Channel 16, if Channel 16 is silenced (Silence Mayday means stop talking on this channel, Channel can only be used by vessel in distress or coast guard) Silence Fini means that the distress communication is over and channel can be used again.

For ordinary communication switch to a non-commercial channel (Channel 68, 69, 71, 72, or 78) and use while on the water only.

Distress Signals

Mayday – Immediate danger
Pan Pan – Threat, but not immediate danger
Securite – Indicates a message about safety, hazards, and obstacles

Repeat distress signal and identification three times, for instance,
"MAYDAY, MAYDAY, MAYDAY, this is Johnboat, Johnboat, Johnboat. MAYDAY, Johnboat. Position 54 25 North 016 33 West. My boat is on fire and sinking. I require immediate assistance. 3 people on board, are taking PFDs and go overboard. OVER."

Also, call name of ship three times to establish contact, for instance,
"Melody, Melody, Melody, this is Johnboat, Johnboat, Johnboat. I am anchored 500 meters ahead of you and need to confirm that you can see me."

Channel 22: Coast Guard. In a non-life threatening emergency coast guard can pass on message for help or could be asked for assistence.
Vessel Assist will charge high fee for towing or other assistence.

Check in with Harbor Master before leaving the marina and check if they are monitoring a specific channel that you could get help on, in case of an emergency.

You can get immediate weather updates through the VHF radio. Just press the weather button "WX".

Wind

- Wind impact depends on tides, water depth, and weather your boat is upwind or downwind.
- In SF Bay when winds come in the afternoon and the tide is going out, dangerous vertical waves are created.
- In shallow waters winds create higher waves. Less max wind speed can endanger the boat trip.
- South winds in the Bay Area predict big storms.
- If winds blow overnight, sampling should not be conducted by boat the following day.

Boating Emergencies

How to prevent boating emergencies:

- The glare, heat, direct sun, motion, noise, and vibration you experience on a boat will make you tired faster than you will expect. Do not underestimate the effects of these stressor to your ability to operate a boat safely.
- Drink plenty of water before you go out and while you are on the water to minimize boater fatigue and dehydration.
- Wear PFDs at all times.
- Never drink alcohol while on the boat.

Man overboard:

- Do not move around while the boat is in transit. Do not sit on the gunwale (upper edge of the hull). Do not lean out from boat.
- If someone falls overboard, immediately shout "Man overboard" to make everybody aware of the situation. Reduce speed. Throw the floatable cushion to the victim. Turn boat around and pull aside of victim, approaching victim from downwind. Switch to neutral or turn off engine if situation allows it. Pull victim into boat over stern while balancing the boat.

Swamping the Boat:

- Turn boat at controlled speeds. Balance the load of gear and passengers and do not overload your boat. Avoid extreme weather.
- If you swamp or capsize your boat, stay with the boat. It will signal distress to others and give you support. Try to get as much of your body as possible out of the water, climb on the bottom of the overturned boat. If the boat sinks, try to hold on to other floating things for support. Huddling with other people in the water lessens the loss of body heat and is good for morale.

Collisions:

- Pay attention to navigational aids. Keep sharp lookout and appoint a person to maintain a lookout. Be aware that floating debris is more common after heavy rainfall.
- In case of a collision, check the condition of your crew and the occupants of the other boat. Immediately apply first aid if there are any injuries.
- Call to nearby boats for help and to the Coast Guard by VHF radio.
- Make necessary emergency repairs if possible.

Running Aground:

- Knowing your boating area is the best way to prevent running aground. Check local Notion to Mariners (see general boat safety recommendations).
- If you run aground, check the hull. Hitting an object can crack or puncture the hull. With a hole in the hull it is better to be aground than afloat so do not more the boat when it is stuck until you take corrective action. Tilt outboard motors up and do not run engines. Wear PFDs and have safety lines ready when attempting any freeing maneuvers. Try to free the boat by rocking it from side to side or wait for a rising tide. Call for help from another boat or the Coast Guard. Another boat could free your boat by creating a wake that could lift you up.

Fire:

- Maintain the fuel system to avoid leaks. Follow safe fueling procedures.
- If a fire erupts while the boat is underway, move crew to an unaffected area, usually toward the wind. Turn off engine and disconnect all sources of electrical power. Cut battery cables (cut closer to battery where the cable is split, do not cut cables together; black one first, then red). Identify the source of the fire and if available, use a dry chemical extinguisher. Unless you are certain that you can put out the fire, get everybody off the boat and as far away as possible.
- If you use a fire extinguisher, hold it upright and point the extinguisher at the base of the fire, sweep from side to side.

Other Field Equipment

High-capacity lead acid battery safety and use

The lead acid battery is an accepted source of reliable DC electricity used for powering many types of equipment used within our SFEI field applications. Most people are familiar with this battery and its use for starting and running the electrical components of standard passenger and commercial vehicles. It is a relatively old invention with no major technological advancement in more than 50 years. Lead acid batteries, when handled appropriately, are relatively safe devices. This SOP outlines the main aspects of safety and care around the transport and use of lead acid batteries specifically, but some of the considerations outlined are applicable to other kinds of batteries.

Product information

General description:	Lead acid battery wet, filled with sulfuric acid
Weight:	>30 lbs not uncommon

Hazards and precautions

Hazards:	Contact with internal components may cause irritation or severe burns to eyes, respiratory system, and skin.
Precautions:	Improper lifting could result in back pain or damage to knees or feet if dropped. Keep out of reach of children. Keep containers tightly closed. Avoid heat, sparks, and open flame while charging. Avoid contact with internal battery acid. Short circuiting (forming a circuit between the two terminals unintentionally) could result in severe heat buildup, explosion, or fire. Be sure to ground yourself before handling battery, and to touch metal to eliminate static charge before handling. Secure overhanging wires away from battery.

Medical first aid

Eye contact:	Flush eyes with large amounts of water for at least 15 minutes. Seek immediate medical attention if eyes have been exposed directly to acid.
Skin contact:	Flush affected area(s) with large amounts of water using deluge emergency shower, if available, shower for at least 15 minutes. Remove contaminated clothing. If symptoms persist, seek medical attention.
Ingestion:	If swallowed, give large amounts of water. Do NOT induce vomiting or aspiration into the lungs may occur and can cause permanent injury or death.
Inhalation:	If breathing difficulties develop, move person to fresh air and seek medical attention.

Firefighting measures and spill containment

Extinguishing media: Dry chemical, carbon dioxide, or foam. Do not use water on live electrical circuits or if the battery casing is cracked open and leaking acid.

Firefighting procedures: Use appropriate media for surrounding fire. Do not use carbon dioxide directly on cells. Avoid breathing vapors. Use full protective equipment (bunker gear) and self-contained breathing apparatus.

Unusual hazards: Batteries evolve flammable hydrogen gas during charging and may increase fire risk in poorly ventilated areas near sparks, excessive heat or open flames.

Specific fire hazards: Thermal shock may cause battery case to crack open. Containers may explode when heated.

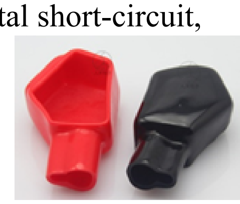
Spill cleanup: Add neutralizer/absorbent to spill area. Sweep or shovel spilled material and absorbent and place in approved container. Dispose of any non-recyclable materials in accordance with local, state, or federal regulations.

Safe handling: Keep containers tightly closed when not in use. If battery case is broken, avoid contact with internal components. Do not handle near heat, sparks, or open flames. Protect containers from physical damage to avoid leaks and spills. Place cardboard between layers of stacked batteries to avoid damage and short circuits. Do not allow conductive material to touch the battery terminals. A dangerous short-circuit may occur and cause battery failure and fire.

Safe transport and proper use

Safe transport: Battery should be placed in an insulating, sturdy plastic (see example to the right) or wooden carry case during transportation; staking over objects on top of the battery enclosure is not advised. Be sure to secure the lid to ensure that the battery remains fully enclosed inside the insulated box during transportation. Failure to do so could result in accidental short-circuit, battery failure, and/or fire.

Proper use: When connecting equipment to a lead acid battery (or any kind of high capacity battery), the standard practice is to ensure that the negative connection (black or blue and/or labeled (-)) is installed first followed by the positive connection (red and/or labeled (+)). Ideally the positive connection would have a plastic insulating cover (examples to the right) installed to reduce the chance of accidental short-circuit during operation. Disconnection would normally occur positive followed by negative.



Handling of Beach Seine and Nets

The following safety and environmental precautions should be taken when conducting beach seining or sampling in the field with minnow traps, or other procedures for netting fish:

1. General prevention of risks:
    a. Keep cell phones charged and handy
    b. Bring contact info of local rangers and SFEI phone list to consult by phone if questions arise
    c. Bring maps and GPS units
    d. Have three crew members (two to seine and one on shore) whenever feasible
    e. Inform local rangers when entering seining site
    f. Do not drive on levees or other slick roads to access seine sites if there is risk of rain causing roads to become impassable. Consult with local rangers regarding conditions.
    g. If thunderstorms begin, leave the water and stay away from electrocution risk.
2. Avoiding physical injury in rugged field conditions
    a. Care should be taken while walking/swimming in rugged terrain.
    b. Hazards to watch out for include potholes, drainage ditches, metal or glass objects, strong currents, or trip/fall hazards such as stumps
    c. Taking care and/or possibly using work gloves when handling metal parts, such as in minnow traps and repairing or disposing of damaged traps with exposed metal.
3. Proper protection against fish and sediment-associated pollutants and pathogens:
    a. Wearing chest waders
    b. Sanitizing hands or washing with water before/after eating
    c. General caution regarding the potential for infection after exposure to fish – e.g., if poked by fish spines or teeth, observe the exposed area for infection. If rapidly spreading pain/swelling occur, it may be necessary to receive urgent health care treatment.
    d. In highly contaminated locations, such as superfund sites, it may be appropriate to wear plastic gloves while conducting fieldwork
4. Beach seining often involves physical stress and potentially exhausting conditions. Avoid health risks from exposure to the elements in these conditions. The following precautions should be taken:
    a. Sufficient hydration to avoid dehydration, heat exhaustion
    b. Bring plenty of layers and changes of clothing to avoid hypothermia and/or common cold
    c. Hat/sunglasses for sun protection
    d. Consider taking a rest or a short nap before returning from the field or while on the road if there is any risk of unsafe driving due to exhaustion. Discuss with crewmembers who is least tired, and most able to operate vehicles.
5. In many circumstances, rising tides may render it necessary to swim for short stints. All those going to locations where swimming may be required should be able to swim or have high quality personal flotation devices handy.

6. Caution is warranted for the risk of transferring invasive species when traveling among sites.
    a. Rinse off seines, buckets, traps, and other exposed equipment in the water body before departing from the site.
    b. Physically remove vegetation, mud clumps, and invertebrate shells between sampling locations.
    c. Prior to sampling a new water body, and after each project is completed, thoroughly wash and dry the truck, boat, and all seining equipment.

Things to remember:
- Make sure all those seining can swim or are wearing a PFD, if they can't.
- Have the safety rope ready to throw to someone stuck in the mud.
- Always work in pairs or > 2 people, keeping an eye on anyone in the mud or the water.
- Know the tide predictions that day – don't get caught in a bad situation by the tide!
- Teach novices how to get out of the mud when stuck (break suction by lifting heel).
- Wet nets are heavy. Ask for help, if needed, to carry them.
- Pull in net with bent knees and contracted abdominal muscles to protect your back.

Handling of Van Veen and Petite Ponar Grab

Inspect the sampler to insure all parts are in good working condition and that the unit is securely fastened to the line. DO NOT HANDLE OR MOVE PONAR GRAB UNLESS THE SAFETY PIN IS FULLY PUSHED ONTO THE LOCKING HOLES. Severe injury to fingers or hands can be caused by movement of the lever arms. To insert the safety pin lock keep clear of the jaws and other working edges. Move the jaws to the open position. Bring the free end of the horizontal locking bar into position in the locking notch on the upper bar. Push the safety pin through both locking holes.

Be sure you are able to keep the boat in proper balance at all times. Wear your life west. Lifting the Petite Ponar into the boat, dumping its contents, and washing the contents may require leaning over the side of the boat.

Loop you rope through the clevis at the top center of the lever arms and tie securely. Strong, tight knots are essential for operator safety and to prevent losing the sampler.

Due to its weight, a winch is supposed to be used with the Van Veen (41 lbs). The Petite Ponar (24 lbs) can be operated by hand. (Always pull up Petite Ponar with bent knees using leg muscles, keep back straight.). To prevent loss of sampler attach the free end of the rope to the boat or the sampling platform for easy recovery.

Just before lowering the grab into the water, hold the rope tightly (no slack) and remove the safety pin so that the closing mechanism will release when the sampler is on the bottom. Firmly push the pinch pin in place. As long as the rope is taut, the pinch pin will stay in place. When the line becomes slack, the pinch pin spring will pop out of the lever arm holes, allowing the scoops to close.

When the grab reaches the bottom, allow the rope to slack, allowing the closing motion of the jaws. By slowly pulling the rope tight again, the lever arms will force the scoops to close completely before the grab is lifted.

When the grab reaches the surface, swing it inboard to a position over a tub to receive the sample. Stay clear of the edges of the grab jaws, open the sampler and discharge the sample into the tub.

At the end of the sampling operation replace the safety pin to prevent accidental closing of the grab jaws during handling or transport. Then wash and inspect the grab and make necessary repairs and adjustments in preparation for next use.

Handling of Peristaltic Pump

Never apply AC voltages directly to the external power inout receptacle on the front panel. The application of AC voltages can result in injury and death of the operator and destruction of the unit. Use only the AC/DC Power Supply/Converter supplied with the unit to power unit from an AC source.
Never short or connect the terminals of the battery terminals together. Shorting of the battery terminals causes rapid internal heating of the battery resulting in the explosion of the battery and severe injury to or the death of the operator.
The AC/DC Power Supply/Converter is rated for indoor use only. Do not use the AC/DC Power Supply/Converter in an outdoor environment to either charge the battery or power the drive. Electrical shock, severe injury and/or death are possible.

Tubing breakage may result in fluid being sprayed from the pump. Use appropriate measures to protect the operator and equipment.
Turn drive off, remove all the power to the unit, including the AC/DC Power Supply/Converter, Automotive Power Adapter or other external power source if present before removing or installing pump head or tubing. Place the Mode of Operation Switch (RUN/CHARGE) in the “CHARGE” position and all other switches in the off position. This will help prevent accidental activation of the drive mechanism so fingers or loose clothing will not get caught in the pump drive mechanism.

Handling of Field Meters

This operating manual of all field meters contains basic instructions that you must follow during the commissioning, operation and maintenance of the measuring instruments. Consequently, all staff leading field work should have read the operating manuals before working with these measuring systems.

The housing components of filed meters are made out of synthetic materials (polyurethane, ABS and PMMA). Thus, avoid contact with acetone and similar detergents that contain solvents. Remove any splashes immediately.

Note that the RS232 interface is not galvanically isolated.
When connecting an earthed PC/printer, measurements cannot be performed in earthed media as incorrect values would result.

Handling of Hach 2100P Turbidimeter
Handling chemical samples, standards, and reagents can be dangerous. Review the necessary Material Safety Data Sheets and become familiar with all safety procedures before handling any chemicals.
Reagents used for calibration for the Hach 2100P turbidimeter include formazin, hexamethylenetetramine, and hydrazine sulfate.

D95/Winch/Four wheel boom truck

- Always work with someone that has experience setting up and sampling with the D95 sampler. This equipment is very heavy, awkward, and is often used in wet/dark conditions. Use caution when working with the equipment.
- Make sure that the sampling location is safe from traffic, has sufficient lighting, and has a railing. If possible, set up on the upstream side of a bridge, so that you can see any debris floating downstream that may get caught in the equipment.
- The biggest hazard in setting up the equipment is pinching fingers. Work slowly and deliberately, and consider wearing heavy work gloves if you are unfamiliar with the equipment. Use proper technique or use two people when lifting the fish or the weights.
- The biggest hazard in sampling with the equipment is getting caught in the reel, wire, or base. Never stand inside the base or on top of it, or inside the steering handles while sampling is occurring. Do not stand directly behind the equipment while sampling is occurring. Be cautious of floating debris potentially getting caught on the fish while it is in the river. Also use caution when adjusting the crane position (folded inside the railing, or extended outside the railing) and when lowering the fish.
- Only one person should operate the handles for lowering and lifting the fish at a time.

Nomad Portable Pressure Washer
The portable pressure washer is designed for cleaning sampling equipment and gear.

- Only use cold water for cleaning.
- Fill tank with water only and with filter in place.
- Be familiar with the controls and know how to bleed pressure quickly.
- Do not overreach or stand on unstable support while cleaning.
- Turn off all controls before unplugging.
- Using improper voltage may result in damage to the motor and possible injury to the user. Proper voltage is listed on the cleaner plate.
- Do not spray at flammable or combustible liquids, such as gasoline, or use in areas where they may be present.
- Do not direct water jet toward the unit itself, electrical parts, or other electrical equipment.
- Discharge residual pressure before disconnecting the portable washer hose.
- Never submerse the machine in water.

Nomad Pressure Washer Charger

- Do not charge outdoors or exposed to wet or damp conditions.
- Keep cord and charger from heat t prevent damage to housing or internal parts.
- An extension cord should not be used.
- Do not operate charger if it has received a sharp blow, been dropped, or otherwise damaged in any way.

Nomad Pressure Washer Battery Pack

- When battery pack is not in use, keep away from other metal objects like: paper clips, coins, keys, nails, screws, or other metal objects that can make a connection from one terminal to the other.
- Do not use battery if it has been dropped.
- Batteries can explode in the presence of a source of ignition, such as a pilot light. An exploded battery can propel debris and chemicals. If exposed, flush with water immediately.
- Do not charge battery in damp or wet location.

Storage of Equipment

- All equipment used in the filed has to be cleaned and stored properly upon return to SFEI.
- Do not leave equipment outside or blocking walkways or hallways.
- Keep field equipment from blocking aisles in garage to prevent injury through tripping and falling.
- Keep painted rectangle in front of flammable cabinet in garage clear at all times.

Electrical Equipment and Water

The major hazards associated with electricity are electrical shock and fire. Electrical shock occurs when the body becomes part of the electric circuit, either when an individual comes in contact with both wires of an electrical circuit, one wire of an energized circuit and the ground, or a metallic part that has become energized by contact with an electrical conductor.

The severity and effects of an electrical shock depend on a number of factors, such as the pathway through the body, the amount of current, the length of time of the exposure, and whether the skin is wet or dry. Water is a great conductor of electricity, allowing current to flow more easily in wet conditions and through wet skin. The effect of the shock may range from a slight tingle to severe burns to cardiac arrest.

Electrical equipment exposed to water can be extremely dangerous if reenergized without proper reconditioning or replacement. It can lead to the destruction of the equipment and severe injury or death of the operator.

Handling of Chemicals that are taken into the Field

The same general safety considerations that are applied to indoor laboratories must also be applied to field research activities (fieldwork). However, specific unpredictable and unavoidable hazards do exist in the field that are not encountered in indoor laboratories. Recognizing the inherent hazards associated with field research and practicing good judgment can aid in preventing injuries and illnesses.

Gloves and protective eye gear should be worn at all times when handling chemicals. Check that all open wounds and skin breaks are covered before you put on gloves. Check for any holes or tears and discard gloves that are defect

Label all chemicals that are taken outside the laboratory with the following information:
- Chemical name (written out in full, such as "50% nitric acid")
- Chemical type (corrosive, carcinogen, flammable, etc.)
- Date opened or created

Chemicals:
Ethanol: Ethanol is used for bioassessment sample preservation in the field.
Keep away from heat, sparks, and flame. Store in a tightly closed container. Containers larger than 4L (1 gallon) should be stored inside a deep pan or other secondary containment. Do not store near perchlorates, peroxides, chromic acid or nitric acid. Always wash hands thoroughly after using ethanol, even if gloves are worn.

Formaldehyde/Formalin: Used for long-term preservation of bioassessment samples.
Be sure that formaldehyde solutions are clearly labeled with the chemical's name and hazards. Containers larger than 4L (1 gallon) should be stored inside a deep pan or other secondary containment. As with any laboratory chemical, do not mouth pipette formaldehyde solutions. Do not eat, drink, or smoke where formaldehyde is handled, processed, or stored, since the chemical can be swallowed. Always wash hands thoroughly after using formaldehyde, even if gloves are worn.

Contact Lenses, Cosmetics, and Skin Ointments: Contact lenses, cosmetics, and ointments should not be worn when working with certain chemicals, including formaldehyde. Stay on the safe side and wear eyeglasses when working with chemicals in the lab or in the field. Similarly, cosmetics and other substances may trap chemical compounds from fumes or the air. Refrain from wearing cosmetics and similar topical skin products in the lab or in the field and be careful to wash your skin well if you have.

Emergency First Aid for Chemicals

- **Ingestion:** Get immediate emergency medical assistance. Give large quantities of water. Never induce vomiting or give anything by mouth to a victim who is unconscious or having convulsions.

- **Eye contact:** Rinse with copious amounts of water for at least 15 minutes. Get emergency medical assistance.

- **Skin contact**: Flush thoroughly with water for at least 15 minutes. Remove contaminated clothes and shoes. Wash clothing before reuse. Discard contaminated shoes. Get emergency medical assistance.

- **Inhalation:** Immediately remove person to fresh air. If breathing is difficult, give oxygen. If not breathing, give artificial respiration. Keep patient warm and at rest. Get emergency medical assistance.

Chemicals that are used for Cleaning of Equipment

Cleaning of equipment using chemicals should be performed in secondary containment to minimize chance of spills.

Methanol: Methanol is used for cleaning of the sample pump tubing. Methanol is circulated through the tubing and pumped back into the container for two minutes. After five cleaning processes, the used methanol will be discarded and collected as needed by Advanced Chemical Transport for proper disposal. When the methanol is not used for cleaning, containers are tightly sealed in a cabinet for flammable chemicals.

HCL: A 10% hydrochloric acid is used to clean sediment sampling equipment.

Chemical Waste Disposal

Formalin: Waste formalin should be transferred to glass receptacle for disposal in a well-ventilated area, preferably under the ventilation hood in the lab. Receptacles should be large enough to store waste and any dilution required, and labeled with SFEI contact information, chemical name, date created, and approximate concentration.
Methanol: Waste methanol should be transferred to container or glass or non-chlorinated waste solvent receptacle for disposal. Receptacles should be large enough to store waste and any dilution required, and labeled with SFEI contact information, chemical name, date created, and approximate concentration.

HCL: Waste HCL should be transferred to glass receptacle for disposal in a well-ventilated area, preferably under the ventilation hood in the lab. Receptacles should be large enough to store waste and any dilution required, and labeled with SFEI contact information, chemical name, date created, and approximate concentration. If diluting, the acid should always be added slowly to water and in small amounts. Never use hot water and never add water to the acid. Water added to acid can cause uncontrolled boiling and splashing.

Once chemical wastes have been transferred to the appropriate receptacle, it should be placed in the waste disposal area to be discarded (see Linda Russio).

Material Safety Data Sheets (MSDS)

MSDS should be consulted prior to using any chemical in the lab. MSDS for each chemical can be found in the yellow binder located outside the lab. An MSDS should in all cases accompany the material to the sampling location.

Instructions for Chemical Spill

When in doubt of how to deal with any chemical spill, or when faced with large hazardous spill, the three steps of action should be 1) evacuate the location, 2) close the door or secure the area, and 3) call the Fire Department.

For small spills or exposures, consult the MSDS.

Hazardous Properties of Chemical Substances

Flammable/Ignitable
Reactive/Explosive
Corrosive
Toxic

Fire Extinguisher (PASS)

Pull pin
Aim at base of fire
Squeeze handle
Sweep side to side

Fire Classes: A (ordinary combustibles) – fire extinguisher or water
B (flammable liquids) – never use water
C (electrical equipment) – never use water

General Chemistry Lab Safety

By the very nature of laboratory work, the lab can be a place of danger if proper precautions aren't taken. While every effort has been made to eliminate the use of explosive, highly toxic, and carcinogenic substances from the work which you will conduct, there is a certain unavoidable hazard associated with the use of a variety of chemicals and glassware. You are expected to learn and adhere to the following general safety guidelines to ensure a safe laboratory environment for both yourself and the people you may be working near.

Attire

1. Safety goggles **must be worn** while in the laboratory. This rule must be followed whether you are actually working on an experiment or simply writing in your lab notebook.
2. Contact lenses are not allowed. Even when worn under safety goggles, various fumes may accumulate under the lens and cause serious injuries or blindness.
3. Closed toe shoes and long pants must be worn in the lab. Sandals and shorts are not allowed.

4. Long hair must be tied back when using open flames.

Conduct

4. Eating, drinking, and smoking are strictly prohibited in the laboratory.
5. Never taste anything. Never directly smell the source of any vapor or gas; instead by means of your cupped hand, waft a small sample to your nose. Do not inhale these vapors but take in only enough to detect an odor if one exists.
6. All liquids must be properly labeled (even water).
7. Coats, backpacks, etc., should not be left on the lab benches and stools. Beware that lab chemicals can destroy personal possessions. Do not leave items in the lab that don't belong there, e.g., empty coolers, plastic bags etc.
8. Always wash your hands before leaving lab.
9. Learn where the safety and first-aid equipment is located. This includes fire extinguishers, fire blankets, and eye-wash stations.
10. Notify Linda Russio immediately in case of an accident.

Proper Handling of Chemicals and Equipment

11. Consider **all** chemicals to be hazardous unless you are instructed otherwise. Material Safety Data Sheets (MSDS) are available in lab for all chemicals in use. These will inform you of any hazards and precautions of which you should be aware.
12. Know what chemicals you are using. Carefully read the label *twice* before taking anything from a bottle. Chemicals in the lab are marked with National Fire Protection Association (NFPA) hazardous materials diamond labels. Learn how to interpret these labels.
13. Excess reagents are **never** to be returned to stock bottles. If you take too much, dispose of the excess.
14. Many common reagents, for example, alcohols and acetone, are highly flammable. **Do not use them anywhere near open flames.**
15. Always pour acids into water. If you pour water into acid, the heat of reaction will cause the water to explode into steam, sometimes violently, and the acid will splatter.
16. If chemicals come into contact with your skin or eyes, **flush immediately** with copious amounts of water and consult with your doctor.
17. Dispose of chemicals properly. Waste containers are provided. Unless you are explicitly told otherwise, assume that only water may be put in the lab sinks.
18. Clean up all broken glassware immediately and dispose of the broken glass properly.
19. Clean up the lab behind you! This is very important to keep the lab a safe workplace.

OSHA's Final Rule of Classification and Labeling of Chemicals

On March 26, 2012, OSHA released its final rule revising the Hazard Communication Standard (HCS) by aligning it with the United Nations Globally Harmonized System (GHS). New rule will be implemented in phases until 2016.

The new rule will make shipping and handling of chemicals easier and safer because Complying with myriad, multi-jurisdictional regulations on chemical hazard communication can be a burden and a risk. This risk is magnified by the need to develop multiple sets of labels and SDSs for each product in international trade.

The rule makes four major changes to the Hazard Communication Standard (HCS): Hazard Classification and labels, Safety Data Sheets (SDS), and required training.

Classification of chemicals and mixtures is still the responsibility of the manufacturer.
Hazard Classification changed:
◊ Skin corrosive definition modified
- *Skin corrosion* is the production of irreversible damage to the skin; namely, visible necrosis through the epidermis and into the dermis, following the application of a test substance for up to four hours
- *Corrosive reactions* are typified by ulcers, bleeding, bloody scabs, and, by the end of observation at 14 days, by discoloration due to blanching of the skin, complete areas of alopecia, and scars. Histopathology should be considered to evaluate questionable lesions

Each hazard "class," *i.e.*, physical, health, is sub-divided into a "hazard category. ¡Hazard categories are:
◊ Based on degree of severity
◊ Several categories per class
◊ Increase in hazard category number indicates a decrease in severity
- Cat 1 is highest level of severity

Hazard Class	Hazard Category						
Explosives	Unstable Explosives	Div 1.1	Div 1.2	Div 1.3	Div 1.4	Div 1.5	Div 1.6
Flammable Gases	1	2					
Flammable Aerosols	1	2					
Oxidizing Gases	1						
Gases under Pressure Compressed Gases Liquefied Gases Refrigerated Liquefied Gases Dissolved Gases	1						
Flammable Liquids	1	2	3	4			
Flammable Solids	1	2					
Self-Reactive Chemicals	Type A	Type B	Type C	Type D	Type E	Type F	Type G
Pyrophoric Liquids	1						
Pyrophoric Solid	1						
Pyrophoric Gases	Single category						
Self-heating Chemicals	1	2					
Chemicals, which in contact with water, emit flammable gases	1	2	3				
Oxidizing Liquids	1	2	3				
Oxidizing Solids	1	2	3				
Organic Peroxides	Type A	Type B	Type C	Type D	Type E	Type F	Type G
Corrosive to Metals	1						
Combustible Dusts	Single Category						

Hazard Class	Hazard Category			
Acute Toxicity	1	2	3	4
Skin Corrosion/Irritation	1A	1B	1C	2
Serious Eye Damage/ Eye Irritation	1	2A	2B	
Respiratory or Skin Sensitization	1	z		
Germ Cell Mutagenicity	1A	1B	2	
Carcinogenicity	1A	1B	2	
Reproductive Toxicity	1A	1B	2	Lactation
STOT – Single Exposure	1	2	3	
STOT – Repeated Exposure	1	2		
Aspiration	1			
Simple Asphyxiants	Single Category			

Shipping hazardous chemicals requires a label that includes
◊ Product identifier

• A product identifier can be a chemical name, trade name, or other designation that is unique to the substance or product. This designation must be the same across all hazard communication documents and other sources of information

◊ Signal word

◊ Hazard statement(s)

◊ Pictogram(s)

◊ Precautionary statement(s)
◊ Name, address, and telephone number of the chemical manufacturer, importer, or other responsible party

- In English, prominently displayed, includes all associated hazard categories

All hazard communication elements must be easily legible

◊ No required label size

◊ No required pictogram size

◊ Must be easily legible

All hazardous chemicals must be labelled in the workplace. Labels must not be removed.

Example:

Product 123

DANGER

Heating may cause a fire or explosion.

Keep away from heat/sparks/open flames/hot surfaces. – No smoking.
Keep/Store away from clothing/oxidising materials/combustible materials.
Keep only in original container.
Wear protective gloves/eye protection/face protection.

Store at temperatures not exceeding 12 °C/53.6 °F. Keep cool.
Protect from sunlight.
Store away from other materials.

Dispose of contents/container to licensed hazardous waste treatment agent.

24 Chemhotline
(555) 123-1234

Chemchain
123 Sunset boulevard, L.A.
California, 123-1234
(555) 321-4321

Training as of 2015 requires that
◊ Training ensures employees are familiar with the new label, SDS formats, and presentation of information
◊ Training clarifies that the labels on shipped containers and workplace labels must be explained

Handling of miscellaneous Equipment used in the Field

- If there is any concern for malfunctioning of equipment or if there are problems identified with any of the equipment that could potentially compromise safe field work practices, notify the PI, the administration office, and the health and safety coordinator
- PIs/Health and Safety Coordinator will conduct an evaluation to identify potential hazards when new substances, processes, procedures or equipment are introduced that present new occupational safety and health hazards.
- Broken glassware that was clean or had contained non-hazardous materials should be placed in a sturdy or hard-walled container and disposed of properly.
- Wash waders with soap and water and then air-dry after use in contaminated waters.
- If waders flood, wash all skin that was exposed to water with soap and wash waders from inside and outside.

Possible Fieldwork related Illnesses

Microbiological Pathogens

Many projects involve the collection of water and sediment samples that could potentially contain a large number of bacteria. All staff should be reminded that skin contact and ingestion of water-borne bacteria can be harmful, as well as the inhalation of dust particles.

Things to remember:

- Wear latex gloves when there is a potential for exposure to deleterious bacteria (e.g., unknown water source, known source of pathogens, etc).
- Use hand sanitizer (provided in crash kit) or regular soap (when bathroom is available) to wash your hands after sampling, especially before eating and drinking.
- Use disposable dust mask when working near rototilling equipment or tractors at work or on windy days near agricultural fields.

Potential Zoonotic Diseases

Aside from food poisonings, the overall incidence of transmission of disease-producing agents from fish to humans is low. There are, however, a number of agents that are found in fish and aquarium water that have the potential to be transmitted to humans. In general, humans contract fish borne disease through ingestion of infected fish tissues or aquarium water, or by contamination of lacerated or abraded skin. An important feature of many of the disease causing agents is their opportunistic nature. The development of disease in the human host often requires a preexisting state that compromises the immune system. If you have an immune-compromising medical condition or you are taking medications that impair your immune system (steroids, immunosuppressive drugs, or chemotherapy) you are at-risk for contracting a fish borne disease and should consult your physician. The following is a list of known and potential fish borne zoonoses.

- Mycobacterium
- Aeromonas spp.

- Other Bacteria and Protozoa

Below is a list of additional zoonotic organisms that have been documented in fish or aquarium water. Human infections are typically acquired through ingestion of contaminated water resulting in gastroenteritis symptoms or from wound contamination.

- Gram-negative Organisms: *Plesiomonas shigelloides, Pseudomonas fluorescens, Escherichia coli, Salmonella spp., Klebsiella spp., Edwardsiella tarda*
- Gram-positive Organisms: *Streptococcus, Staphylococcus, Clostridium, Erysipelothrix, Nocardia*
- Protozoa: *Cryptosporidium*

How to Protect Yourself

- Wash your hands. The single most effective preventative measure that can be taken is thorough, regular hand washing. Wash hands and arms after handling fish and aquarium water. Never smoke, drink or eat in the animal rooms or before washing your hands.
- Wear gloves. If you are in a situation in which you will spend a significant amount of time with your hands immersed in water or if you have any cuts or abrasions on your hands or arms, you should wear sturdy, impervious gloves. Check that all open wounds and skin breaks are covered before you put on gloves. Check for any holes or tears and discard gloves that are defect.
- Seek Medical Attention Promptly. If you are injured on the job, promptly report the accident to your supervisor even if it seems relatively minor. Minor cuts and abrasions should be immediately cleansed with antibacterial soap and then protected from exposure to fish and aquarium water.
- Tell your physician you work with fish. Whenever you are ill, even if you're not certain that the illness is work-related, always mention to your physician that you work with fish. Many zoonotic diseases have flu-like symptoms and would not normally be suspected. Your physician needs this information to make an accurate diagnosis.

Heat Stress

Heat can cause safety problems. You are more accident-prone while working in the heat. Heat stress can affect your coordination, your concentration, reduce your strength and alertness, and make you irritable. Avoid heat stress by

- Acclimatizing (allow your body to adjust to heat naturally, gradually increase time spent in heat)
- Drink water (drink plenty of cool water before and after work, drink before you feel thirsty, drink at least four ounces of water every 15-20 minutes)
- Take in electrolytes (add salt to your diet but avoid salt tablets, electrolyte replacement drinks can help but they are loaded with sugar)
- Plan ahead (plan activities as early in the day as possible when it’s cooler)
- Rest often (seek shade or ventilated room)
- Wear right clothes (brimmed hats, sunglasses, breathable clothing)
- Stay physically fit (the best protection against heat stress is physical fitness and a strong, healthy heart)

- Avoid alcohol and caffeine (it causes dehydration)

Heat-related Illnesses

Heat-related illnesses usually come in stages

1. Heat cramps (can be very painful)
2. Heat exhaustion (cool, moist, pale skin, headache, dizziness, nausea)
3. Heat stroke (vomiting, decreased alertness, unconsciousness, high body temperature, sweating stopped, rapid, weak pulse, shallow breathing)

Treatment:

1. Cool body (get person out of the sun immediately, wrap in cold wet sheets, ice packs under arm pits, in groin, or behind knees)
2. Give fluids (cold fluids in small amount, sport drinks)
3. Minimize shock (keep person lying down, elevate feet, keep airways clear)
4. Call 911 if symptoms do not improve or person is un-responsive.

New OSHA standards apply to heat illness prevention in outdoor places of employment. This will become effective in May 2015. Even though our line of work is not listed with the industries that these new requirements are written for, I think it would be good practice to comply with them.

(a) Provision of water. Employees shall have access to potable drinking water that is fresh, suitably cool, and free of charge. Sufficient quantity is one quart per employee per hour for the entire shift. The frequent drinking of water shall be encouraged.
(b) When the outdoor temperature exceeds 80 degrees Fahrenheit a shaded area shall be provided and maintained at all times. The shade shall be provided as close to the working area as practical and shall allow employees to sit in full shade in a normal posture.
(c) When the temperature does not exceed 80 degree Fahrenheit shade needs to be provided upon employees' request.
(d) Employees shall be allowed and encouraged to take preventative cool-down rest. Employees experiencing symptoms of heat illness shall be monitored, encouraged to remain in shade, and not ordered back to work.
(e) If employees exhibit signs or reports symptoms of heat related illnesses appropriate first aid or emergency response shall be provided.
(f) The supervisor shall ensure effective observation (e.g., effective communication, mandatory buddy system, etc.) at all times during the work day.

Conduct a briefing before the commencement of work in the field, point out the location of available drinking water, encourage employees to drink plenty of water, and remind them to take cool-down rests when necessary. Go over the different types of heat illness and common signs and symptoms, as well as the first aid or emergency responses to different types of heat illness.

Insects

Wear long sleeves and long pants (tucked into socks). Use Deet for exposed skin parts.
If bitten by tick, keep tick alive in Ziploc bag with wet paper towel. Labs will check if tick is carrying lime disease. If sampling occurs in mosquito infested areas, check with mosquito abatement district prior to sampling to be aware of potential diseases carried by mosquitoes and use extra precaution.

Treatment of bee and wasp stings will depend on the severity of the person's condition. It is important to note that no specific antivenom is available to counteract the poison injected by the insect. The majority of problems requiring medical treatment result from an allergic reaction to the sting. Many of the complications from an allergic reaction respond well to various medications, when given in time.

- Remove any stingers remaining in the skin (most likely from bees) immediately. Some experts recommend scraping out the stinger with a credit card. However, it is more important to get the stinger out as quickly as possible than to be overly concerned about how it is removed.

- Application of ice to the sting site may provide some mild relief. Ice may be applied for 20 minutes once every hour as needed. Cloth should be placed between the ice and skin to avoid freezing the skin.

- Consider taking an antihistamine such as diphenhydramine (Benadryl) or a nonsedating one such as loratadine (Claritin) for itching.

- Consider taking ibuprofen (Motrin) or acetaminophen (Tylenol) for pain relief as needed.

- Wash the sting site with soap and water. Place an antibiotic ointment on the sting site.

- If it has been more than 10 years since your last tetanus booster immunization, get a booster within the next few days.

- Most insect stings require no additional medical care. More serious reactions may need immediate medical care.

- If you have been stung by a bee or wasp and have previously had a serious allergic reaction, seek medical attention. Consider taking an antihistamine such as diphenhydramine (Benadryl) or a nonsedating one such as loratadine (Claritin) as soon as possible. If any allergic symptoms develop, consider using the epinephrine part of an emergency allergy kit (EpiPen) if previously prescribed by a doctor.

Spiders

Although serious, a black widow bite is rarely lethal. This spider can be identified by the red hourglass marking on its belly. The bite feels like a pinprick. At first there may be slight swelling and faint red marks. Within a few hours, though, intense pain and stiffness can begin. Other signs and symptoms include:

- Chills
- Fever
- Nausea and vomiting
- Severe abdominal pain

It is important that the spider is identified. First aid for all spider bites includes:

1. Cleanse the wound. Use soap and water to clean the wound and skin around the spider bite.
2. Slow the venom's spread. If the spider bite is on an arm or a leg, tie a snug bandage above the bite and elevate the limb to help slow or halt the venom's spread. Ensure that the bandage is not so tight that it cuts off circulation in your arm or leg.
3. Use a cold cloth at the spider bite location. Apply a cloth dampened with cold water or filled with ice.
4. Seek immediate medical attention. Treatment for the bite of a black widow may require an anti-venom medication.

Snakes

- Identify or be able to describe the snake, but only if it can be done without significant risk for a second bite or a second victim.

- Safely and rapidly transport the victim to an emergency medical facility unless the snake has positively been identified as harmless (nonvenomous). Remember, misidentification could be fatal. A bite without initial symptoms can still be dangerous or even fatal.

- Provide emergency medical care within the limits of your training.

- Remove constricting items on the victim, such as rings or other jewelry, which could cut off blood flow if the bite area swells.

- If you are in a remote area in which transport to an emergency medical facility will be prolonged, you should apply a splint to the affected limb. If you do apply a splint, remember to check periodically to ensure that it is not cutting off blood flow. Check to make sure toes and fingers are still pink and warm, that the limb is not going numb, and that pain is not getting worse.

- The two guiding principles for care often conflict during evacuation from remote areas.
- First, the victim should get to an emergency care facility as quickly as possible because antivenom (medicine to counteract the poisonous effects of the snake's venom) could be life-saving.
- Second, the affected limb should be used as little as possible to delay absorption of the venom.

Poison Oak

Most poison ivy, oak, or sumac rashes can be treated successfully at home. Initial treatment consists of washing the area with water immediately after contact with the plants. To relieve symptoms, use wet compresses and take cool baths. Nonprescription antihistamines and calamine lotion also may help relieve symptoms. Moderate or severe cases of the rash may require treatment by a doctor, who may prescribe corticosteroid pills, creams, ointments, or shots (injections).

The best way to prevent the rash is to learn to identify and avoid the plants. When you cannot avoid contact with the plants, heavy clothing (long pants, long-sleeved shirt, and vinyl gloves) and barrier creams or lotions may help protect you.

Safety Protocols for Different Habitat Types

Safety and precaution measures differ from site to site depending on the type of environment where the samples have to be collected. This section addresses specific safety concerns and protocols to be observed in the listed terrains.

Marsh Safety

- Wear sun protection, mosquito repellent, sunglasses, and hat.
- Confirm that you are allowed to be in the marsh. Access is typically denied at certain time during the breeding season of sensitive species.
- Drive only on levee roads that are known to be safe and passable. Do not drive when the road is wet or moist, the sediment is very clayey, and will cause the vehicle to slide. Do not park on unconsolidated road sediment, especially if it is wet, the tires will sink in.
- Be aware of where you are walking. Often small channels or ditches are hidden by vegetation. Be aware of linear features in the marsh, these are typically mosquito ditches that can be hidden by vegetation.
- Do not step in tidal marsh channels, pannes, or ponds. The mud is very soft and you may get stuck.

- Be careful when walking on sediment dredged from the marsh, it is often unconsolidated and it is possible to sink in all the way to you knees or hips.
- Have the safety rope ready to throw to someone stuck in the mud.
- Always work in pairs or > 2 people, keeping an eye on anyone in the mud or the water.
- Know the tide predictions that day – don't get caught in a bad situation by the tide!
- Teach novices how to get out of the mud when stuck (break suction by lifting heel and use vegetation for a foothold).
- Do not pick up boards/logs on the marsh plain, this is habitat for critters.
- Wash your hands after exiting the marsh. Be careful to not get water splashed on your face.

Salt Ponds

- Be careful of rubble (rip rap, etc.) on the levees and under water. It provides treacherous footing and many ways to hurt yourself.
- Step carefully; sediment that appears dry in the ponds may be more like quicksand.
- Have the safety rope ready to throw to someone stuck in the mud.
- Always work in pairs or > 2 people, keeping an eye on anyone in the mud or the water.
- Teach novices how to get out of the mud when stuck (break suction by lifting heel).
- Drive slowly (15 MPH) on the levees to avoid killing wildlife. This is a permit condition and must be followed.
- Do not drive on levees when they are soaked with rain, as they could collapse. This is also a permit condition.
- Know and observe all cautions regarding bird nesting areas to avoid disturbance. Contact Clyde Morris at Don Edwards SFBNWR, 510.792.0222, for more information. There are endangered species breeding in the ponds.
- Inform the Refuge when you'll be sampling on their property. Contact Clyde Morris (see above).

Streams/Canals

- Do not walk on unstable stream banks
- In tidal reaches of streams and rivers, use caution when walking on the channel bed as it is likely soft silts and muds.
- Always wear a PFD when wading.
- Wade into streams only if it is safe to do so and be constantly aware of depth, current, velocity, holes, and slippery surfaces
- Do not wade into the stream/canal when water level reaches above your hips or strength of flow makes you feel unstable
- During high flow, never wade in water deeper than your knees. Be aware of floating debris and unstable channel beds
- USGS Rule of Thumb: Do not wade in stream if depth (ft) x velocity (ft/s) > 10 ft^2/s
- Before sampling, walk approximately 150 meters downstream and assess the situation for a water exit, in case you fall into water at sampling site

- Check weather forecasts, river stages and hydrographs and consider canceling work if field conditions will be potentially dangerous http://www.cnrfc.noaa.gov/ or http://cdec.water.ca.gov/river/rivcond.html.
- Wear a wader belt or a flotation vest in addition to waders whenever working in unfamiliar waters and when the depth and flow of the waters are variable or potentially dangerous. Some sort of a wading rod (net pole, etc.) is recommended for probing water depths before you step. Never wade alone, never jump into unknown waters, and never underestimate the force of the flow.
- Be aware of possible hidden/underwater debris that could be moving with the flow
- If sampling next to a road wear high visibility safety west.

Water Safety and Rescuing Techniques

Essential Safety Equipment:
- Personal Flotation Device (PFD)
- Throw-bag/safety rope
- First-Aid Kit

Prior to going onto water:
- Tell someone when and where you are going, when you expect to return, and what to do if you do not.
- Inform others in your party about your swimming ability.
- Assign someone to take charge in the event of an emergency situation, and assign a back-up person in case the leader is the victim.
- Secure your PFD properly. Straps should be buckled and PFD should be tight around waste and chest.

If you fall into the water:
- Remain calm.
- In cold water. The temperature shock can take your breath away, try to not panic.
- Position your body safely for traveling downstream, floating on your back with feet together and pointed downstream.
- Save yourself – swim back to the boat, to an eddy, or to the shore if close by.
- Avoid objects in the water that can trap you (i.e. rocks, bushes, branches, etc.)
- Look to people on the boat for direction.
- When on the Bay, the boat will come to rescue you.
- People on boat should keep their eyes on victim and constantly point in their direction. This helps the skipper locate the victim even in wavy water while maneuvering the boat.

Rescuing a victim in the water – from the boat:
- Do not follow a victim into unsafe water.
- One person on the boat should take the lead in directing the victim to safety.
- Point positive – direct the victim to the location you want them to go; do not point towards dangerous areas.
- Extend a paddle or throw a safety rope to the victim.

- Pull victim into the boat via their PFD shoulder straps (in case of neck or back injuries/severe neck or back pain, try to place victim on stable board and lift them out of the water without stretching or twisting their spine).

Rescuing a victim in the water – from land:

- From land, rescuers can throw a safety rope to the victim.
- Only enter the water if it is safe, and/or if your swift-water rescue skills warrant it.
- Know techniques for walking in swift water (using a paddle, using multiple people).
- In fast moving water, run downstream to a safe place for exit and try to help victim out.

Ag Fields

- Do not sample when field or neighboring field is chemically treated. Avoid skin and eye contact with pesticides at all times and also avoid inhalation. Consider spray drift and wait for application to end before entering area.
- Protect your skin with gloves when in contact with plants, water, or soil.
- During irrigation or when the field is wet, be aware of slippery soil and the risk of getting stuck.
- When sampling drainage ditches, avoid loose parts where sediment will erode when stepped on. Ideally, sample from wooden board that can lie across the ditch.
- Do not eat or drink while sampling and clean your hands after you have taken off your gloves
- Wear surgical mask and eye protection on extremely windy days that kick up a large amount of dust. This will protect you from inhaling dust particles and possibly contracting San Joaquin Valley fever.
- If sampling next to a road wear high visibility safety west.

Nighttime Sampling

- Try to avoid sampling in the dark if you can. If you have to sample after sunset, bring sufficient lights (e.g., head lights, flash lights, lanterns). If the sampling site is located near roads with poor lighting, wear reflective clothing and/or high visibility safety west.
- Never sample alone at night
- Notify Linda Russio or Admin staff and Project Manager when you are going out in the field and when you will be back at SFEI and leave cell phone numbers where you can be reached.
- Bring fully charged cell phone. If your personal phone battery is low, take SFEI phone as back-up.
- Check for possible hotel options before you leave, so you have a back-up plan if you feel too tired to drive.
- Never drive when you are too tired, intoxicated, or are taking prescription medication that may affect your performance.
- Get direct phone number of local police or sheriff station to report non-sampling related concerns (e.g., same car passing by slowly repeatedly) and ask for patrol car to check on the site while you are out there.

Invasive Species

Include HACCP in you project planning (Hazard Analysis and Critical Control Point Planning) that focuses on identifying pathways and control measures to prevent the undesired movement of organisms from one sampling site to another. Be aware of the potential risks for certain invasive species in your sampling area (USGS provides maps of distribution of some aquatic invasive species in CA). Try to control all pathways as best as you can.

Report invasive species to US Fish and Wildlife Services 1-800-STOP ANS

Control Measures

- Visually inspect all sampling equipment and gear, truck tires, trailer, boat, boat engine, anchor, oars etc.
- Thoroughly remove all plant and animal material
- Steam clean (120° F) or power wash equipment and gear
- Freeze gear overnight
- Chlorine **does not** have the desirable effect for killing or removing invasive species
- If using the boat, drain any water through vessel's hull plug and ensure the area is dry before moving on to next site
- Empty and dry all buckets, coolers, or other sampling containers before use at a different site
- 10-min exposure to 100% Formula 409 or to a Sparquat 256 solution of at least 3.1% results in 100% mortality for New Zealand Mudsnail and also controls whirling disease spores and other fish pathogens

Electro-Fishing

Predominant hazard in electro fishing is receiving an electrical shock. Electro-fishing equipment uses a variety of output waveforms – direct currents, rectified alternating current, alternating current, square-wave current, and pulses of current. The hazard is related to the magnitude of the current, the duration of the shock, and the current waveform. As an example, direct current causes a severe shock when the circuit is made or broken but not while the current is steady. By contrast, a 50 or 60 Hz alternating current will produce a continuous painful shock. It requires about three or four times more direct current than alternating current for a lethal shock.

Risks involved

Ventricular fibrillation is described as an uncoordinated, asynchronous contraction of the ventricular muscle of the heart. The greatest risk of ventricular fibrillation occurs when an electrical shock is received and the path of the current is through the chest (e.g., between two arms or one arm and a leg). The heart's natural rhythm is stopped and replaced by an asynchronous quivering. A defibrillator must be used to restore a stable pulse. CPR can be used to stabilize the patient until they can be defibrillated.

Respiratory arrest can be caused by shocks or blows to the head. The respiratory control center is contained at the base of the skull and can be deactivated by a shock in this area. CPR or artificial respiration can help.

Asphyxia is caused by the chest muscle contracting and not releasing. Current from an electrical shock which is above a certain level (i.e., 0.005 A at 60 Hz) can cause a person grasping a life wire to be unable to let go. This can cause the chest muscle to restrict and in turn asphyxiate the person.

Drowning is possible when an individual is in the water and an electrical current is present. Even a very low current can make it impossible to swim.

Safety Rules

- Only use electrical fishing apparatus that has been designed and constructed so that it conforms with a standard set of national or local electrical fishing safety guidelines and receives regular maintenance.
- Personnel involved in electric fishing operations need to be trained in the fundamentals of electricity, the correct procedures for operating electric fishing equipment, CPR, and first aid.
- All electric fishing procedures and activities are carried out under a standard set of safety guidelines as dictated by national or local regulations.
- Keep hands and other body parts out of the water, especially in the vicinity of electrodes.
- Do not hold or touch conductive material that is partially submerged while electric fishing equipment is in use.
- Leave the water immediately if rubber boots or gloves or electrically insulated protective clothing leaks and allows pathway for electrical current.
- Make all electrical connections while the unit is turned off
- Refuel generators with equipment turned off and when surfaces cooled.
- Never operate electrical fishing equipment alone.
- Never fish under inclement weather conditions.
- Never fish while other unprotected persons are in the proximity to the fishing activity.
- If using backpack electro-fishing unit, equipment must have a tilt switch that opens the circuit in case the operator falls. Switches that are manually reset are preferred over automatic resets.
- Do not wear conductive jewelry or clothing (such as watchbands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, or metal head gear.
- Be sure to remain well hydrated; the rubber clothing can make overheating especially easy.

If you are not comfortable with your field assignment, sampling equipment provided, or have concerns about sampling condition, SPEAK UP!
All injuries must be reported to the field supervisor, PI, SFEI health and safety coordinator, and SFEI administration staff.

Safety Training Program

Along with annual safety training, employees are provided training when assigned to a new task for which training has not been received. A training session is provided for each new employee. In each instance, a new Employee Training Documentation form must be completed by the health and safety coordinator and employee. The PI and health and safety coordinator maintains safety and health training records for each employee, documenting training dates and types of training. The retention period for these records is three years.

Bay Area Emergency Rooms (click on link to see and print maps or related emergency info, e.g., police department by choosing "search nearby" in google window and typing "police" or related searches)

1	Alameda County Medical Center--Highland Campus 1411 E 31st St Oakland, CA 510-437-4800
2	Alameda Hospital 2070 Clinton Ave Alameda, CA 510-522-3700
3	Alta Bates Summit Medical Center--Ashby Campus 2450 Ashby Ave Berkeley, CA 510-204-4444
4	Alta Bates Summit Medical Center--Summit Campus 350 Hawthorne Ave Oakland, CA 510-655-4000
5	California Pacific Medical Center--Davies Castro & Duboce Sts San Francisco, CA 415-565-6000
6	California Pacific Medical Center--Pacific Campus 2333 Buchanan St San Francisco, CA 415-563-4321
7	Children's Hospital & Research Center at Oakland 747 52nd St Oakland, CA 510-428-3000
8	Chinese Hospital 845 Jackson St

	San Francisco, CA 415-677-2300
9	Community Hospital of Los Gatos 815 Pollard Rd Los Gatos, CA 408-378-6131
10	Contra Costa Regional Medical Center 2500 Alhambra Ave Martinez, CA 925-370-5000
11	Doctor's Medical Center--San Pablo Campus 2000 Vale Rd San Pablo, CA 510-235-7000
12	Dominican Hospital 1555 Soquel Dr Santa Cruz, CA 831-462-7700
13	Eden Medical Center 20103 Lake Chabot Rd Castro Valley, CA 510-537-1234
14	El Camino Hospital 2500 Grant Rd Mountain View, CA 650-940-7000
15	Good Samaritan Hospital 2425 Samaritan Dr San Jose, CA 408-559-2011
16	Healdsburg District Hospital 1375 University Ave Healdsburg, CA 707-431-6500
17	John Muir Medical Center 1601 Ygnacio Valley Rd Walnut Creek, CA 925-939-3000
18	Kaiser Permanente Hayward Medical Center

	27400 Hesperian Blvd Hayward, CA 510-784-4000
19	Kaiser Permanente Oakland Medical Center 280 W MacArthur Blvd Oakland, CA 510-752-1000
20	Kaiser Permanente Redwood City Medical Center 1150 Veterans Blvd Redwood City, CA 650-299-2000
21	Kaiser Permanente Richmond Medical Center 901 Nevin Ave Richmond, CA 510-307-1500
22	Kaiser Permanente San Francisco Medical Center 2425 Geary Blvd San Francisco, CA 415-202-2000
23	Kaiser Permanente San Rafael Medical Center 99 Montecillo Rd San Rafael, CA 415-444-2000
24	Kaiser Permanente Santa Clara Medical Center 900 Kiely Blvd Santa Clara, CA 408-236-6400
25	Kaiser Permanente Santa Rosa Medical Center 401 Bicentennial Way Santa Rosa, CA 707-571-4000
26	Kaiser Permanente Santa Teresa Medical Center 250 Hospital Pkwy San Jose, CA 408-972-7000
27	Kaiser Permanente South San Francisco Medical Center 1200 El Camino Real South San Francisco, CA 650-742-2547

28	Kaiser Permanente Vallejo Medical Center 975 Sereno Dr Vallejo, CA 707-651-1000
29	Kaiser Permanente Walnut Creek Medical Center 1425 S Main St Walnut Creek, CA 510-295-4000
30	Marin General Hospital 250 Bon Air Rd San Rafael, CA 415-925-7000
31	Mills Health Center 100 S San Mateo Dr San Mateo, CA 415-696-4400
32	Mills-Peninsula Medical Center 1783 El Camino Real Burlingame, CA 650-696-5400
33	Mount Diablo Medical Center 2540 East St Concord, CA 925-682-8204
34	North Bay Medical Center 1200 B Gale Wilson Blvd Fairfield, CA 707-429-3600
35	Novato Community Hospital 180 Rowland Way Novato, CA 415-209-1300
36	O'Connor Hospital 2105 Forest Ave San Jose, CA 408-947-2500
37	Palm Drive Hospital 501 Petaluma Ave Sebastopol, CA

	707-823-8511
38	Petaluma Valley Hospital 400 N McDowell Blvd Petaluma, CA 707-778-1111
39	Queen of the Valley Hospital 1000 Trancas St Napa, CA 707-252-4411
40	Regional Medical Center of San Jose 225 N Jackson Ave San Jose, CA 408-259-5000
41	Saint Francis Memorial Hospital 900 Hyde St San Francisco, CA 415-353-6000
42	San Francisco General Hospital Medical Center 1001 Potrero Ave San Francisco, CA 415-206-8000
43	San Jose Medical Center 675 E Santa Clara St San Jose, CA 408-998-3212
44	San Leandro Hospital 13855 E 14th St San Leandro, CA 510-667-4510
45	San Mateo County General Hospital 222 W 39th Ave San Mateo, CA 415-573-2222
46	San Ramon Regional Medical Center 6001 Norris Canyon Rd San Ramon, CA 925-275-9200
47	Santa Clara Valley Medical Center 751 S Bascom Ave

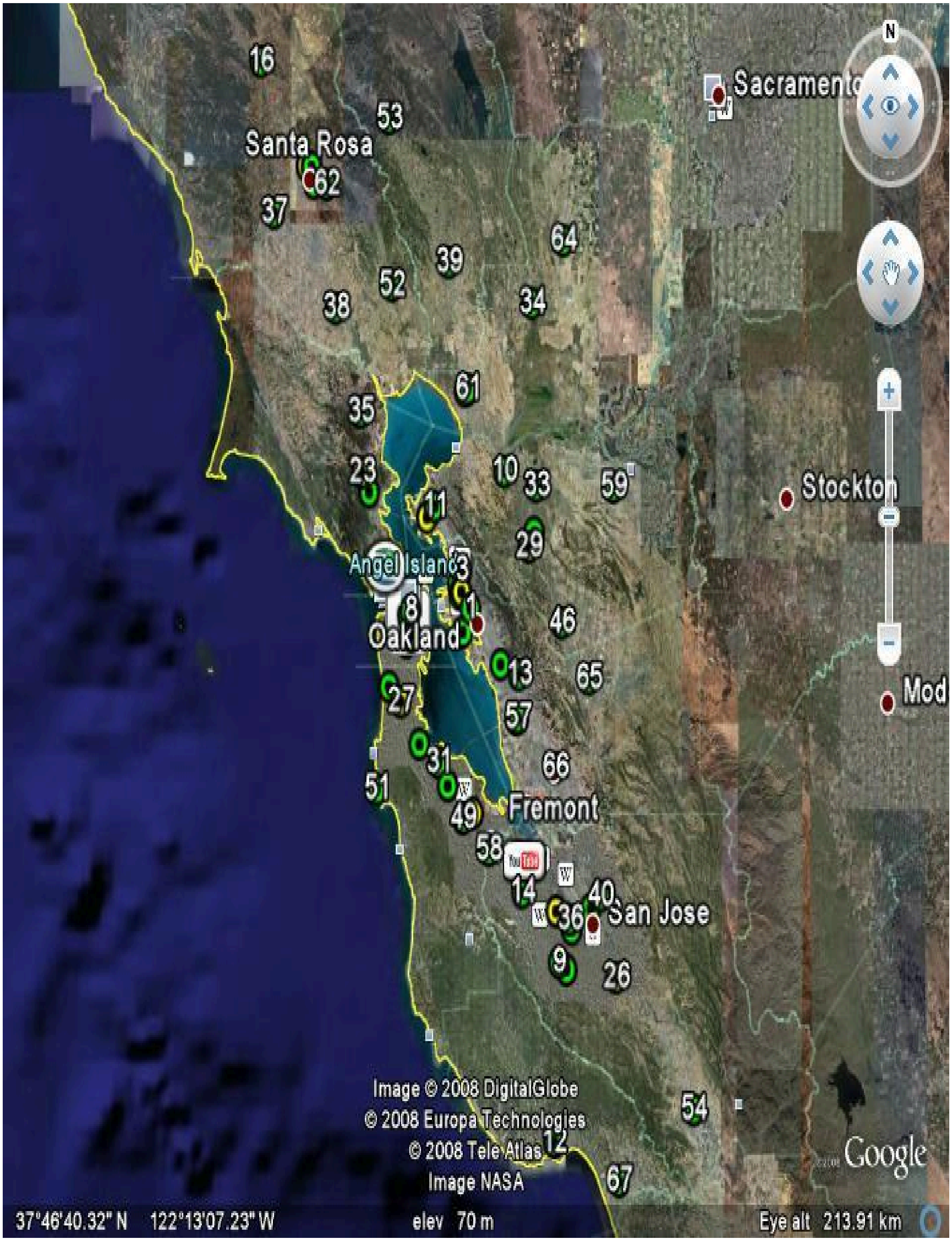
	San Jose, CA 408-885-5000
48	Santa Rosa Memorial Hospital 1165 Montgomery Dr Santa Rosa, CA 707-546-3210
49	Sequoia Hospital 170 Alameda de las Pulgas Redwood City, CA 650-369-5811
50	Seton Medical Center 1900 Sullivan Ave Daly City, CA 650-992-4000
51	Seton Medical Center Coastside 600 Marine Blvd Moss Beach, CA 650-728-5521
52	Sonoma Valley Hospital 347 Andrieux St Sonoma, CA 707-935-5000
53	St Helena Hospital 650 Sanitarium Rd Deer Park, CA 707-963-3611
54	St Louise Hospital 9400 No Name Uno Gilroy, CA 408-848-2000
55	St Luke's Hospital 3555 Cesar Chavez St San Francisco, CA 415-647-8600
56	St Mary's Medical Center 450 Stanyan St San Francisco, CA 415-668-1000
57	St Rose Hospital

	27200 Calaroga Ave Hayward, CA 510-264-4000
58	Stanford Hospital & Clinics 300 Pasteur Dr Stanford, CA 650-723-4000
59	Sutter Delta Medical Center 3901 Lone Tree Way Antioch, CA 925-779-7200
60	Sutter Medical Center of Santa Rosa 3325 Chanate Rd Santa Rosa, CA 707-576-4000
61	Sutter Solano Medical Center 300 Hospital Dr Vallejo, CA 707-554-4444
62	Sutter Warrack Hospital 2449 Summerfield Rd Santa Rosa, CA 707-542-9030
63	UCSF Medical Center 500 Parnassus Ave San Francisco, CA 415-476-1000
64	Vacavalley Hospital 1000 Nut Tree Rd Vacaville, CA 707-446-4000
65	ValleyCare Medical Center 5555 W Las Positas Blvd Pleasanton, CA 925-847-3000
66	Washington Hospital 2000 Mowry Ave Fremont, CA 510-797-1111
67	Watsonville Community Hospital

	75 Nielson St Watsonville, CA 831-724-4741

Bay Area Hospitals. Interactive map available through Google Maps. To access map insert following url into the search bar in Google Maps:
http://www.sfei.org/watersheds/kml/hospital.kml
This will pull up the 67 points. By left clicking on one of the points, it pulls up the name of the hospital and the address in the balloon. To get directions to a point, right click on the point and pick "Directions to here".

Yellow Circles – Kaiser Permanente Hospitals
Green Circles – Other Bay Area Hospitals



Santa Rosa
Sacramento
Stockton
Angel Island
Oakland
Fremont
San Jose
Mod
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Image © 2008 DigitalGlobe
© 2008 Europa Technologies
© 2008 Tele Atlas
Image NASA
37°46'40.32" N 122°13'07.23" W
elev 70 m
Eye alt 213.91 km
Google

Appendix B: NMS Moored Sensor Program Field Form

EXO Servicing

Station *

Please Select
NA
SPA8
SPA4
EMR
POND

Date

MM-DD-YYYY

Field Crew

NA
Lilia Mourier (SFEI NMS)
Lucy Montgomery (SFEI NMS)
Katie Noland (SFEI NMS)
Dylan Burau (USGS WSC)
Kyle Nakatsuka (USGS WSC)

(Select all that apply)

Weather Conditions

NA
Calm
Waves
White caps
Rain
Overcast

(Select all that apply)

Retrieved EXO SN

Please Select
NA
13D100786
13D100787
13H102015
13H102016

Deployed EXO SN

Please Select
NA
13D100786
13D100787
13H102015
13H102016

Time of package retrieval

HH : MM PM

Please use PST

Condition of retrieved EXO

NA
Clean body

(Select all that apply)

Deployment Data Review

Please Select
Yes
No

Instrument Performance Verification

Please Select
Yes
No

Zinc condition / replacement

- [ ] Zincs added this trip
- [ ] No zincs added this trip
- [ ] Add zincs next trip
- [ ] Pack more zincs in hardware box for the next trip

Time of package deployment

HH : MM PM

Please use PST

Servicing Notes

Bay Regional Monitoring Program QAPP

Group A. Project Management and Information/Data Quality Objectives

A4. Project Purpose, Problem Definition, and Background

Tracking Bay Health: Water Quality Science to Inform Management will support a wide range of monitoring and modeling tasks in support of addressing the San Francisco Bay Regional Monitoring Program (RMP) goal and management questions over the next five years. The goal of the RMP is to collect data and communicate information about water quality in San Francisco Bay in support of management decisions.

The stakeholders of the RMP have articulated a tiered framework of management questions that organize and guide RMP studies. The management questions are closely linked to existing and planned regulations. The management questions provide a foundation for adjusting the monitoring program, designing special studies capable of testing specific hypotheses prior to implementing management actions or revising policies, and communicating key messages to policy-makers and the public. In addition, subsets of the questions have been embedded into various Water Board discharge permits in order to guide the design, effectiveness, and collaboration of individual discharger and regional monitoring efforts. The current management questions and workplan elements for the Program are documented annually in the RMP Multi-Year Plan (Kleckner and Davis 2024).

The Clean Water Act of 1972 set ambitious goals of all waters of the US being fishable and swimmable by 1983, and eliminating all pollutant discharges by 1985. While much progress has been made in improving water quality in San Francisco Bay, we have not fully met the goals set in the Clean Water Act or by the regulatory processes it established. The Regional Monitoring Program for Water Quality in San Francisco Bay (Bay RMP) was formed in 1993 to collect data and communicate information about water quality in the Bay to support management actions to address continuing water quality challenges. In other words, the RMP provides the information needed to track and guide progress in meeting Clean Water Act goals for the Bay.

A5. Project Task Description

There are multiple tasks within Tracking Bay Health that will use field monitoring and modeling to inform water quality management in San Francisco Bay.

This QAPP covers each of these elements as described below.

Task 1 - Contaminant Monitoring in Water: This task aims to continue and expand the RMP's monitoring of San Francisco Bay water quality and overall ecosystem health through the collection and analysis for various contaminants in water samples from Bay water, wastewater and stormwater inputs, and watershed pathways. Various reports, publications, and presentations subject to peer review will be produced throughout the duration of the project and posted to the SFEI website. Data collected will be uploaded to publicly accessible databases CEDEN and CD3.

Task 2 - Contaminant Monitoring in Tissue: This task aims to continue and expand the RMP's monitoring of San Francisco Bay water quality and overall ecosystem health through the collection and analysis for various contaminants in samples from bird egg, fish, invertebrate, and mammal tissues. Various reports, publications, and presentations subject to peer review will be produced throughout the duration of the project and posted to the SFEI website. Data collected will be uploaded to publicly accessible databases CEDEN and CD3.

Task 3 - Contaminant Monitoring in Sediment: This task aims to continue and expand the RMP's monitoring of San Francisco Bay water quality and overall ecosystem health through the collection and analysis for various contaminants in sediment. Various reports, publications, and presentations subject to peer review will be produced throughout the duration of the project and posted to the SFEI website. Data collected will be uploaded to publicly accessible databases CEDEN and CD3.

Task 4 - Bay and Watershed Modeling: This task aims to develop models for sediment, mercury, PCBs, and contaminants of emerging concern (CECs) that address high priority water quality management questions and identify priority monitoring locations. Watershed models to simulate transport of water, sediment, and contaminants from regional watersheds are being developed to characterize response of the ecosystem under various scenarios such as changes in climate, land use, and contaminant loads. The watershed model outputs will serve as inputs to models of Bay processes. The Watershed Dynamic Model is based on LSPC. The Bay model is based on the Delft Flexible Mesh hydrodynamic model also used for the regional Nutrient Management Strategy. The primary project tasks will be parameterizing, calibrating, and applying these models using available local monitoring data, and using these tools to simulate the short- and long-term fate of contaminants in water, sediment, and biota.

The models will help assess potential impacts, spatial and temporal variation, long-term recovery forecasts, and effects of management actions. PCB modeling will provide a strong foundation for the potential revision of the TMDL scheduled for 2030. Various peer-reviewed reports, publications, and presentations will be produced throughout the duration of the project and posted to the SFEI website.

A6. Information/Data Quality Objectives and Performance/Acceptance Criteria

Questions to be answered, decisions to be made, action to be taken, or hypotheses to be tested	General categories of information needed to answer questions	Specific measurements/ observations needed to answer questions	Quantitative criteria (action level, decision threshold value, etc.) associated with each measurement/ observation needed

			to answer the question
1) Are chemical concentrations in San Francisco Bay potentially at levels of concern and are associated impacts likely? 2) What are the concentrations and masses of contaminants in San Francisco Bay and its segments? 3) What are the sources, pathways, loadings, and processes leading to contaminant related impacts in San Francisco Bay? 4) Have the concentrations, masses, and associated impacts of contaminants in San Francisco Bay increased or decreased? 5) What are the projected concentrations, masses, and associated impacts of contaminants in San Francisco Bay?	Ambient chemical concentrations, loads, mechanistic and conceptual models, toxicity tests. Appropriate guidelines for protection of beneficial uses. Spatial patterns and long term trends of contaminant concentrations and masses in San Francisco Bay and its segments.	Quinquennial aquatic toxicity testing Biennial water contaminant monitoring (dry and wet seasons) Quinquennial Bay sediment contaminant monitoring Monitoring of contaminants in tissue every 2-5 years.	Water Quality Objectives (WQO's) as listed in the Basin Plan for San Francisco Bay. Comparisons to effects levels in peer reviewed literature.

PRECISION: Precision of field measurements is determined by repeated measurement of the same parameter within a single sample, or samples taken in rapid succession (only when conditions are not dynamically variable). Approximately 5-10% of measurements, a minimum of one measurement per event, should be repeated for all measured parameters. Repeated measurement may also be accomplished by continuous logging of in situ probes or meters. Precision of lab measurements is determined by repeated measurement of an analyte within a single sample (e.g., via lab replicates sub-sampling a homogenous collected sample), or by measurement of field replicates collected simultaneously, in rapid succession, and/or close proximity in a homogenous location. For evaluation of lab performance, lab replicates are preferable, as uncertainty introduced by heterogeneity in the environment by field replicates is minimized. However, for some matrices (e.g., hydrophobic organic compounds in water), low ambient concentrations and consequent large sample size requirements do not allow sub-sampling for lab replicates without loss of measurement sensitivity, requiring use of separately collected field splits or replicates for precision evaluation instead. In other cases where sample size and available material may be limited, other sample types may be used in place of locally field-collected samples as replicates. Such samples can include matrix or blank (LCS) spike replicates (at low levels within ~10x of those typically seen in field samples), larger field samples collected from other locations for other projects, and/or CRMs and LRMs for similar matrices. General constraints for other sample types used for replicate analyses are that 1) the samples be taken through all the same analytical procedures (reagent additions, extractions, drying, etc.) and 2) that concentrations be similar in magnitude (at maximum 100x, preferably 10x or lower) relative to average project samples.

ACCURACY (BIAS): Accuracy of field measurements is established by periodic measurement of known standards or by recalibration to known standards. Instrument recalibration should be performed prior to each sampling day or event for user-calibrated instruments (e.g., daily for handheld field meters: pH, conductivity, DO), or at the manufacturer-specified interval for instruments requiring factory servicing or otherwise incapable of field recalibration. Accuracy of lab measurements is evaluated by measurement of known standards or samples containing the appropriate analytes. Calibration standards and calibration-check samples establish the adequacy of instrument performance, but measurements of accuracy incorporating all preparation, extraction, and cleanup steps are required for evaluating the entire analytical process. When available, certified reference materials in an appropriate similar matrix and concentration range are most preferred, as the certified or reference values provide an external confirmation of the expected concentrations for those samples. However, in some cases, particularly for low level measurements (e.g., hydrophobic organics in water samples) or for newer contaminants of interest reported by relatively few labs, such materials are not available in many or any matrices, so recoveries for other sample types with expected or known values (e.g., LRMs, MSs, LCSs) may be used, but their use as exclusive indicators of measurement accuracy should be discussed with and agreed to by the Project Manager and Quality Assurance Officer/Manager. In other cases, reference material may be available, but concentrations are much higher than those typically seen locally, so good accuracy on such reference materials provides less assurance of accuracy at lower concentrations. For such instances, other recovery sample types (i.e., LRMs, MSs, LCSs) may supplement to provide a better indication of ongoing measurement accuracy than high concentration certified reference materials alone.

REPRESENTATIVENESS: Field measurements will include spatial and temporal variations of interest. The sampling and analytical methods are chosen in accordance with well-documented procedures used for previous water quality monitoring in the Bay. Representativeness will be assessed after each sampling event to help adjust criteria for additional sampling events, and through post hoc analysis of the temporal and spatial distribution and variability in the collected data.

COMPARABILITY: Methods used for sample collection and laboratory analysis will match those used in monitoring efforts in the region. Comparable QA/QC practices should provide a level of uniformity across various datasets. Any differences in data collection methods will be identified and clearly noted. The datasets may be analyzed for trends and anomalies to provide a clear understanding of the heterogeneity between the datasets.

SENSITIVITY: Sensitivity of field measurements is generally fixed by the output of the analytical instrument. Appropriate instruments and/or instrument settings should be chosen that generally allow differences between sites or within a site at different times to be reported. Resolution on the order of approximately 1% of the maximum or range of measurements likely to be encountered is desired. Sensitivity of lab measurements, expressed as detection or reporting limits, are determined by a combination of factors, often including sample size, extraction efficiency, background contamination, matrix interferences, and instrument sensitivity. Appropriate methods should be chosen that generally allow significant differences between sites or within a site at different times to be reported. For chemical analyses, the ability to detect an analyte at concentrations at least 10 times below any applicable criterion or toxicity threshold, and preferably detected in at least half of all collected samples is generally desired. Such low detection limits are sometimes not achievable due to limitations on currently available instrumentation as well as other practical constraints such as maximum extractable sample size, ubiquitous background contamination, and other factors. In such cases, analyses may proceed with the best currently available methodology, as long as the analyses provide information usable by the RMP (e.g., non-detects or semi-quantitative results providing estimates for upper bounds of possible concentrations), with attention to advances in instruments or methods that can overcome some of these obstacles.

A7. Distribution List

Name	Organization	Role	Contact
Dana Michels	USEPA	USEPA Grant Project Officer	michels.dana@epa.gov; 415-972-3783
Jay Davis	SFEI	RMP Lead Scientist	jay@sfei.org; 510-746-7368
Amy Kleckner	SFEI	RMP Manager	amyk@sfei.org; 415-531-3390
Don Yee	SFEI	RMP QA Officer, Sr. Scientist	donald@sfei.org; 510-746-7369
Rebecca Sutton	SFEI	Sr. Scientist, Principal	rebeccas@sfei.org; 510-746-7388
Diana Lin	SFEI	Sr. Scientist, Principal	diana@sfei.org; 510-746-7385
Alicia Gilbreath	SFEI	Sr. Scientist, Principal	alicia@sfei.org; 510-746-7308
Matt Heberger	SFEI	Environmental Scientist, Principal	matth@sfei.org; 510-746-7399
Scott Dusterhoff	SFEI	Sr. Scientist, Principal	scottd@sfei.org; 510-746-7350
Beth Birmingham	SFEI	Project Manager	bethb@sfei.org; 909-646-0914
Thomas Young	UC Davis	Sr. Scientist, Principal	tyoung@ucdavis.edu
Benjamin Linhoff	USGS - Water Resources Mission Area	Research Hydrologist	blinhoff@usgs.gov
Bill Arnold	University of Minnesota	Principal Investigator	arnol032@umn.edu
Ed Kolodziej	University of Washington	Principal Investigator	koloj@uw.edu

A8. Project Organization

SFEI maintains primary responsibility for ensuring the successful completion of the grant. SFEI oversees all project scheduling, progress, and deliverables, including progress reports that provide timely information on project outputs and outcomes. The roles and responsibilities of those involved in the implementation of tasks within Tracking Bay Health are described below.

<u>Senior Project Manager</u> will have executive leadership authority and be the responsible official for overseeing the overall project and budget, as well as tasking subawardees and contractors with work required to complete this project. They will communicate project needs to subawardees and contractors.

<u>Operations Manager/Project Manager</u> will be responsible for supporting the Senior Project Manager in overseeing the overall project and budget, as well as managing the subawards and procured contracts required to complete this project.

<u>Task Leaders</u> will be responsible for ensuring each task is completed on time and according to the standards laid out in the QAPP. They will have overall responsibility for assigning appropriate personnel to complete the tasks included in this plan. They will ensure that the project budget is adhered to and will communicate with the Project Manager on work accomplished in this plan and any problems or deviations that need to be resolved.

<u>Project Quality Assurance Manager (QAM)</u> will be responsible for reviewing and approving the QAPP. They may provide technical input on proposed sampling design, analytical methodologies, and data review. In collaboration with the Principal Investigator, the QAM will determine if the QAPP needs to be updated.

<u>Project Principal Investigator</u> (PI) will be responsible for ensuring the deliverables produced by the grantee, subawardees, and contractors are coordinated and meet the goals of the project. The PI will also determine if the QAPP needs to be updated.

Title/Responsibility	Name/ Qualification
EPA Project Officer/Oversees Direction of Project	Dana Michels, Program Officer
Senior Manager	Amy Kleckner, RMP Manager
Project Principal Investigator	Jay Davis, RMP Lead Scientist

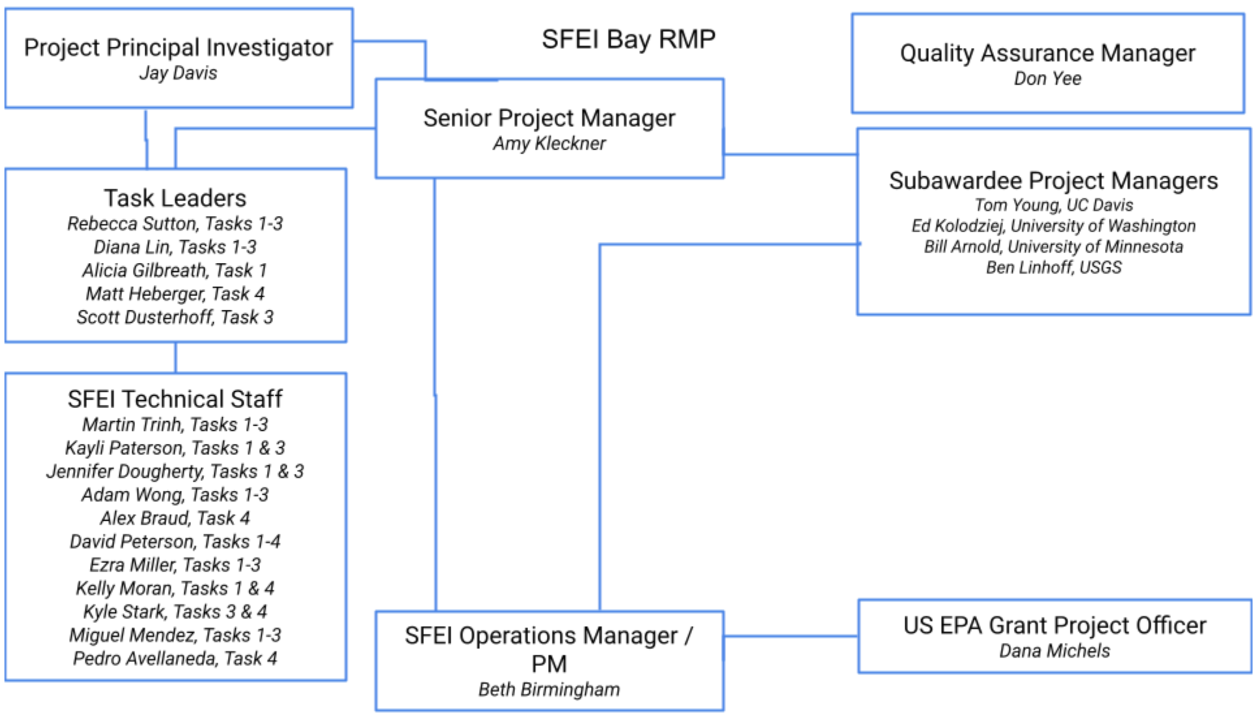
Operations Manager/Project Manager	Beth Birmingham, Project Manager
Project QA Manager/Oversees QA Activities for Field, Lab, Data Review	Don Yee, RMP QA Officer, Sr. Scientist
Task Leaders/QAPP Maintenance	1. Rebecca Sutton 2. Diana Lin 3. Alicia Gilbreath 4. Matt Heberger 5. Scott Dusterhoff 6. Jay Davis
Staff/Performs Project Tasks	1. Martin Trinh 2. Kayli Paterson 3. Jennifer Dougherty 4. Adam Wong 5. Alex Braud 6. David Peterson 7. Ezra Miller 8. Kelly Moran 9. Kyle Stark 10. Miguel Mendez 11. Pedro Avellaneda
Principal Environmental Data Users	1. Rebecca Sutton 2. Diana Lin 3. Alicia Gilbreath 4. Matt Heberger 5. Scott Dusterhoff 6. Jay Davis 7. Thomas Young, UC Davis 8. Bill Arnold, University of Minnesota 9. Ed Kolodziej, University of Washington
Collaborators/Performs Project Tasks	1. Thomas Young, UC Davis 2. Benjamin Linhoff, USGS 3. Bill Arnold, University of Minnesota 4. Ed Kolodziej, University of Washington

A9. Project QAM Independence

The Project Quality Assurance Manager (QAM) is independent of environmental information operations. The Project QAM's independence is ensured through separation of sections and reporting chains within the San Francisco Estuary Institute. The Project QAM has oversight authority and responsibilities for planning, documenting, coordinating, and assessing effectiveness of the QAPP. The QAM has authority to access and discuss quality-related issues with senior management outside of the direct supervisory chain as necessary.

A10. Project Organizational Chart and Communications

Figure 1. Template Organization Chart



A11. Personnel Training/Certification

No special training is required for field sampling and measurements. All staff participating in field work are trained by more experienced personnel and use the Health and Safety Manual for Fieldwork created by SFEI (see Appendix A of the NMS portion of this QAPP) as guidelines.

There is no specific training for laboratory staff. Staff are trained by more experienced personnel on the protocol described for each task.

A12. Documentation and Records

SFEI will collect records for sample collection, field analyses, and laboratory chemical analyses. Samples sent to analytical laboratories will include a Chain of Custody form. The analytical laboratories will maintain records of sample receipt and storage, analyses, and reported results.

SFEI maintains hard copy or scanned files of field notes and measurements, as well as laboratory submitted documentation and results at the SFEI main office. The SFEI Data Manager is responsible for the storage and organization of information. Contract laboratories are responsible for maintaining copies of project documentation originating from their respective laboratories, with backup archival storage offsite where possible.

Copies of laboratory methods, SOPs, and QA plans are available by request from the SFEI QA Officer. Some laboratory methods and SOPs may be edited to exclude proprietary details about the analyses. Quality assurance documents are reviewed by the PI of the project and QAO or their designees.

Copies of all records will be maintained at SFEI and at the laboratory for a minimum five years after project completion, after which they may be destroyed, except for the database at SFEI, which will be maintained without destruction. All data will be backed up and secured at a remote location (i.e., separate from the SFEI office). As needed, data recovery can be initiated by contacting the back-up facility for restoration and this will be covered through SFEI overhead.

After QA by the QA officer at SFEI, data will be uploaded by the data management team into CEDEN.

Group B: Implementing Environmental Information Operations

B1. Identification of Project Environmental Information Operations

To address the management questions posed, the RMP regularly conducts sampling of various environmental matrices annually or less frequently. This work is planned and performed under the guidance of the RMP Steering and Technical Review Committees, which are composed of environmental regulators and representatives of local stakeholders. The types of information that will be generated are manual and remote field sampling, field observations, lab analysis, and modeling.

Task 1 - Contaminant Monitoring in Water
Data will be collected from Bay water (ambient) and pathways (wastewater and stormwater) annually or less frequently to investigate ambient chemical concentrations of CECs, metals, legacy contaminants, and ancillary parameters for loadings, as well as spatial patterns and long term trends of contaminant concentrations and masses in San Francisco Bay and its segments. Information will be compared to WQO's as listed in the Basin Plan for San Francisco Bay where applicable and compared to levels in prior Bay monitoring and in peer reviewed literature.

Task 2 - Contaminant Monitoring in Tissues
Data will be collected from bird egg, fish, bivalve and mammal tissues annually or less frequently to investigate chemical concentrations of mercury, selenium, PCBs, PBDEs, PFAS and legacy pesticides, as well as spatial patterns and long term trends of contaminant concentrations in biota from San Francisco Bay. Information will be compared to WQO's as listed in the Basin Plan for San Francisco Bay where applicable and compared to levels in prior Bay monitoring and in peer reviewed literature.

Task 3 - Contaminant Monitoring in Sediment

Data will be collected from Bay sediments annually or less frequently to investigate ambient chemical concentrations of CECs, metals, legacy contaminants, and ancillary parameters for loadings, as well as spatial patterns and long term trends of contaminant concentrations and masses in San Francisco Bay and its segments. Information will be compared to WQO's as listed in the Basin Plan for San Francisco Bay where applicable and compared to levels in prior Bay monitoring and in peer reviewed literature.

Task 4 - Bay and Watershed Modeling

Modeling of Bay and watershed processes, including contaminant loading and fate will be conducted to simulate the response of the system under different scenarios. Models will be calibrated and validated in a retrospective application, using available past monitoring data, with the goal of reproducing general patterns of contaminant distribution and trends over time. Model sensitivity to various parameters and overall model uncertainty will be explored, to identify model elements most in need of additional refinement or data collection.

Once developed, the models will be used to make predictive explorations of the system response under different management scenarios, e.g., increases or decreases in various sources and loading pathways, redistribution within the Bay or watersheds, environmental transformations, and accumulation and impacts on resident biota. Predictive application of the models will allow regional managers to assess our ability to maintain or improve water quality under various planned action alternatives.

B2. Methods for Environmental Information Acquisition (sample collection)

Detailed Sampling and Analysis Plans will be developed for each field sampling effort to organize specifics for each monitoring effort, i.e., target analytes, sampling locations, personnel, analytical methods, handling requirements, etc. Field personnel will strictly adhere to RMP sampling protocols (Shimabuku et al., 2018) to ensure the collection of representative, uncontaminated, and uncompromised samples.

Any deviations from a sampling and analysis plan; for example a lost sample, broken equipment or improper or unsuccessful sample collection, will be immediately communicated to the field lead and documented in the projects SAP deviation log and the field data sheet.

Task 1 - Contaminant Monitoring in Water:

Field Sampling Methods - Water samples can be collected through either the use of a stainless steel bailer filled manually, or by using an automated pumping sampler to pump water either directly into pre cleaned sample bottles, or into a pre cleaned graduated cylinder to measure the appropriate aliquot size and then poured into the pre cleaned sample bottle. A high level of effort to avoid field contamination will be undertaken by the field staff. Clean hands/dirty hands technique will be implemented by field staff for handling of cleaned tubing as well as any sample bottles that are contained in cleaned double bags.

Laboratory Analysis Methods - Water samples will be analyzed using the methods listed in table B2-1 below

Table B2-1 Analytes and Lab Analysis Methods for contaminant monitoring in water samples.

Analytes	**Lab-Method**
Dissolved Organic Carbon	EPA 9060 / 9060M
Particulate Organic Carbon	EPA 440 - 9060
Chlorophyll-a	Caltest - SM 10200 H
Suspended Sediment Conc.	Caltest - ASTM D 3977-97, Method B-filtration
Cyanide	Caltest - SM 4500-CN I/E-11
Hardness	EPA 1638M (calculated from Ca & Mg)
Copper (dissolved)	EPA 1640 (column chelation) / BA-5020 Rev 001
Copper (particulate)	EPA 1638M
Oxygen (dissolved)	AMS-CA - YSI 556 Water Quality Meter
pH	AMS-CA - YSI 556 Water Quality Meter
Specific Conductivity	AMS-CA - YSI 556 Water Quality Meter
Temperature	AMS-CA - YSI 556 Water Quality Meter
As, Cd, Co, Pb, Ni, Ag, Zn	EPA 1640
Selenium, methyl mercury	EPA 1630M
Fe, Mn	EPA 1638M
Hg	EPA 1631EM
PAHs	SGS AXYS - MLA-021 Rev 07-08
PCBs	SGS AXYS - MLA-010 Rev 08-10, MLA-010 Rev 11
PFAS	SGS AXYS - MLA-110 Rev 02
PFAS TOP	SGS AXYS - MLA-111 Rev 02
PFAS NMR	Gauthier and Mabury, 2022
Pesticides	SGS AXYS - MLA-028 Rev 03, MLA-035 Rev 05
Bisphenols	SGS AXYS - MLA-113 Rev 01 ver. 03

Organophosphate esters	SGS AXYS - MLA-098 Rev 01 ver. 03
Non-target analysis	Moschet et al., 2017
QACs	Mahony et al., 2023
Novel Stormwater Tracer Suite	Hou et al., 2019
Plastic Additives	Chen et al., 2021
Xenopus laevis tadpole induced metamorphosis assay	Mengeling et al., 2017
GH3.TRE-LUC assay (thyroid hormone receptor reporter assay)	Freitas et al., 2011
Gal4-RXR reporter assay	Luria et al., 2004
ERalpha-CALUX estrogen receptor reporter assay	Rogers and Denison, 2000
231GR glucocorticoid receptor reporter assay	de la Rosa et al., 2021
Cell based bioassay for progesterone receptor activity	Finckh et al., 2022

Task 2 - Contaminant Monitoring in Tissues:

Field Sampling Methods - Bird Eggs will be hand collected from nests by USGS-WERC using approved USGS field collection and handling protocols (Ackerman et al., 2013). Bivalve samples can be collected using a clam dredge or a Van Veen grab sampler. Fish will be collected using otter trawls, Mamou trawl, hook and line, gill nets, beach seines, poke poling, and or cast nets. Mammal tissues will be collected by Marine Mammal Center staff using their approved and existing recovery and sample collection efforts.

Laboratory Analysis Methods - Tissue samples will be analyzed using the methods listed in table B2-2 below

Table B2-2 Analytes and Lab Analysis Methods for contaminant monitoring in tissue samples.

Analytes	**Tissue Type**	**Lab-Method**

Selenium	Bivalve	USGS - Kleckner et al. 2017, EPA 6020AM EPA 1638M
Mercury	Bird Egg, Fish	EPA 7473
Selenium	Bird Egg	EPA 200.8
Selenium	Fish	USGS - Kleckner et al. 2017, BAL-5000 Rev 001a
PBDEs	Bird Eggs	EPA 8081BM
PBDEs	Fish	EPA 1614A
PCBs	Bivalves	EPA 1668A
PCBs	Bird Eggs, Fish	EPA 8082M
Dioxins and Furans	Bird Eggs	EPA 1613BM
Dioxins and Furans	Fish	SGS AXYS MLA-017 Rev 20
Pesticides	Bird Eggs	EPA 8081BM
PFAS	Bird Eggs, Fish	SGS AXYS - MLA-110
PFAS NMR	Bird Eggs, Fish, Mammal	Gauthier and Mabury, 2022
PFAS	Mammal	SGS AXYS - MLA-110 Rev 02 Ver 12
Non-target analysis	Fish	Nonpolar compounds, Crimmins lab: Fernando et al. 2018; Renaguli et al. 2020 Polar compounds, Crimmins lab: Crimmins et al. 2014; Fakouri Baygi et al. 2021
Non-target analysis	Mammal	Nonpolar compounds, Hoh lab: Cossaboon et al. 2019 Nonpolar compounds, Crimmins lab: Fernando et al. 2018; Renaguli et al. 2020 Polar compounds, Crimmins lab: Crimmins et al. 2014; Fakouri Baygi et al. 2021

Task 3 - Contaminant Monitoring in Sediment:

Field Sampling Methods - Sampling in San Francisco Bay will be conducted from a vessel equipped with an a-frame and hydraulics for deploying a 0.1 m2 modified Van Veen sediment grab. A stainless steel scoop and bucket will be used to remove and composite sediments All sampling and handling will be conducted using clean techniques. Samples will be collected from the top 5 cm of the VanVeen grab following the protocols in the 2018 Field Operations Manual (Shimabuku et al., 2018) To avoid contamination between stations, equipment used at different sampling stations will be cleaned in the field between uses.

Laboratory Analysis Methods - Sediment samples will be analyzed using the methods listed in table B2-3 below

Table B2-3 Analytes and Lab Analysis Methods for contaminant monitoring in sediment samples.

Analytes	**Lab - Method**
Total Organic Carbon	EPA 9060M - EPA 440
Total Nitrogen	EPA 440
Al, Cd, Cu, Fe, Pb, Mn, Ni, Ag, Zn, As	EPA 6020AM
Methyl mercury	EPA 1630M
Mercury	EPA 6020AM - EPA 1631
Selenium	EPA 6020AM - EPA 1632
PAHs	EPA 8270M
PBDEs	EPA 1614M
PCBs	EPA 1668A
PFAS	SGS AXYS MLA-110 Rev 02
PFAS NMR	Gauthier and Mabury, 2022
Pesticides	EPA 1668AM

Task 4 - Bay and Watershed Modeling

The evaluation of sediment and contaminant fate and transport will build upon a strong foundation of hydrodynamic and watershed modeling by the San Francisco Estuary Institute (SFEI) and other Bay-wide studies.

The in-Bay fate model will be developed to evaluate sediment and contaminant transport and will leverage the well-verified SF Open Bay hydrodynamic model (SFEI 2023) using DFlow-FM. The model grid will be refined as necessary for the open Bay and specific margin areas of particular interest. Sediment transport processes will be added to simulate sediment fate and the fate of sediment-associated contaminants like PCBs.

B3. Integrity of Environmental Information

Field Sampling - Samples are maintained chilled on ice in coolers or refrigerators or frozen on dry ice or in freezers, if required. Samples will be checked periodically to ensure that samples are appropriately protected and ice is added as needed. Container lids are checked for tightness and sealed with tape if necessary. Immediately upon return from the field, the samples will be packed with more ice or dry ice as appropriate, and then protectively wrapped and shipped to the respective laboratories via overnight carrier, or placed into appropriate storage (refrigerator or freezer, or kept in coolers on wet or dry ice), if shipping that day is not possible. For sampling events occurring on Thursdays or Fridays, staff should consider the potential for shipping delays (e.g., customs, bad weather) and the laboratory work schedule, which could allow samples to thaw or warm. Consult with laboratory staff as needed to determine whether holding time or storage condition is a more critical factor to sample integrity for the analyses to be performed. All shipped samples will be accompanied by a 'Chain of Custody' form that serves as a shipping record and indicates the pertinent sample identification information and analyses requested for each sample. Chain of custody (COC) forms are filled out, copied, and stored each time control of samples is transferred (e.g., from the field to a receiving laboratory or between laboratories). In addition to standard shipping information, the following information is required: sampling event number, site name and code, collection date, sample type, analysis required, preservatives added, and other remarks as needed. The Project Manager is responsible for sample handling, tracking, and chain of custody forms. Copies of all COCs are maintained in SFEI records.

Laboratory Analyses - A Performance-Based Measurement System (PBMS) is a flexible approach wherein the data quality needs, mandates or limitations of a program or project are specified, rather than prescribing particular methods for analyses. Although methods for laboratory analyses are listed in Tables B2-1-3, in a PBMS approach they only document the methods currently or previously used or planned for Project studies rather than prescribing particular analytical methods. Key questions will be addressed to determine the appropriateness of methods to be used. For the methods selected for a particular application, the Laboratory Project Manager must be able to demonstrate and document that the method's performance meets the data quality requirements of the project. Two separate factors are involved in demonstrating method applicability: First, demonstrating that the laboratory can perform the method properly in a clean matrix with the analytical system under control, and second, demonstrating that the method selected generates "effective data" in the matrix of concern. The former addresses lab or operator training and proficiency, while the latter demonstrates that the selected method performs with the appropriate selectivity, sensitivity, bias and precision, in the actual analytical matrix, to achieve project goals. All analytical methods SOPs will be requested from the respective analytical laboratories. Copies of laboratory SOPs are also stored at SFEI but cannot be released to any external parties without prior consent of the laboratory. Corrective actions for laboratory analytical failures will be specified in the laboratory analytical method SOPs.

B4. Quality Control

Field QC Measurements: Calibration of any field meters (e.g., hand-held pH, temperature, conductivity, DO, or other measurements) should be checked in the field at least once daily and recalibrated using certified standards where possible. Instruments will be recalibrated when significant drift or miscalibration is found. Beyond initial calibration of handheld field instruments and periodic calibration checks in the field, QC measures taken for field instrument measurements should include replicates at a frequency of one per day or per 20 measurements, taken on a spatial and temporal scale at which measurements are expected to be relatively invariant, as the goal is to establish the precision of a measurement, rather than just characterize the variability of the ecosystem.

Field QC Samples: Field QC samples that are frequently collected for later lab analysis in sampling protocols are listed below. Some of these samples only need to be taken when an established procedure is changed or when problems are identified, whereas others need to be taken at intervals throughout the sampling process. These may include:

1. Travel/bottle Blanks: These account for contaminants introduced during the transport process between the laboratory and field site, in addition to any contamination from the source solution and container.

2. Equipment Blanks: These account for contamination introduced by the field sampling equipment in addition to the above sources.

3. Field Blanks: These account for all of the above sources of contamination that might be introduced to a sample, as well as those due to the immediate field environment. Field blanks are generated under actual field conditions and are subjected to the same aspects of sample collection, field processing, preservation, transport, and laboratory handling as the environmental samples.

4. Field Replicates: These account for variability in the field collection and laboratory analysis combined.

Routine preparation, collection, and analysis of all the field performance samples mentioned above are generally not necessary. Of the possible blank samples, only field blanks will be routinely collected and analyzed, as they will encompass all the possible contamination sources in container and equipment preparation, transport, handling, and sampling methodology. If problems are found with field blanks, other blank sample types may be collected in follow-up sampling to try and determine the source of contamination.

Field blanks for water will be generated under actual field conditions at a minimum frequency of one per field effort (e.g., a set of samples collected by the same methods over the duration of a sampling cruise) or approximately per 20 sites. They will be treated in both the field and laboratory procedures in as similar a manner as possible as the environmental field samples.

Labs generally send sample containers that have already been checked for contamination, and transport of unopened bottles is unlikely to introduce contamination. Possible contamination during the transport between the laboratory and field site will be mitigated by measures taken to keep the sample bottles in an enclosed microenvironment (e.g., double bagging). Travel and equipment blanks will rarely be collected unless field blanks or field sample results indicate potential problems.

Field replicates of all types of samples to be analyzed will be routinely collected at a minimum frequency of 1 per 20 samples to evaluate variability including performance of the sampling system and methodology. Short-term environmental variability, most notably due to changing currents and heterogeneous suspended sediment loads, can affect the sampling reproducibility, although water is generally more easily mixed and thus often consistent between field replicates. In contrast, sediment contaminant concentrations can vary greatly within small distances. Therefore, much of the variability captured in sediment field replicates reflects spatial variability of the sampling scheme rather than of performance of the collection and analytical methods.

Laboratory QC Samples: Data to be provided to the project manager for evaluation for the full QA/QC program used is in the individual scopes that are part of contracts but should include at the least the following QC data:

1. Surrogate Recovery (for all field and QC samples, if applicable)

2. Method Blank

3. Matrix Spike Recovery

4. Certified/Lab Reference Material (CRM) Recovery

5. Replicate precision (field, CRM, matrix spike, blank matrix spike samples)

Surrogate spikes should be included in all samples where appropriate for the analysis. Although surrogate spike recoveries can be used to estimate and correct for losses of the target analytes in the analytical process, unusually low or high recoveries reflect analytical issues that are not overcome simply by surrogate correction, because at low recoveries, surrogate correction factors become inversely larger. It is generally left to the professional judgment of the lab's QAO to set appropriate control/acceptance limits and corrective actions for surrogate recoveries. Results for organic analytes should generally be reported as surrogate-corrected, unless specific issues are identified (e.g., analytical interference for the surrogate, but not the target compound) that would render the surrogate-corrected result less accurate than the uncorrected result. The results for individual surrogates should also be reported, as percent recoveries (i.e., not just applied to correct target analyte results).

Method blanks should be run at a minimum frequency of one per batch or per 20 (field) samples for larger analytical batches. Results for laboratory method blanks, combined with those for field blanks, can help identify whether probable causes of sample contamination originated in the field or in laboratory analyses. If both field and lab method blanks have similar levels of contamination, it is likely caused primarily in lab procedures. If field blanks have higher contamination, sample collection methods are likely the cause. Raw results for method blanks should be reported, even (and especially) when field sample results are reported as blank-corrected. Batches with a single method blank measurement cannot be reported as blank-corrected, as in such cases there is no data on the variability (and thus appropriateness) of the subtracted blank value.

Matrix spikes (MS) should be run at a minimum frequency of one per batch or per 20 samples. Matrix spike results are to be reported, along with the expected result (unspiked sample concentration + spike concentration), and a recovery estimate. The spiking concentrations should be high enough to produce an expected result sufficiently over the analytical variability in quantifying the unspiked sample to quantify recovery (at least ~3 times the unspiked result), but also low enough to be a relevant accuracy indicator in the concentration range of field samples (below 100x and preferably nearer 10x the unspiked result). In cases where analytes are mostly not detected in unspiked samples, a concentration range of that magnitude (10-100x) over the MDL may be appropriate to use instead.

Precision can be determined with all sample types analyzed and reported in replicate. Lab replicates (split and analyzed in the laboratory) of field samples are generally the preferred indicator of precision for typical field samples, as the target analyte concentration range, matrix, and interferences are most similar to previous analyzed samples or samples from nearby sites. However, sometimes field sample concentrations are below detection limits for many analytes, so replicate results on CRMs, LRMs, MS/MSDs, or blank spikes (LCSs) may be needed to supplement and obtain quantitative precision estimates. These alternative sample types, in particular LCSs, should not serve as the primary or exclusive indicator of measurement precision without prior approval by the Project Manager and QAO. LCSs are often created from a clean laboratory matrix, so they are likely not representative of the measurement precision routinely achievable in more complex matrices of real field-originated samples. RPDs or RSDs should be calculated as described previously and reported for all samples analyzed in replicate.

Certified reference material (CRM) or other externally established performance testing samples should be run at a frequency of one per 20 samples, a minimum of one per set (e.g., reported for one sampling season) of samples analyzed, with results reported along with the expected values and recoveries (as % of the expected value), where available for target analytes in appropriate matrices. In some cases, no widely available reference materials have been established and laboratories maintain internal lab reference materials (LRM) to track the relative internal accuracy of an analytical method. CRMs are likely the most robust indicators of measurement accuracy, given requirements for consensus among labs as well as validation through different methods of measurement. Reference values for CRMs or internal LRMs, although less rigorous (fewer labs in consensus, or only one analytical method provided), provide at least some indicator of measurement accuracy. Although poor recoveries on these uncertified values may be used to flag potentially unreliable data for use in data analyses and decision-making, they should not be used to cite or sanction a lab for “failing” to meet MQO requirements. Data will be flagged for performance outside of the target ranges, even if the published method has wider acceptance criteria for an analyte. However, data will not be rejected or refused for being outside of targets, especially if they are still within the published method acceptance limits.

For modeling watershed processes, hydrologic processes will be calibrated using available flow data from well-monitored watersheds, with a portion of the data (e.g., specific watersheds or time periods) excluded and used instead to validate model performance for data outside of the model training (calibration) set. Pollutant loading models will be validated using available contaminant monitoring data from sample watersheds, and validated using data withheld from the calibration. Similarly, Bay processes will be calibrated using available monitoring data, with a portion withheld for use in model validation. Model sensitivity to individual parameters or combinations of input parameters will be explored by testing model outcomes using different plausible input parameter values.

B5. Instrument/Equipment Calibration, Testing, Inspection, and Maintenance

Prior to use in the field, water quality instruments are calibrated against appropriate standards and, if possible, checked against a standard from a different source. For some measurements such as dissolved oxygen, probes are often calibrated to ambient conditions (water-saturated air) rather than to known standards. In such cases, the field staff should verify appropriate qualitative instrument response (e.g., in water deoxygenated by sparging, sodium sulfite addition, or other means). All calibrations are documented on a calibration checklist on the individual instrument or its case with date, time, and operator name. If an instrument cannot be calibrated or is not reading correctly, a backup instrument will be used to measure water quality parameters. If possible, problems with an instrument are addressed by field staff, who will also notify the Field Supervisor and other staff trained in troubleshooting and/or repair. For instruments that cannot be repaired in-house, the Field Supervisor in consultation with the Program Manager will choose an appropriate course of action, either sending the instrument for repair, or purchasing a replacement as necessary.

Laboratories maintain calibration practices as part of their method SOPs. Upon initiation of an analytical run, after each major equipment disruption, and whenever on-going calibration checks do not meet recommended MQOs, the system will be calibrated with a full range of analytical standards. Immediately after this procedure, the initial calibration must be verified through the analysis of a standard obtained from a different source than the standards used to calibrate the instrumentation, prepared in an independent manner, and ideally having certified concentrations of target analytes (e.g., a certified solution). The calibration curve is acceptable if it has an r2 of 0.990 or greater for all analytes present in the calibration mixtures. If not, the calibration standards, as well as all the samples in the batch, must be re-analyzed. All calibration standards will be traceable to an organization that is recognized for the preparation and certification of QA/QC materials (e.g., NIST, NRCC, US EPA). Calibration curves will be established for each analyte and batch analysis from a calibration blank and a minimum of three analytical standards of increasing concentrations. If the instrument response is demonstrated to be linear over the entire concentration range to be measured in the samples, the use of a calibration blank and one single standard that is higher in concentration than the samples may be appropriate. Otherwise, only data within the working calibration range (above the MDL) should be reported (i.e., extrapolation is not acceptable). Samples outside the calibration range will be diluted as appropriate, and reanalyzed.

Field measurement equipment will be checked for operation in accordance with the manufacturer's specifications. This includes battery checks, routine replacement of membranes, and cleaning of electrodes. All equipment will be inspected for damage or malfunction when first handed out and when returned from use by the field sampling crew. Needed repairs or operational problems are to be reported to the Field Supervisor. The Field Supervisor will also (or instruct appropriate staff to) examine equipment at least quarterly for operational status, even if no sampling using that equipment is immediately planned.

Instruments delivered through a manufacturer were equipped with a corresponding accessory case including spare parts and maintenance supplies. All spare parts will be transported to the field and will be available for replacing malfunctioning parts. Additionally, two extra sets of batteries will be available in the field. If any instrument deficiency should occur, troubleshooting can be conducted on site utilizing the instrument manual and experience of the field staff, making any necessary repairs, and re-calibration. All incidents and issues regarding the proper functioning of the equipment will be recorded on the Field Form and reported to the SFEI Field Supervisor. Contract laboratories maintain equipment in accordance with their respective SOPs, which include those specified by the manufacturer and those specified by the method. Under the performance-based approach, the adequacy of contract laboratory testing, inspection, and maintenance procedures are determined through regular review of results for analysis of field and QC samples for all submitted data.

B6. Inspection/Acceptance of Supplies and Services

Supplies are examined for completeness, damage, and/or suitability for use as they are received whenever possible, and upon use for supplies that should remain sealed. The Project Manager or designated staff will be responsible for inspecting supplies for damage and suitability for use. Checks should include the following:

1. Sample containers – should be appropriately sealed (e.g., double bagged), of the correct/expected materials, with appropriate documentation of cleaning or testing (batch numbers, residue tests), visibly clean, and intact (no evidence of degradation, damage).

2. pH, conductivity, and other standards are to be checked by comparing their measurements with those generated by the current lot of standards, unless the current lot is expired or is suspected to have been compromised. Standards must agree within 1%. If results disagree, the instruments should be checked with standards from another source.

3. Other supplies such as gloves, coolers, and ice packs should be checked for condition and integrity before use in the field. Supplies should be of appropriate materials both to avoid contaminating samples (e.g., powder free gloves) and to protect field staff from chemicals to which they might be exposed during sampling (methanol washes, preservative acids)

Missing, damaged, or incorrect field supplies should be noted and immediately reported to the Project Manager and Field Supervisor, who will then contact the appropriate suppliers and laboratories to replace damaged items. Chemical supplies and calibration standards should be checked at least quarterly to meet the required criteria (e.g., expiration date) and to assure that decreasing and missing supplies are reordered. The analytical laboratory maintains internal SOPs for inspection and quality checking of supplies. Under a PBMS approach, these procedures are presumed to be effective unless field and QC data from analyses or issues noted by SFEI staff receiving supplies indicate otherwise (e.g. container damage, visible contamination). SFEI will then work with the laboratory to identify the causes and address deficiencies in the SOPs that resulted in those problems. If the problem is serious and cannot be corrected by the laboratory, the Project Manager and QAM will discuss and identify alternatives, including changing the sampling materials and methods, the extraction and analytical methods, the laboratory, or any combination of these.

B7. Environmental Information Management

SFEI will collect records for sample collection, field analyses, and laboratory chemical analyses. Samples sent to analytical laboratories will include a Chain of Custody form. The analytical laboratories will maintain records of sample receipt and storage, analyses, and reported results.

SFEI maintains hard copy or scanned files of field notes and measurements, as well as laboratory submitted documentation and results at the SFEI main office. The SFEI Data Manager is responsible for the storage and organization of information. Contract laboratories are responsible for maintaining copies of project documentation originating from their respective laboratories, with backup archival storage offsite where possible.

Copies of laboratory methods, SOPs, and QA plans are available by request from the QAM. Some laboratory methods and SOPs may be edited to exclude proprietary details about the analyses. Quality assurance documents are reviewed by the PI of the project and QAM or their designees.

Copies of all records will be maintained at SFEI and at the laboratory for a minimum five years after project completion, after which they may be destroyed, except for the database at SFEI, which will be maintained without destruction. All data will be backed up and secured at a remote location (i.e., separate from the SFEI office). As needed, data recovery can be initiated by contacting the back-up facility for restoration and this will be covered through SFEI overhead.

Group C: Elements for Assessment, Response Actions and Oversight

C1. Assessments and Response Actions

Laboratory Performance Audits/Corrective Action: Initially, a desktop or on-site performance audit will be performed by the QAM and designated staff to determine if each laboratory can meet the requirements of the QAPP and to assist the laboratory where needed. Review of current NELAP and/or state ELAP certification of a laboratory for the analyses performed for the RMP may be accepted in some cases in lieu of an on-site audit. Reviews may be conducted at any time during the scope of the study. Results will be reviewed with participating laboratory staff and corrective action recommended and implemented, where necessary. Furthermore, laboratory performance may be assessed through laboratory intercomparison studies (round robins) when requested by SFEI, such as those conducted by the National Institute of Standards and Technology (NIST). The progress of the work conducted on RMP studies will be evaluated monthly. If data quality issues are identified, a preliminary meeting will be held between SFEI's QAM and the Senior Project Manager to discuss possible solutions. If necessary, a corrective action plan will be developed in consultation with the appropriate lab(s), the corrective actions taken, and the issue and its resolution summarized in a brief report or memorandum. A summary of these issues will be maintained in the Project files, and will be noted in any reporting that includes affected data.

C2. Oversight and Reports to Management

RMP data are publicized through RMP Annual Monitoring and/or Pulse of the Bay reports, which are available online via the SFEI website (sfei.org) or as printed hardcopies, as well as in downloadable data tables. Reporting of pilot and special study results are included in various reports, publications, and presentations subject to peer review, and will be produced throughout the duration of the project and posted to the SFEI website. Following general goals for RMP reporting, data from monitoring samples are reviewed and available for dissemination within one year of the sample collection. More detailed analyses such as statistical analyses and/or modeling of temporal and spatial trends follow the specific reporting timelines of those program elements. Reporting goals may be modified as study plans are further developed. The QAM is responsible for summarizing potential QA issues with reported data and communicating those issues to the Project Manager. The QAM also reviews any SFEI analyses and reports generated from the data, to ensure that QA issues are appropriately acknowledged and addressed.

Group D: Elements for Environmental Information Review and Usability Determination

D1. Environmental Information Review

After data are submitted, SFEI staff examine the data set for completeness (e.g., correct numbers of samples and analyses, appropriate QC sample data included) and accuracy (e.g., in sample IDs). The QAM or designee will examine submitted QA data for conformance with MQOs. Data that are incomplete, inaccurate, or failing MQOs without appropriate explanation will be referred back to the laboratory for correction or clarification. The QAM will discuss data failing MQOs with laboratory staff to determine whether modifications to analytical methods can be made to improve results on reanalysis. If problems cannot be readily corrected (insufficient sample, irremovable interferences, or blank contamination based on past attempts with the lab), results outside the MQOs may be flagged to alert data users to uncertainties in quantitation. Results greatly outside the target MQO range (z-scores or p-scores > 2) may be censored and not reported.

In addition to contamination and other artifacts introduced by sampling and analytical methods, errors may arise at many points in the processing and transmittal of data generated for the RMP. Characteristics of reported data are examined to identify possible problems in the generation and transmission of data. Organic data submitted to the RMP are compared to values in the literature for comparable environments and from previous SFEI monitoring to evaluate their environmental coherence. Simple statistics (e.g., minimum, maximum, mean, median) may be generated to quickly identify data sets or individual data points greatly outside of their expected range. Anomalous individual points will be examined for transcription errors. Unit conversions and sample quantitation calculations may be reviewed to identify larger and systematic errors.

Where groups of analytes or results in different environmental phases are or can be summed to generate totals (e.g., % gravel + sand + fines = 100%, dissolved + particulate = total), data sets or individual samples will be further checked for internal consistency. For example, total water concentrations of contaminants should generally be greater than dissolved concentrations. Gross deviances may be used to identify problems in sampling, analysis, quantitation, or data transcription and transmission. Problems found by SFEI staff will be relayed to the appropriate laboratory and field sampling staff to address. However, in some cases (particularly where the differences are on the order of the MDL), total results less than dissolved or other deviations from expected ratios may indicate the uncertainty typical for the analytical method and apparent anomalies will be evaluated on a case-by-case basis.

Data are submitted to SFEI in an electronic tabulated format. The Project Manager or designated project staff verify that results for appropriate field and QC samples are reported by comparing the sample types and numbers provided against those specified in the detailed project plan, chain of custody forms, and/or contracts. SFEI's QA Officer or a designee/and designated trained staff perform all QA reviews. The contract laboratory's QA Officer (QAO) performs checks of all of its records and with the laboratory's Director or Project Manager should verify consistency among lab records, submitted reports (hardcopy and/or pdf and other fixed formats), and electronic data deliverables. As data are formatted and QA reviewed at SFEI, issues are noted in a narrative list and communicated to the field or laboratory teams as needed to correct any problems found (e.g., unanalyzed samples left in storage, transcription errors). Reported QC sample data are compared to measurement quality criteria. Exceedances of MQOs not already noted by the laboratory are flagged in any electronic databases and communicated to the analyzing laboratory for possible recalculation and/or reanalysis. Reconciliation and correction of errors in reported data will be addressed by consultation among SFEI's Project Manager, QAM, Field Supervisor, and Analyst(s) with the Laboratory's QAO, Laboratory and/or Project Manager, and appropriate lab personnel. The involved parties will agree upon any corrections.

Analyses sometimes produce results that fail MQOs and may not be possible to overcome for a small number of analytes within a large group of related compounds. For example, there may be contamination that is impossible to eliminate for all analytes when analyses are conducted at ultra-trace levels. With agreement of the SFEI Project Manager and QAM in consultation with the Laboratory, results for sample groups with data outside of MQOs may be flagged, to indicate the greater uncertainty in the quantitation of those data. Results on individual analytes that are greatly outside the target MQO range (e.g., z-scores > 2) will be censored as needed rather than subjected to repeated analysis. Reports, graphs, tables, or summary statistics generated from datasets with censored data should note their exclusion or other handling.

Repeated analysis may not fix any issues but rather just mask variability, creating a false impression of the quantitative certainty of results. Contamination of method blanks can sometimes represent a temporary source of contamination, and flagging results of batches in which contamination is found in blanks is appropriate. However, consider for example a batch of samples in which the odds of an airborne microparticulate contaminant in the lab falling into an individual sample is 10%. In a batch of samples, 1 in 10 times that contamination enters the blank sample, raising alarm and perhaps triggering reanalysis. Repeated blank analysis in various batches will apparently pass muster 90% of the time, but contamination may in reality still affect 10% of the non-blank field samples. By eliminating the "failed" batches with contamination in blanks, all that remain are the seemingly good batches, with no indication of the level of contamination that is truly still present in many (10%) of the samples. As a good practice, sample results in batches with detected blank contamination will be flagged (for field samples with analyte concentration > 3x those found in method blanks) or censored (for results < 3x those in blanks) by SFEI, but data users should be aware of the possible influence of sporadic contamination in other batches analyzed around the same time, particularly for samples with low concentrations similar to those in blanks.

Similar analogies can be made with failures of precision or accuracy QC measurements. Individual failures may fall within the range of the true variance in the measurement, e.g., NIST acceptance ranges are sometimes in excess of ±50% of the mean values, and while reporting only successful reanalysis batches may appear to produce more consistent and certain results, without fundamental changes to the analytical process, the underlying uncertainty may only have been masked/censored rather than truly reduced for the reported field samples. This is not to say that reanalyses are never warranted or desirable, but rather to underscore that improved results on QC measurements, which can sometimes be achieved simply by repeat analysis and discarding previous failed results, should not be confused with improved measurements, which are only achieved by making real substantive changes to the sampling and/or analytical methods. If reanalyses are to be attempted, it is therefore imperative that the Project Manager and QAO work in consultation with laboratory staff to identify and change the factors that may have led to MQO deviances, rather than simply repeat the analyses until the QC passes. For MQO deviations (z-score or p-score > 1) for which causes are not identified and that are not fixed by corrective actions, field sample results may be qualified, or censored if grossly deviating (z-score or p-score > 2). The QC data used for determination of flagging is subject to the availability of data on various QC sample types and the professional judgment of the QAO, but where possible, data for flagging recovery should be 1) in a similar matrix as samples, 2) with externally validated expected values, 3) in a quantitative range, and 4) in a similar concentration range as field samples. Thus for evaluating recovery, the order of preference is generally CRM > LRM > MS > LCS, with exceptions and changes in preference made for factors such as non-certified values, certified values with wide uncertainty bands, and concentrations greatly different from those in field samples. Similarly, for evaluation and flagging of lab precision, QC samples should: 1) be in the same matrix as field samples, 2) isolate lab variation from other causes, 3) be in a quantitative range, and 4) be in a similar concentration range as field samples, where available. For evaluating precision then, the preferred sample types for replicates are: lab > field > MS ~ CRM > LCS, again with exceptions made depending on the available sample types, their inherent variability, concentration ranges, and other factors.

D2. Usability Determination

The QA/QC requirements presented in the preceding sections are intended to provide a common foundation for each laboratory's protocols; the resultant QC data will enable assessment of the comparability and uncertainty of results generated by different laboratories and analytical procedures. It should be noted that the QC requirements specified in this plan represent the minimum requirements for any given analytical method; labs are free to perform additional QC in accordance with their standard practices. In addition to performance on required QC measures and samples (i.e., MDLs, blanks, matrix spikes, CRM, replicates), data are also examined for internal and external consistency to ensure that reported values are realistic and representative for the locations and matrices of collected samples. This review may include but is not limited to:

1. Comparison of reported values to those from previous years for the same locations and matrices, where available; large differences from previously reported values may not necessarily indicate analytical issues and may simply reflect natural spatial and temporal variability of the ecosystem.

2. Comparison of reported values to those in the published literature, where available; differences from other regions and/or species may merely indicate differences in resident species and ecosystem structure, but very large (e.g., 2-3 orders of magnitude) differences may sometimes help identify errors in analysis or reporting (e.g., unit conversions).

3. Internal checks of relative analyte abundance – variations in concentrations of one compound or isomer in a class of chemical contaminants are often tightly linked to those of related compounds, such as a compound and its degradation products or manufacturing byproducts, or various congeners in a commercial mixture. Deviations in these relative abundances can sometimes indicate matrix interferences or other analytical problems, although care should be taken to not disregard results that might reveal atypical sources and/or ecosystem processes.

4. Relative abundance in sample fractions or matrices – contaminants often partition between phases in predictable ratios, depending on their chemical properties and ambient conditions such as dissolved organic carbon and sediment organic carbon content. Big differences from expected ratios in dissolved versus particulate phases for water samples or sediment versus porewater concentrations may indicate problems with extraction or analysis for individual samples or sets of samples. In particular, sample concentrations for filtered (dissolved phase) water samples should always be lower than results for whole (dissolved and particulate phase) water, although at low concentrations, the variability in quantitation may be sufficient for some total water results to be reported at concentrations lower than those for dissolved phase alone.

Tables, Figures, Appendices, Abbreviations

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