

Fiscal Year 2027 Program Plan

San Francisco Bay Nutrient Management Strategy



PREPARED BY

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PREPARED FOR

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Table of Contents

Acknowledgements	1
Table of Contents	2
1. Introduction	3
2. FY27 Program Plan Budget and Overview	4
3. FY27 Program Plan	7
3.1. Modeling	7
CMOD.1 Biogeochemical Model Development	7
CMOD.2 Predicting the 2022 HAB Event's Progression and Effects	9
CMOD.3 Scenarios: Environmental Change, Critical Conditions, Management Alternatives	11
CMOD.4 Load Reduction Scenarios (Nutrient Trading)	13
CMOD.5 Source Apportionment: Techniques for Determining DIN Zones of Influence	15
CMOD.7 Model Infrastructure	17
CMOD.8 Convene NMS Model Advisory Group	18
EMOD.1 & 2 LSB model Refinements, Tracer Simulations, and Workplan development	19
EMOD.6 HAB Modeling Workgroup	20
3.2. Monitoring	21
CMON.1 Ship-based Monitoring	21
CMON.2 Moored Sensor Monitoring	23
CMON.3 Biogeochemical Mapping: South Bay + Central-San Pablo-Suisun	25
EMON.1 Expand Ship-Based Monitoring	26
EMON.5 Data Management, QA/QC, Documentation	27
3.3. Field/Lab Studies, Synthesis	28
FLOB.1 Monitor Changes from POTW Load Reductions	28
FLHAB.1 Investigate Whether the 2022 H. akashiwo was a Recent Arrival to SFB	29
FLHAB.2 Investigate the Role of Viruses in Terminating the Summer 2022 Event	30
FLHAB.X Consolidated Placeholder: FLHAB.4, FLHAB.6, and FLHAB.8	32
FLHAB.7 HAB Toxins in Archived Mussel Samples	34
AFHAB.3A Incorporate Space-Time Considerations Into Condition Assessment	35
AFOB.1 Open Bay Assessment Framework	36
SYNOB.2 Semi-Empirical Estimates of Biogeochemical Transformation Rates (Denitrification)	37
SYNHAB.1 Analysis of Multi-year HAB and Toxin Datasets	38
SYNHAB.2 Analysis of Long-term Forcing and Condition Data	39
SYNHLS.1 High Level Science Communications Products	40
3.4. Program Management	41
PM Program Management	41
Appendix A. NMS Management Questions for 2025-2030	42

1. Introduction

This Program Plan summarizes the planned work for the San Francisco Bay Nutrient Management Strategy (NMS) Program during FY27 (July 1, 2026 through June 30, 2027). The planned work includes a suite of projects and priorities targeting 2025-2030 NMS Management Questions, established by the NMS Steering Committee ([Appendix A](#)).

The FY27 Program Plan is developed under the LOW funding scenario summarized in the [2025–2030 Science Plan](#). The NMS Steering Committee provided initial guidance on expanding some projects and adding additional projects, as noted below. Program staff presented the FY27 Program Plan at the May 2026 NMS Steering Committee meeting and received conditional approval. The conditions included budget and project updates that are incorporated into this plan.

An overview of the FY27 Program Plan budget is presented in Section 2, including FY27 revenue sources and estimated expenses. Section 3 opens with an overview of the FY27 projects, followed by write-ups for each project that include project descriptions, work products, and budget justifications.

Most of the FY26 Program Plan's core monitoring, modeling, and synthesis projects are carried forward into FY27, several as Year 2 of multi-year work. The following adjustments have been made to the FY27 project portfolio:

- EMOD.6 HAB Modeling Workgroup is added as a new project.
- FLHAB.7 HAB Toxins in Archived Mussel Samples is added as a new project.
- CMOD.4 has been re-scoped to assess general load-reduction scenarios and nutrient-trading scenario modeling in support of 2027 compliance decisions under the 2024 Nutrient Watershed Permit.
- FLHAB.4, FLHAB.6, and FLHAB.8 are included under a consolidated placeholder (FLHAB.X). Final scopes will be developed with input from a HAB Expert Workgroup convened in fall 2026 and brought to the Steering Committee for approval at the December 2026 meeting.
- Continuing FY26 FLHAB.3 funds will be used to host the HAB Expert Workgroup mentioned above; it is no longer a standalone project. No additional FY27 funding is planned.
- FLHAB.5 (post-bloom controls) is not carried as a standalone project in FY27. The fall 2026 HAB Expert Workgroup will be asked to weigh in on how the NMS can help evaluate post-bloom controls (including clay and biological controls), which may inform future-year projects.
- SYNLSB.1 (Lower South Bay Synthesis) and SYNQB.1 (Zooplankton and Turbidity) will be completed with FY26 funding. No FY27 funding was planned.

2. FY27 Program Plan Budget and Overview

Table 1 summarizes the NMS FY27 revenue sources and amounts, which total to \$4,880,000. The sources listed are: R.1 NMS FY26 Permit Funds (\$2,200,000); R.2 RMP special study funds to support moored sensor monitoring (\$250,000); R.3 RMP Status and Trends funds for ship-based monitoring (\$299,000); and R.4 EPA-WQIF Tracking Bay Health Grant funds (\$2,131,000).

Table 1 NMS FY2027 Program Plan Revenue

	Revenue Source	Revenue
R.1	Nutrient Permit: FY2027 Funds	\$2,200,000
R.2	RMP Moored Sensor Support funds (anticipated)	\$250,000
R.3	RMP Contribution to Ship-based Monitoring (anticipated)	\$299,000
R.4	EPA Tracking Bay Health Grant	\$2,131,000
	TOTAL	\$4,880,000

Table 2 provides an overview of proposed work for FY27 and cost estimates. The total estimated cost for the proposed work is \$4,880,000. This estimate specifically excludes ongoing work associated with established supplemental funding sources summarized in Table 3.

Table 2 NMS FY2027 Program Plan Expenses

	MODELING	Budget
CMOD.1	Biogeochemical Model Development	\$300,000
CMOD.2	Predicting the 2022 HAB Event's Progression and Effects	\$200,000
CMOD.3	Investigate Environmental-Change Scenarios, Probability	\$100,000
CMOD.4	Simulate Load Reduction Scenarios & Influence on Water Quality	\$50,000
CMOD.5	Source Apportionment: Develop and Test Approaches	\$50,000
CMOD.7	Model Infrastructure	\$50,000
CMOD.8	Convene NMS Model Advisory Group	\$75,000
EMOD.1&2	LSB Simulations: Fluxes; Transformations; System Responses	\$75,000
EMOD.6	HAB Modeling Workgroup	\$75,000
	Subtotal	\$975,000

Table 2 NMS FY2027 Program Plan Expenses cont.

MONITORING		
CMON.1	Ship-based Monitoring	\$600,000
CMON.2	Moored Sensor Monitoring	\$710,000
CMON.3	Biogeochemical Mapping: A. South Bay; B. CB, SPB, SUI	\$300,000
EMON.1	Expand Ship-Based Monitoring	\$100,000
EMON.5	Data Management: QA/QC, documentation	\$75,000
Subtotal		\$1,775,000
Special Projects		
FLOB.1	Monitor Changes from POTW Load reductions	\$200,000
FLHAB.1	Investigate Whether the 2022 <i>H. akashiwo</i> was a Recent Arrival to SFB	\$100,000
FLHAB.2	Investigate Weak Top-down Pressure, Summer 2022	\$100,000
FLHAB.X	TBD HAB Studies	\$275,000*
FLHAB.7	FLHAB.7 HAB Toxins in Archived Mussel Samples	\$75,000
AFHAB.3A	Incorporate Space-Time Considerations Condition Assessment	\$20,000
AFOB.1	Open Bay Assessment Framework	\$50,000
SYNOB.2	Semi-Empirical Estimates of N losses, Denitrification	\$125,000
SYNHAB.1	Analysis/Interpretation of Multi-Year HAB and Toxin Datasets	\$150,000
SYNHAB.2	Analysis of Long-term Forcing and Condition Data	\$75,000
SYNHLS.1	Science Communications Products	\$100,000
Subtotal		\$1,270,000
PROGRAM MANAGEMENT		
PM.1	Program Management	\$850,000
TOTAL		\$4,880,000*

*FLHAB.X and the \$275,000 budget is a placeholder for a formal project proposal that will be brought to the Steering Committee in December 2026. Funding is conditional based on Steering Committee approval.

Several FY27 Program Plan projects will also be advanced by related projects funded by ongoing grants and continuing projects. Table 3 provides an overview of the additional funding that is expected to be spent during FY27.

Table 3 NMS FY2027 Additional Funding Sources and Spending

Funding Source	Planned Spending
EPA Destination Clean Bay Grant Supports modeling team and subcontractor work on sediment, source apportionment, future scenario evaluation, and nutrient management alternatives, and open source sharing	\$350,000
EPA BayInsight Grant Supports monitoring team and subcontractor work on water quality dashboard development, Lower South Bay monitoring, Suisun and Delta data analysis, baseline conditions assessments, moored sensor program expansion, and regional monitoring coordination.	\$875,000
NOAA MERHAB Grant Supports monitoring team and subcontractor work on enhanced remote sensing, data dashboard development, and regional HAB monitoring coordination.	\$162,000
Delta RMP Project Supports modeling team and subcontractor work modeling POTW flows in the Delta.	\$175,000
Continuing Permit Funds (and potential OPC Grant) Supports modeling team and subcontractor work on coastal modeling.	\$115,000
TOTAL	\$1,677,000

3. FY27 Program Plan

Sections 3.1 through 3.4 present project-level write-ups organized by program area: Modeling, Monitoring, Field/Lab Studies & Synthesis, and Communications & Program Management. Each write-up includes a budget summary table, project description, work in FY26 (where applicable), plans for FY27, work products, and budget justification.

3.1. Modeling

CMOD.1 Biogeochemical Model Development	Proposed FY27 Funds
Team: SFEI, external collaborators	\$300,000

Project Description

CMOD.1 supports biogeochemical (BGC) model development that underpins the NMS's scenario analysis, source apportionment, and diagnostic modeling activities. The project targets priority model development, validation, and documentation, and provides the modeling infrastructure used by CMOD.2, CMOD.3, CMOD.5, and EMOD.1 & 2.

Work in FY26

- Incorporated model updates identified during the 2022 HAB diagnostic modeling effort (CMOD.2). Established a validated physical backbone covering WY2013–WY2023, including an 11-year hydrodynamic simulation used across modeling applications.
- Advanced BGC model configurations used in scenario framing work (CMOD.3) and source apportionment (CMOD.5).

Plans for FY27

- Continue targeted BGC model development supporting CMOD.2, CMOD.3, CMOD.5, and EMOD.1 & 2.
- Develop a 5-Year NMS Modeling Plan in coordination with the Model Advisory Group (MAG; see CMOD.8). The plan will identify priority model development, validation, and scenario work across FY27–FY31, and address the balance between in-house SFEI capacity and external collaborator support.
- Coordinate with the HAB Modeling Workgroup (NEW-EMOD.6) to incorporate HAB-modeling feasibility recommendations into the 5-Year Plan.

Work Products

- Updated BGC model code and documentation, maintained on the SFEI/NMS GitHub.
- Validation summaries for updated model configurations.
- Draft 5-Year NMS Modeling Plan for MAG review.

Budget Justification

Funds will support SFEI modeling labor (approximately 1 FTE) and core collaborator labor contributing to BGC model development and 5-Year Plan scoping.

CMOD.2 Predicting the 2022 HAB Event's Progression and Effects

**Proposed
FY27 Funds**

Team: SFEI

\$200,000

Project Description

CMOD.2 is a multi-year project that has developed a diagnostic numerical modeling framework, paired with remote-sensing and mooring data, to interpret the 2022 *H. akashiwo* bloom's progression. The work identifies five components of the bloom's trajectory – emergence, stalling, rapid spread, abrupt termination, and overall severity/spatial extent – and uses a lightweight coupled hydrodynamic-phytoplankton model that captures key bloom features over a three-week period to reproduce each phase. Building on this foundation, the FY27 scope continues on-going HAB modeling to deepen mechanistic understanding through additional simulations and targeted process analyses, informed by MAG and other expert input.

Work in FY26

- Developed and tested a version of the NMS physical-biogeochemical model to simulate the August 2022 HAB event, using observational data to tune and test model performance.
- Made substantial progress on the diagnostic modeling effort, including quantification of the influence of priority forcings and mechanisms, and demonstrated that the coupled hydrodynamic-phytoplankton model captures key bloom features over a three-week period.
- Identified candidate factors and combinations of factors hypothesized to have shaped aspects of the bloom's progression, including initiation, high biomass accumulation, spatial occurrence, and abrupt termination.
- Produced a near-final technical report, shared in draft form in March 2026.

Plans for FY27

- Finalize the technical report, incorporating Steering Committee and NTW comments and integrating new FY27 results.
- Prepare and submit a peer-reviewed manuscript; respond to reviewer comments.
- Coordinate with related FY27 projects (CMOD.3 scenarios; SYNHAB.1 multi-year HAB analysis).
- Complete the full set of remaining simulations of priority forcings and processes.

Targeted analysis of key processes (no-regrets directions, informed by MAG and other experts):

- Incorporate top-down pressure; test virus vs. grazer hypotheses.
- Test forcing/process combination.
- Further testing of temperature stratification and its causal factors.
- In-depth analysis of DIN influence, including rate-limiting effects and DIN uptake.

Model development:

- Migrate components of the streamlined phytoplankton model into the full biogeochemical model to support continued work.

Work Products

- Final NMS technical report on the 2022 HAB event, updated to incorporate new FY27 results.
- Peer-reviewed manuscript submission and revisions.
- Model evaluations to inform the FY27 MAG review process.

Budget Justification

Funding will support SFEI labor (~0.75 FTE) and core collaborator contributions (GEI, Spheros) to finalize the technical report, advance the journal manuscript, and execute the on-going HAB modeling priorities (remaining simulations of priority forcings/processes, targeted process analyses, and migration of streamlined model components to the full biogeochemical model).

CMOD.3 Scenarios: Environmental Change, Critical Conditions, Management Alternatives

Proposed
FY27 Funds

Team: SFEI

\$100,000

Project Description

CMOD.3 investigates the potential for extreme or episodic nutrient-related impacts to occur due to changes in environmental forcings (episodic/anomalous or gradual shift), and explores the conditions and management alternatives that could shape critical water quality outcomes. Extreme or episodic events may manifest as high-phytoplankton-biomass/low-DO, HAB toxin production, or direct lethality of HABs on wildlife. A key component of the project is using numerical models to identify the factors or combinations of factors that could result in a critical water quality condition, and that would potentially be among the priority scenarios against which management actions would aim to protect. In FY27, work will advance one or more no-regrets directions, informed by MAG and other expert input, while concurrently developing a multi-year workplan for the on-going scenario effort.

Work in FY26

- Completed scoping and initial test runs of the scenario framework, beginning with continuations of the 2022 HAB-event analysis.
- Framed observed changes in South Bay and Central Bay gross primary production and chlorophyll (1990s–2020) as a scenario to assess the model's ability to reproduce biomass increases.
- Convened an initial expert advisory discussion to help prioritize scenarios.

Plans for FY27

Advance one or more no-regrets work directions (selected with MAG and other expert input):

- Investigate the major historical changes in gross primary production from the 1990s to the 2020s, including:
 - South Bay: 2–3x increase from the 1990s to the late 2000s, followed by a large decrease 2010–2020.
 - Central Bay: 2–3x increase from the late 1990s through the early 2010s, with no subsequent decrease.
- Investigate high-growth / high-impact scenarios using numerical modeling techniques that efficiently explore wide ranges of conditions and evaluate combinations of forcings and mechanisms.

Coordination and partner work:

- Interpret results in coordination with SYNHAB.1, SYNHAB.2, and the updated conceptual model activity in CMOD.1.
- Coordinate with SCCWRP and UCLA to provide model runs that inform their coastal modeling work; this coordination will be scoped as a subset of CMOD.3 staff effort and coordinated with partner funding where available.

Workplan and engagement:

- Develop a multi-year workplan for on-going scenario work, drawing on expert input (MAG and others) and stakeholder input on management considerations.
- Present interim results to the NMS-SC and the MAG.

Work Products

- Technical memo documenting the FY27 scenario work and interpretation.
- Multi-year workplan for on-going scenario work.
- Documentation of SCCWRP/UCLA coordination, including model outputs delivered to partners.
- Interim updates to NMS-SC and MAG on scenario results.

Budget Justification

Funds support SFEI modeling labor and core collaborator labor for FY27 no-regrets scenario simulations (historical GPP-change investigation and/or high-growth/high-impact scenario exploration), analysis, partner coordination with SCCWRP and UCLA, and development of the multi-year workplan.

CMOD.4 Load Reduction Scenarios (Nutrient Trading)

**Proposed
FY27 Funds**

Team: SFEI

\$50,000

Project Description

CMOD.4 focuses on nutrient-trading scenario modeling in support of 2027 permit compliance decisions. Under the 2024 Nutrient Watershed Permit, dischargers must identify compliance plans in 2027. The scenarios to be modeled are those identified by BACWA and the Freshwater Trust as potential trades of nutrient-load-reduction credits by smaller dischargers. The high-level goal in FY27 is to develop a framework for assessing the water-quality influence of trades involving small discharges and to evaluate that framework for a limited set of examples or specific test cases. The resulting information will be used by the Water Board and BACWA to consider options. The project also addresses model uncertainty and the sensitivity of source apportionment outputs, both of which are relevant to the technical basis for trading.

Plans for FY27

Approach and framework development:

- Work with BACWA, the Freshwater Trust, and the Water Board to define the approach, scope, and the specific trade scenarios to be modeled.
- Develop a framework for assessing the water-quality influence of trades related to small discharges.

Application to test cases:

- Use the NMS hydrodynamic-biogeochemical model to evaluate the framework for a limited set of examples or specific test cases.
- Quantify model uncertainty and the sensitivity of source apportionment outputs supporting the scenarios.

Coordination:

- Coordinate with CMOD.1, CMOD.3, and CMOD.7 for supporting model infrastructure.

Work Products

- Framework for assessing the water-quality influence of small-discharge trades.
- Trade-scenario definition memo, coordinated with BACWA, the Freshwater Trust, and the Water Board.
- Scenario simulation results for the selected test cases, with uncertainty characterization.
- Presentations to NMS-SC and the MAG on methods and initial findings, supporting Water Board / BACWA consideration of options.

Budget Justification

Funds support SFEI labor for framework development, scenario/test-case definition, initial simulations, and coordination with BACWA, the Freshwater Trust, and the Water Board. Additional modeling infrastructure is supplied by CMOD.1, CMOD.3, and CMOD.7.

CMOD.5 Source Apportionment: Techniques for Determining DIN Zones of Influence

**Proposed
FY27 Funds**

Team: SFEI, core collaborators

\$50,000

Project Description

San Francisco Bay receives the majority of its dissolved inorganic nitrogen (DIN) from the discharge of treated effluent from the region's 40 Publicly Owned Treatment Works (POTWs). Accurate estimates of how individual DIN sources contribute to ambient DIN concentrations over space and time are essential for evaluating nutrient management options, including nutrient trading. Estimating a source's zone of influence (ZOI) requires predicting and individually tracking the transport and transformations of each source's nutrients, which cannot be carried out with standard numerical tracer approaches.

CMOD.5 develops numerical modeling tools that enable a source's ZOI to be accurately and efficiently predicted, and it superimposes ZOIs from all sources to quantify relative contribution to total DIN over space and time. The approach combines reactive numerical tracers with space-time varying DIN transformation rates (net loss, net gain) extracted from calibrated biogeochemical model simulations. The technique is being developed in successive versions: v.I (proof-of-concept) was completed in FY26; v.II is the focus of FY27; and v.III will incorporate time-space varying rates from full-biogeochemical simulations in subsequent years (start timing is budget-dependent).

Work in FY26

- Completed proof-of-concept implementation of the reactive-tracer / rate-extraction approach, applied within SYNOB.2 and CMOD.1.
- Prepared a source apportionment report.

Plans for FY27

Refine the technique:

- Develop approaches for incorporating space-time varying loss rates into the reactive-tracer technique.
- Test and refine the technique under varied conditions.
- Document method sensitivity and uncertainty, noting that source apportionment is a new technique and sensitivity is not yet firmly established.

Apply within other projects (applications carried out in and supported by partner projects):

- Apply v.II within the nutrient-trading scenario work (CMOD.4), the 2022 HAB-event modeling (CMOD.2), the environmental-change scenarios (CMOD.3), and the updated conceptual-model work (SYNOB.2).

Reporting:

- Finalize and share the FY26 source apportionment memo with the Steering Committee.

Work Products

- Technical memo describing the approach and results from applying the technique under varied conditions.
- Sensitivity and uncertainty documentation for the method.
- Source apportionment outputs applied within CMOD.2, CMOD.3, CMOD.4, and SYNOB.2.
- Finalized FY26 source apportionment memo for the Steering Committee.

Budget Justification

FY27 work is partially supported by the EPA-WQIF Destination Clean Bay grant. The combined funding supports approximately 0.3 FTE SFEI labor and core collaborator labor. FY27 effort is focused on v.II development (incorporating space-time varying loss rates), test/refinement under varied conditions, and applications supported through CMOD.2, CMOD.3, CMOD.4, and SYNOB.2.

CMOD.7 Model Infrastructure	Proposed FY27 Funds
Team: SFEI, core collaborators	\$50,000

**2023 EPA-WQIF Grant (Destination Clean Bay)*

Project Description

CMOD.7 supports model code maintenance, documentation, post-processing workflows, and the NMS's in-house computing capacity. The open-source D-Flow Flexible Mesh (Deltares) model is publicly available as an enabling platform for collaborators (Valley Water, GEI, Delta RMP, UC Davis, and potential SFPUC dilution modeling).

Work in FY26

- Expanded HPC capacity in response to rate-limiting constraints observed during FY25.
- Migrated key tools to the public SFEI/NMS GitHub, alongside routine best-practice documentation.
- Began incorporating performance metrics and mass balance scripts into standard workflow.

Plans for FY27

- Continue documentation of model code and datasets, maintained on the SFEI/NMS GitHub.
- Streamline post-processing scripts, including automated performance metrics and fine-tuned mass balance outputs.
- Migrate to running fully coupled hydrodynamic-biogeochemical simulations, including investigation of faster run-times on supercomputers (with Deltares or collaborators).
- Add HPC capacity or storage as needed.

Work Products

- Updated code repositories and documentation on the SFEI/NMS GitHub.
- Streamlined post-processing workflows with automated performance metrics.

Budget Justification

FY27 work is partially funded by the Destination Clean Bay Grant and NMS Permit funds. Funding supports SFEI labor, core collaborator labor, and direct costs as needed.

CMOD.8 Convene NMS Model Advisory Group	Proposed FY27 Funds
Team: SFEI	\$75,000

Project Description

The Model Advisory Group (MAG) provides independent technical review of NMS modeling priorities, approaches, and performance. The first round of MAG meetings was held in May 2022, November 2022, and February 2023. Since the February 2023 MAG meeting, the third Bay-wide nutrient permit has been released, and several high-priority management questions have been reshaped. The MAG is reconvening to update members on progress relative to their 2023 recommendations, to incorporate the reshaped management questions, and to advise on the 5-Year NMS Modeling Plan (see CMOD.1).

Plans for FY27

- June 10, 2026 – MAG webinar (1 hour) reviewing model progress.
- June 12, 2026 – MAG webinar (3 hours), including a background briefing on the 2024 Nutrient Watershed Permit.
- August 26–27, 2026 – MAG in-person meeting.
- Fall–winter 2026/2027 – MAG report-out and integration of recommendations into the 5-Year Modeling Plan (CMOD.1).
- Develop technical materials and charge questions in advance of each meeting, in coordination with the NMS-SC modeling subcommittee.

Work Products

- Pre-meeting technical materials and charge questions.
- Meeting summaries and MAG report-out (prepared by the MAG chair in coordination with MAG members).
- MAG input incorporated into the 5-Year NMS Modeling Plan (CMOD.1).

Budget Justification

Costs include MAG honoraria (6–7 members); travel and lodging for the August in-person meeting; and additional funds for the MAG chair to support engagement on meeting organization and summary materials. SFEI labor is covered within other modeling projects.

EMOD.1 & 2 LSB model Refinements, Tracer Simulations, and Workplan development	Proposed FY27 Funds
Team: GEI, SFEI	\$75,000

The work proposed below is a hybrid of EMOD.1 and EMOD.2 in the [2025-2030 Science Plan](#).

Project Description

Tidal sloughs connected to LSB managed ponds experience high phytoplankton biomass and frequent low-DO events due to the combination of high nutrient concentrations, strong tides transporting nutrients into ponds, high within-pond production, and tidally-induced biomass fluxes back into sloughs. LSB is a physically and biogeochemically complex system, and representing these processes requires a higher-resolution version of the NMS hydrodynamic-biogeochemical model. An LSB-focused model that fully resolves LSB sloughs and connections to restored and managed ponds has been developed by SFEI/NMS and GEI and has undergone several rounds of refinements and recalibration over the last several years.

Plans for FY27

- Develop a workplan describing a prioritized set of restoration scenarios for simulation, coordinated with the South Bay Salt Pond Restoration Project (SBSPRP), regulators, and technical experts, including MAG review.
- Extend hydrodynamic simulations to additional time periods to include a wider range of environmental forcings (freshwater flows), seasons, and gate openings.
- Run numerical tracer simulations to develop improved DIN-loss estimates south of the Dumbarton Bridge and support Bay-wide modeling work.

Work Products

- Updated LSB model for use in informing full-Bay modeling work and LSB-specific studies, including model output from a series of numerical tracer simulations.
- Workplan describing potential modeling/analysis scenarios and proposed approaches, developed in coordination with SBSPRP, regulators, and interested parties.

Budget Justification

Core collaborator labor on model updates and tracer simulations and SFEI modeling and workplan labor.

EMOD.6 HAB Modeling Workgroup	Proposed FY27 Funds
Team: SFEI, external workgroup	\$75,000

Project Description

EMOD.6 convenes a HAB Modeling Workgroup to assess what HAB-focused modeling is realistically feasible in SFB and to bridge the diagnostic modeling work (CMOD.2) and the forward-looking scenario and source-apportionment modeling (CMOD.3, CMOD.4, CMOD.5). It will also assess our capabilities of modeling the 2023 bloom and whether this should instead fall under a synthesis project to examine the factors that led to the bloom and why it terminated early yet still resulted in sturgeon mortality. Workgroup recommendations will inform the 5-Year NMS Modeling Plan under development with the MAG (CMOD.1, CMOD.8).

Plans for FY27

- Develop charge and participant roster in coordination with the NMS-SC modeling subcommittee.
- Convene one or two working meetings, aligned with the MAG timing (August 2026 in-person) to minimize scheduling conflicts.
- Prepare a brief report-out with HAB-modeling recommendations and feasibility assessments.

Work Products

- Workgroup charge and participant roster.
- Meeting materials and summaries.
- Report-out with HAB-modeling recommendations for input to the 5-Year NMS Modeling Plan.

Budget Justification

Funds support participant honoraria, travel/lodging as needed, SFEI organizing labor, and report preparation.

3.2. Monitoring

CMON.1 Ship-based Monitoring	Proposed FY27 Funds
Team: USGS, UCSC, Bend Genetics, BSA, SFEI	\$600,000*

*\$299,000 from RMP S&T contribution

Project Description

This project supports biweekly to monthly ship-based water quality cruises along San Francisco Bay's deep channel. Work is pursued through an ongoing collaboration with USGS aboard the R/V Peterson, continuing the USGS's long-term SFB water quality measurements. The overall program is jointly funded by USGS, the RMP, and the NMS.

Monitoring work includes:

- Vertical water column profiles using submersible water quality sensors (CTD casts) and continuous surface water measurements while underway by optical sensors plumbed into the vessel's flow-through system.
- Surface water grab samples at a subset of stations: inorganic and organic nutrients, chlorophyll-a, phytoplankton taxonomy by microscopy, molecular techniques for quantifying phytoplankton taxa (18s, 16s sequencing), dissolved harmful algae (HA) toxins using SPATT.
- In addition to the Peterson's standard flow-through sensors, a YSI EXO2 multi-parameter instrument and a SUNA nitrate sensor (matching NMS mooring sites) are incorporated into the vessel's flow-through system, enabling cross-validation among channel cruises, moored sensors, and shoal mapping.

Work in FY26

- Completed a subset of the planned cruise schedule (10 full-Bay cruises and 5 South+Central Bay cruises). Several cruises were missed due to the government shutdown and shipyard time for repairs.
- Continued SFEI staff participation on cruises to support nutrient sample collection and filtration.

Plans for FY27

- Continue the biweekly/monthly cruise program: 12 full-Bay cruises and 8 South+Central Bay cruises.
- Reinstate Station 19 to better constrain coastal nutrient fluxes and model boundary conditions.
- Add new parameters on the R/V Peterson: SUNA nitrate sensor on the CTD, pCO₂, and discrete nutrient samples from bottom water.
- Incorporate contingency event-response cruises tied to HAB events. USGS can add cruises for approximately \$25,000 each and can waive costs in years where scheduled cruises were missed. Expanded October coverage is a priority HAB-risk window.

Work Products

- Datasets for nutrients, chlorophyll-a, phytoplankton community, and toxins, made publicly available through the USGS website.
- Results summarized in NMS Multi-year Report; data used across NMS program areas (model calibration, synthesis, condition assessment).

Budget Justification

The total funding of \$600,000 includes RMP and NMS funds. RMP funding (\$299,000) supports USGS technicians who carry out the field work, analyze a subset of samples (chl-a, SPM, etc.), and manage datasets. NMS funds support: nutrient measurements including ammonium, nitrate+nitrite, reactive phosphorus, dissolved silicate, total N, and total P (Chesapeake Bay Laboratory); phytoplankton taxonomy by microscopy (BSA); dissolved toxin measurements (UCSC); molecular techniques (18s/16s amplicon sequencing, qPCR; Bend Genetics); SFEI labor for fieldwork participation, inter-program coordination, and data management. USGS in-kind programmatic funds cover ship captain, direct costs (fuel, maintenance, transportation), program management support, and remaining technician costs.

CMON.2 Moored Sensor Monitoring	Proposed FY27 Funds
Team: SFEI, USGS-BGC, USGS-MarFac	\$710,000*

*\$250,000 from RMP contribution

Project Description

This project supports the collection of high-frequency water quality data (15-min) at the SFEI-NMS network of mooring sites, distributed across the South, Lower South, Central, and (newly) San Pablo Bays. Work includes monthly maintenance trips, instrument maintenance and calibration, standard data QA/QC and management, and ongoing refinements to data management tools.

Work in FY26

- Completed installation of the Alameda and San Pablo Bay moorings and installed telemetry at the Alameda station with federal funding (EPA BayInsight and NOAA MERHAB grants).
- Continued high-frequency sensor measurements at 15 stations (13 full stations with multi-parameter instruments, 2 oxygen-focused sites).
- Continued monthly calibration and servicing of water quality instruments.
- Completed transition from in-house Python code to Aquarius Informatics software for moored sensor QA/QC, enabling faster, more accurate processing across the network.
- Published moored sensor data to the Environmental Data Initiative (EDI) with DOIs, making the data citeable.
- Retired the two oxygen-focused sites in February to reallocate resources.
- Mentored two Watershed Steward Program (WSP) corpsmembers who assisted with field and lab work.

Plans for FY27

- Continue water quality measurements at all existing stations, including maintenance trips at 3–4 week intervals.
- Continue telemetry build-out, with Dumbarton and San Pablo Bay as near-term targets.
- Continue Aquarius-based QA/QC operations and data dashboard integration (EMON.5).
- Pursue funding continuity beyond 2028, when BayInsight and MERHAB support expires. The "Turning the Tide" EPA grant application is designed to bridge this gap (submitted in March 2026).
- Pursue permits from landowners and applicable regulatory agencies for all moored sensor monitoring stations, including payment of applicable fees (i.e. State Lands Commission, Army Corps of Engineers, others).
- Recruit and mentor two new WSP corpsmembers.

Work Products

- Curated 15-minute dataset of water quality parameters from ~15 stations (T, S, DO, chl, turbidity, fDOM).

- Curated 15-minute nitrate dataset from three stations.
- Updated QA/QC scripts and documentation, maintained and versioned on GitHub.
- Moored Sensor Program update reports (semi-annually).

Budget Justification

The Moored Sensor Program costs for FY27 funds include:

- Field support: boat support and field/deployment logistics from USGS-Pacific Marine Facility (MARFAC) and USGS-Water Science Center (WSC), and WSC contributions to instrument troubleshooting and discrete sample collection/processing (\$263,000).
- Analysis of discrete samples (\$8,000).
- SFEI labor for field and laboratory work, fieldwork planning, documentation, and overall project management (\$300,000).
- Data processing and QA/QC, review, and report-outs (\$64,000), and Aquarius software (\$13,000).
- Direct expenses, including instrument and sensor repair/factory-calibration/replacement, reagents, equipment, permitting costs, and other direct expenses (\$30,000).
- Support for the WSP corpsmembers (\$33,000)

RMP funding (\$250,000) and NMS funds (\$450,000) together support the Moored Sensor Program.

CMON.3 Biogeochemical Mapping: South Bay + Central-San Pablo-Suisun

**Proposed
FY27 Funds**

Team: SFEI, USGS-BGC

\$300,000

Project Description

CMON.3 conducts high-resolution biogeochemical mapping surveys in the South Bay and the Central Bay/San Pablo Bay/Suisun Bay system to characterize fine-scale spatial variability in nutrients, chlorophyll, turbidity, and related parameters. Mapping data are used extensively in CMOD.1 model tuning and validation, and in synthesis analyses (SYNHAB.1, SYNHAB.2).

Work in FY26

- Completed 10 mapping surveys (six South Bay, four North Bay).
- New North Bay data revealed high chlorophyll at San Pablo Bay shoals and turbidity dynamics tied to tidal cycles, supporting both remote-sensing algorithm calibration and model validation.
- Restarted particulate carbon and nitrogen sampling on mapping cruises, and began sampling for discrete alkalinity analyses.

Plans for FY27

- Conduct North Bay mapping cruises, pending analysis of data collected in FY26 (refer to EMON.1).
- Support up to 12 mapping surveys across South Bay, Central Bay, San Pablo Bay, and Suisun Bay.
- Continue particulate carbon and nitrogen sampling; add exploratory alkalinity measurements.
- Pilot benthic grab sampling and sample analysis.

Work Products

- Dataset of continuous underway measurements from approximately 12 mapping surveys.
- Discrete sample data from 15–20 stations per cruise (nutrients, chl-a, phytoplankton assemblage including HABs).
- Mapping data used in CMOD.1 tuning/validation and in SYNHAB.1 and SYNHAB.2.

Budget Justification

Funds cover up to 12 mapping surveys, including vessel preparation, field time, and data curation; discrete sample analysis (nutrients, chl-a, phytoplankton by 18s/16s sequencing); and SFEI labor for joining a subset of cruises, post-survey sample processing, data curation, and project management.

EMON.1 Expand Ship-Based Monitoring	Proposed FY27 Funds
Team: SFEI, external collaborators (USGS)	\$100,000

Project Description

EMON.1 supports expansion of the ship-based monitoring program (CMON.1) beyond the core biweekly/monthly cruise schedule.

Plans for FY27

- Support targeted cruise activities identified in CMON.1, including contingency event-response cruises and expanded October HAB-risk coverage.
- Support participation in supplemental cruises when coordinated with collaborators (e.g., USGS supplemental cruises, Central Bay summer cruises tied to FLOB.1).
- Support nutrient sample analysis from bottom water and Station 19.
- Analysis of north bay mapping cruises to inform the scope of additional surveys.

Work Products

- Additional cruise data beyond the core CMON.1 schedule, integrated into the NMS ship-based monitoring dataset.

Budget Justification

Funds support SFEI labor, supplemental analytical costs, and contingency cruise expenses that complement the CMON.1 retainer with USGS.

EMON.5 Data Management, QA/QC, Documentation

**Proposed
FY27 Funds**

Team: SFEI

\$75,000

Project Description

All current and completed NMS data collection projects include appropriate QA/QC and data management over the course of the projects. However, there are additional (and nontrivial) hurdles related to making data publicly available and hosted in public data repositories. These include: additional documentation (site descriptions, sampling approaches, analytical methods), QA/QC summaries, compiling data into merged files (across sites, analytes, dates), and reformatting to conform with repository-specific formatting requirements. Similar requirements apply to data compilations used in synthesis/desktop studies.

Work in FY26

- Established documentation, QA/QC summaries, metadata and public data publication for priority NMS datasets.
- Published moored sensor data to EDI with DOIs.
- Published phytoplankton eDNA and toxin monitoring data to EDI with DOIs.
- Published phytoplankton raw sequence data from the Peterson cruises on NCBI.
- Advanced data publication for code and data associated with the HAB synthesis (SYNHAB.1).
- Continued development of the NMS water quality dashboard (supported by MERHAB/BayInsight funding), integrating moored sensor, remote sensing, and USGS Delta data.

Plans for FY27

- Maintain published datasets, augmenting with new data as collected.
- Complete the Aquarius transition for moored sensor QA/QC across the full sensor network.
- Continue development of the NMS water quality dashboard.
- Add additional datasets to the data publication pipeline as they mature.

Work Products

- Updated NMS public datasets maintained on EDI and other repositories.
- Aquarius-based QA/QC workflow for all moored sensor stations.
- Continued development of NMS water quality dashboard.

Budget Justification

Funds support 0.30–0.35 FTE SFEI labor for the NMS data manager role.

3.3. Field/Lab Studies, Synthesis

FLOB.1 Monitor Changes from POTW Load Reductions	Proposed FY27 Funds
Team: SFEI, USGS collaborators	\$200,000

Project Description

The primary goal of this multi-year project is to establish baseline estimates of water quality conditions in San Francisco Bay prior to upcoming nutrient load reductions by POTWs, against which post-upgrade conditions can be compared. The data analysis effort initially focuses on dissolved inorganic nitrogen (DIN) concentrations – quantitatively characterizing spatial, seasonal, and interannual variability, including variability and uncertainty in concentration and mass – to support comparisons with mass loads and anticipated changes in mass loads. Results from numerical model simulations will inform data analysis and planning for ongoing monitoring.

Work in FY26

- Completed analysis of existing data, including long-term monitoring datasets, augmented 2021-present datasets, and numerical model output.
- Developed a progress report summarizing work to date and recommended next steps and shared it with the NMS Steering Committee. Limited amount of additional follow-on synthesis work recommended by the steering committee, to integrate model-based weightings of percent loading contributions of POTWs into statistical loading model.
- Initiated targeted, low-cost/high-value data collection (e.g., vertical nitrate profiles) in coordination with CMON.1.

Plans for FY27

- Execute targeted data-collection elements identified in the Year 1 work plan, including vertical nitrate profiles on CTD casts during CMON.1 cruises.
- Refine detection approaches for changing DIN concentrations using augmented monitoring data.
- Continue analysis of phosphorus, total N, and total P alongside DIN.

Work Products

- Updated technical memo presenting results from the data analysis and identification of priority data gaps.
- Refined work plan, including proposed approach(es) for addressing data gaps and for analyzing observational data to characterize changes in response to load reductions.

Budget Justification

SFEI labor (~0.3 FTE) and external collaborator labor (USGS).

FLHAB.1 Investigate Whether the 2022 *H. akashiwo* was a Recent Arrival to SFB

Proposed
FY27 Funds

Team: H Bowers (Moss Landing), S Jungbluth (SFSU), SFEI

\$100,000

Project Description

FLHAB.1 tests the hypothesis that the *Heterosigma akashiwo* strain responsible for the August 2022 HAB event was a recent arrival to SFB — e.g., recently transported (coast-bay exchange) or recently delivered via ballast water release. *H. akashiwo* has been well documented as transported region to region by shipping/ballast water (cyst-forming organisms can survive weeks to months in ballast tanks with no sunlight).

The hypothesis is tested by sequencing well-studied regions of the *H. akashiwo* genome in isolates from two *H. akashiwo* events within SFB, separated by 20 years. Strain #1 is from the 2022 event, maintained in culture by H. Bowers. Strain #2 is from a 2002 event in Richardson Bay, submitted to a phytoplankton archive. A third strain from the short-lived 2023 *H. akashiwo* bloom is also included. The sequenced regions are compared against each other and against sequences from approximately 50 other *H. akashiwo* strains that have been investigated in prior studies.

Work in FY26

- H. Bowers completed genetic analysis showing that the 2022 and 2023 isolates are genetically identical to each other, but approximately 1% different from the 2002 strain across ~900 base pairs of mitochondrial DNA, based on indel patterns.
- Findings presented to the NTW and the HAB Expert Workgroup, interpreting the genetic distinction as indicating the 2022 strain may be a new arrival to SFB since 2002, though the exact timing remains unknown.

Plans for FY27

- Perform whole-genome sequencing of the 2002, 2022, and 2023 isolates to confirm whether the variable mitochondrial regions are the best targets for developing an environmental assay.
- Following confirmation, screen archived environmental samples back to 2015 using SFEI's existing molecular dataset.
- Attempt isolation of a current-year (2024+) specimen via an upcoming Peterson cruise to confirm whether the 2022 strain is still circulating.
- Expand comparative scope to include international *H. akashiwo* strains.

Work Products

- Genetic fingerprint data from whole-genome sequencing of SFB 2002, 2022, and 2023 strains, plus compiled international strain data.
- Technical memo describing results and initial interpretations.

Budget Justification

External collaborator labor for study design, wet lab work, sample analysis, and interpretation; SFEI labor for contributions to data interpretation, report preparation, and project management.

FLHAB.2 Investigate the Role of Viruses in Terminating the Summer 2022 Event

Proposed
FY27 Funds

Team: SFEI, S Jungbluth (SFSU), F Schulz (LBNL)

\$100,000

Project Description

This study investigates the hypothesis that marine viruses played an important role in the termination of the 2022 *H. akashiwo* event, with an expanded focus on viral abundance, identity, and host specificity. During the bloom's termination, chlorophyll concentrations decreased by ~20–30× over 1–2 days (from ~100 µg/L to <5 µg/L), and this crash occurred simultaneously at four distinct moored sites. The sharp decrease in chlorophyll was accompanied by a sharp drop in dissolved oxygen (DO). The rate at which DO decreased is comparable to first-order rates expected in the presence of abundant and highly-labile dissolved organic carbon, consistent with viral lysis. The *H. akashiwo* literature emphasizes that viruses are often the dominant top-down control, with grazing typically secondary, and *H. akashiwo* strains isolated from the same estuary can exhibit starkly different susceptibility to naturally occurring marine viruses — so a recently-introduced or recently-dominant strain could initially bypass endemic SFB viral pressure and later become vulnerable as the viral community or specific viral lineages shift.

The project is structured as a two-part study pursued in series: an exploratory genomic characterization phase (FY26) followed by targeted quantitative and time-series analyses (FY27), with the FY27 scope contingent on FY26 results indicating that viruses were important players. If viruses were central to termination, we expect time-series results to show not simply higher bulk viral signal at bloom collapse but a marked increase in sequences and quantitative signals from viruses taxonomically and functionally associated with *H. akashiwo* (i.e., markers and genes indicating host specificity, or repeated recovery of the same viral lineage across samples). If instead bulk viral abundance rises without lineage-specific signatures, the data will point to alternative mechanisms (non-specific viral opportunism, grazing, environmental drivers, or sampling biases).

Work in FY26

- Exploratory long-read (nanopore) sequencing of archived *H. akashiwo*-enriched filters; Sean's pilot run produced ~2.1–2.2 TB of data, with multiple long reads mapping to *Heterosigma*-related viruses.
- Initial assembly and preliminary mapping of candidate viral fragments to known *H. akashiwo*-infecting viruses.
- Exploratory phase will be complete by June 30, 2026.

Plans for FY27

- Finish deep processing and annotation of the full nanopore dataset to recover and characterize additional long viral contigs and hallmark genes (capsid, polymerase, etc.), confirming candidate viral lineages.
- Design and validate molecular assays (qPCR primer sets and probe-based approaches) that cover both broad *Heterosigma*-virus diversity and lineage-specific variants, so we can distinguish overall viral load from the presence of viruses specific to *H. akashiwo*.

- Apply the validated assays across an assembled time-series of archived filters (stored at -80°C) spanning early, peak, and termination phases of the 2022 event, and compare viral signals to chlorophyll, DO, and taxonomic data.

Work Products

- Annotated long-read viral contigs and hallmark gene catalog from the full FY26 nanopore dataset.
- Validated qPCR/probe-based assays for broad and lineage-specific *H. akashiwo*-virus quantitation.
- DNA-based time-series measurements of viral abundance and speciation across the 2022 event, integrated with chlorophyll, DO, and taxonomic data.
- Technical memo summarizing results and the determination of whether viral identity and host specificity, in addition to abundance, explain the rapid, synchronous collapse of the 2022 bloom.

Budget Justification

Analytical costs for broad-scan and targeted sequencing; external collaborator labor on study design, sample processing, and metagenomics analysis; SFEI labor for study design, interpretation, and project management.

FLHAB.X Consolidated Placeholder: FLHAB.4, FLHAB.6, and FLHAB.8	Proposed FY27 Funds
Team: SFEI, external experts (TBD)	\$275,000*

*FLHAB.X and the \$275,000 budget is a placeholder for a formal project proposal that will be brought to the Steering Committee in December 2026. Funding is pending Steering Committee approval.

Project Description

FLHAB.X is a consolidated FY27 placeholder covering three projects whose FY27 scopes will be refined based on input from a HAB Expert Workgroup to be convened in fall 2026. Final project scopes and budgets will be brought to the NMS Steering Committee for approval at the December 2026 meeting. The three projects covered by this placeholder are:

- FLHAB.4 – Investigate Resilience to Future HABs (nature-based approaches). Previously framed as an eelgrass study; being re-framed as tidal wetland / nature-based solutions work aligned with the "Turning the Tide" EPA competitive grant. FY27 scoping includes outreach to the Tiburon Institute regarding capabilities for eelgrass, oyster beds, and other NbS, and consideration of whether to merge with Turning the Tide as match or an early-start project.
- FLHAB.6 – HAB Organisms and Toxins in LSB Managed Ponds. Builds on FY26 slough-pond exchange findings; prioritization relative to other HAB projects to be evaluated by the HAB Expert Workgroup.
- FLHAB.8 – Experimental: Numeric Thresholds for *H. akashiwo* Direct Lethality. FY27 scope begins with a written literature review / white paper synthesizing the state of knowledge on *H. akashiwo* lethality mechanisms and the rationale for the proposed study design. The plan extends through a direct lethality test along with off-ramps. FY27 deliverables include the literature review / white paper (to be advanced during K. Harding's leave), another expert meeting, and a full study recommendation with off-ramps. The FY27 placeholder is subject to confirmation by the Steering Committee following the fall expert meeting.

Plans for FY27

- Convene the HAB Expert Workgroup in fall 2026 (supported by \$50,000 of FY26 continuing funds).
- Advance the FLHAB.8 literature review / white paper during K. Harding's leave.
- Develop full FY27 scopes and budgets for FLHAB.4, FLHAB.6, and FLHAB.8, based on workgroup recommendations.
- Seek Steering Committee approval of final scopes and budgets at the December 2026 meeting.
- Request workgroup input on how the NMS can help evaluate post-bloom controls (clay, biological controls) to inform future-year projects. Don Anderson (WHOI) is being considered as a potential speaker for the Steering Committee on this topic, building on the January 2026 OPC HAB Control Workshop.

Work Products

- HAB Expert Workgroup charge, participant roster, meeting summary, and recommendations.
- FLHAB.8 literature review / white paper on *H. akashiwo* direct lethality.
- Revised project descriptions and budgets for FLHAB.4, FLHAB.6, and FLHAB.8, approved by the NMS-SC in December 2026.

Budget Justification

The \$275,000 FY27 placeholder is carried as a single line pending refinement. Upon December 2026 SC approval, the allocation may be split among multiple proposed projects. Workgroup convening is supported by \$50,000 from FY26 continuing funds and does not require new FY27 funding.

FLHAB.7 HAB Toxins in Archived Mussel Samples

**Proposed
FY27 Funds**

Team: SFEI, Kudela Lab (UCSC)

\$75,000

Project Description

EMON.4 supports targeted toxin testing of archived SFB mussel samples to characterize the presence and variability of HAB-relevant toxins in resident bivalves. The project focuses on toxins most relevant to fish and human health — saxitoxin (STX, from *Alexandrium*), domoic acid (DA), and microcystin (MCY). We will also target a limited subset of samples for untargeted analysis of mussel tissue via High Resolution Mass Spectrometry approaches, searching for brevetoxin-like compounds putatively associated with *Heterosigma akashiwo*. Temporal and spatial patterns will be investigated, particularly to determine if toxins are regularly elevated at the Central Bay Ballena Isle station, directly adjacent to Seaplane Lagoon. The project leverages archived mussel samples from 2015 onward (inventoried through EMON.5) and complements the molecular HAB monitoring program (SYNHAB.1), which has identified a statistically meaningful relationship between *Alexandrium* relative abundance in sequencing data and mussel exceedance of the 100 ng/g regulatory threshold for saxitoxin.

Plans for FY27

- Select a prioritized subset of archived mussel samples, with a focus on periods of higher risk of HAB events.
- Analyze samples at the Kudela lab (UCSC) for STX, DA, and MCY, and also a TBD collaborator (still in early scoping) for pilot HRMS analysis
- Prepare a brief technical memo summarizing results in the context of SYNHAB.1 molecular monitoring.

Work Products

- Toxin analysis results (STX, DA, MCY) for prioritized archived mussel samples.
- Brief technical memo summarizing results.

Budget Justification

Funds cover sample selection and management, and a technical memo (SFEI labor), shipping, and analytical costs at the Kudela lab (UCSC).

AFHAB.3A Incorporate Space-Time Considerations Into Condition Assessment

**Proposed
FY27 Funds**

Team: Water Board, SFEI, expert group

\$20,000

Project Description

AFHAB.3A supports incorporation of space-time considerations into the NMS condition assessment framework, in coordination with the Water Board and an external expert group.

Plans for FY27

- Convene a focused expert discussion to refine how spatial and temporal variability should be represented in assessment metrics.
- Document recommended approaches in a technical memo.

Work Products

- Technical memo documenting recommended space-time approaches for condition assessment.

Budget Justification

Funds support SFEI labor and expert honoraria for a one-time working session.

AFOB.1 Open Bay Assessment Framework	Proposed FY27 Funds
Team: SFEI, SCCWRP	\$50,000

Project Description

AFOB.1 completes the Open Bay Assessment Framework. Some elements may be absorbed by continuing-funds work; if continuing-funds work progresses sufficiently, the FY27 budget may not be fully drawn.

Plans for FY27

- Complete framework documentation.
- Integrate with the condition assessment work in AFHAB.3A.

Work Products

- Finalized Open Bay Assessment Framework technical documentation.
- Integration with AFHAB.3A condition assessment work.

Budget Justification

Funds support SFEI labor for completion and integration.

SYNOB.2 Semi-Empirical Estimates of Biogeochemical Transformation Rates (Denitrification)

Proposed
FY27 Funds

Team: SFEI, GEI/ R Holleman

\$125,000

Project Description

Early NMS science planning and prioritization studies identified numerous data gaps that were considered high priority to support accurate predictions of nutrient cycling, concentrations, and nutrient-related responses. SYNOB.2 leverages the intensive monitoring work and rich datasets collected over the last several years to pursue a range of data analysis approaches and develop ecosystem-scale rate estimates of key biogeochemical processes (net DIN loss/gain, net O₂ loss/gain, net biomass production, pelagic respiration, benthic respiration).

The approach combines statistical methods (mechanistic equations, solving for rates) with numerical modeling techniques (conservative tracer, reactive tracers) to analyze several years of high-resolution/high-frequency field measurements (mapping data, mooring data). Rate estimates are optimized by minimizing residuals between observed and predicted state-variable concentrations.

Work in FY26

- Developed initial conceptual models for nutrients and phytoplankton, informed by broader data sources.
- Established the semi-empirical modeling approach, including conservative- and reactive-tracer numerical simulations.

Plans for FY27

- Execute the semi-empirical analysis across multiple years of high-resolution data.
- Use rate estimates to refine the conceptual models developed in Year 1 and to provide semi-independent validation of biogeochemical model performance (CMOD.1).
- Deliver rate estimates relevant to nutrient-trading scenarios (CMOD.4) and wetland nitrogen-removal framing.

Work Products

- Technical report(s) presenting ecosystem-scale rate estimates for priority biogeochemical processes.
- Updated conceptual models for nitrogen, phytoplankton, and related cycles.
- Rate estimates delivered to CMOD.1 and CMOD.4.

Budget Justification

0.3 FTE SFEI labor and external collaborator labor (USGS, GEI, UC Berkeley) for data analysis.

SYNHAB.1 Analysis of Multi-year HAB and Toxin Datasets

**Proposed
FY27 Funds**

Team: SFEI; Collaborators: SFSU, UCSC, UCB

\$150,000

Project Description

This HAB-focused synthesis covers space-time variability in HAB detection and abundance and influential factors. Beginning in 2019–2020, NMS funds were directed toward building the technical capacity to use high-throughput sequencing (18s and 16s rRNA gene amplicon sequencing) to detect and quantify HAB taxa, and to characterize phytoplankton community composition. Biweekly cruise samples (n ~ 600) from 2020–2023 and archived samples from 2015–2019 (n ~ 800) have been sequenced. Shoal mapping survey samples (n ~ 270; 6 surveys per year × 15 samples per survey, 2021–2023) have also been processed.

SYNHAB.1 analyzes and interprets this 9-year record to explore space/time variability in HAB-species occurrence and how HAB species differ from other phytoplankton taxa. Work is carried out within an overarching goal of developing an updated HAB/phytoplankton-community conceptual model.

Work in FY26

- Completed initial analyses across the 9-year record.
- Produced an HAB synthesis report in draft form.
- Confirmed that 14 of 15 priority HAB genera are detected in SFB by sequencing, and that phycotoxins (STX, DA, MCY) are routinely present.
- Identified a statistically meaningful relationship between Alexandrium relative abundance in sequencing data and mussel exceedance of the 100 ng/g STX regulatory threshold.

Plans for FY27

- Wrap up the multi-year analysis, including completion of the updated HAB/phytoplankton community conceptual model.
- Incorporate the Alexandrium/saxitoxin mussel relationship and other Year 1 findings into final synthesis products.
- Coordinate with EMON.4 mussel toxin testing.
- Publish results, including in the RMP Pulse nutrient feature (SYNHLS.1).

Work Products

- Final technical report on multi-year HAB and toxin dataset analysis.
- Updated HAB/phytoplankton conceptual model.
- Contributions to RMP Pulse and related communications products (SYNHLS.1).

Budget Justification

Funds support 0.35 FTE SFEI labor and external collaborator support to complete analysis, finalize the conceptual model, and prepare publication-quality products.

SYNHAB.2 Analysis of Long-term Forcing and Condition Data

**Proposed
FY27 Funds**

Team: SFEI, UCSC, NOAA

\$75,000

Project Description

This project investigates the environmental forcings known or hypothesized to influence phytoplankton production in SFB, characterizing seasonal variability, interannual variability, and long-term trends. Candidate forcings include: suspended sediment concentrations (including remote-sensed data); temperature (air and water); wind (speed and direction); solar insolation (or cloud/fog cover); rainfall and freshwater flows; and basin-scale climate forcings (upwelling indices, El Niño, PDO). The primary focus is on long-term changes, including changes in upper/lower quantiles or the occurrence of extreme/episodic events.

Work in FY26

- Advanced suspended-sediment/turbidity analysis, including comparison of remote-sensed estimates from Sentinel-3 (2016–present) with MERIS (2002–2011). That work is substantially complete.
- Contributed to the updated conceptual model being developed in SYNHAB.1 and SYNOB.2.

Plans for FY27

- Extend the analysis to additional high-priority forcings: wind, air and water temperature, and solar insolation.
- Address second-tier forcings (rainfall, freshwater flows, basin-scale climate indices) as time permits.
- Frame bloom initiation ecology as a priority consideration, given its recognition as an understudied gap.
- Integrate results with scenario planning (CMOD.3).
- If capacity allows, build 2023 bloom data into future analyses.

Work Products

- Compiled datasets for priority forcing parameters.
- Technical report at project completion.
- Integration with updated conceptual model (SYNHAB.1) and scenario planning (CMOD.3).

Budget Justification

Funds support SFEI labor (0.2 FTE × 2) to continue forcings work and prepare a technical report, along with support for an external collaborator/expert advisor. NOAA MERHAB grant funding supports remote-sensed imagery processing and algorithm development/testing; NOAA remote-sensing staff participate as unfunded collaborators.

SYNHLS.1 High Level Science Communications Products

**Proposed
FY27 Funds**

Team: SFEI

\$100,000

Project Description

This project supports the development of high-level science communication products for distribution to the NMS Steering Committee, decision-makers (boards and managers), and other interested parties.

Near-term work focuses on the RMP Pulse nutrient articles, continuing to prepare plain language summaries for all new NMS reports, continuing to finalize and post past NMS reports .

Work in FY26

- Developed the NMS communication plan, shared with the Planning Subcommittee and NMS-SC.
- Produced plain language summaries for all new NMS reports.
- Completed the State of the Science synthesis report and a brief NMS Overview report for stakeholder dissemination.
- Drafted nutrient articles for the 2026 RMP Pulse.
- Began finalizing and posting past NMS reports.

Plans for FY27

- Additional contributions to the nutrient articles for the RMP Pulse
- Produce plain language summaries for NMS reports
- Annual Report
- Finish finalizing and posting past NMS reports
- Minor website updates

Work Products

- 2026 RMP Pulse articles
- Plain language summaries
- NMS communication plan (maintained)
- Annual Report
- Posted finalized NMS reports on the website

Budget Justification

The budget includes SFEI labor (0.40 FTE) and graphics costs.

3.4. Program Management

PM Program Management	Proposed FY27 Funds
Team: SFEI	\$850,000

Project Description

This funding covers the costs associated with NMS program management, including:

- Science oversight for the NMS, including study design, scientific contributions to projects, review of work products, and identification of ongoing NMS science priorities.
- Program management, including working with the NMS Steering Committee, Planning Subcommittee, other subcommittees, and additional stakeholder engagement.
- Internal program management, including managing workflow and resource allocation for NMS technical projects, deliverable tracking, and budget reporting.
- Program budget tracking, including external contract management, accounting, and invoicing.
- Fundraising to support NMS work, including active pursuit of the EPA Turning the Tide competitive grant and the non-competitive EPA installment.

Budget Justification

The vast majority of the PM budget supports labor, including the lead scientist, program manager, and project manager's efforts across the range of NMS scientific activities. It also covers Steering Committee and partner engagement; SFEI staff time for attending NMS-SC and NTW meetings and internal team meetings; and other NMS business (e.g., hiring). Minimal expense funds are used for travel and supplies/food for Steering Committee and related meetings.

Appendix A. NMS Management

Questions for 2025-2030

1. **What water quality-based effluent limits are required to protect SF Bay beneficial uses?**
 - a. How can the current numerical model be improved to more accurately represent nutrient sources, transport, and transformations, including under current and projected future nutrient loading scenarios?
 - b. What region-specific or topic-specific modeling developments or applications are needed to address critical nutrient management questions related to HAB risk and low dissolved oxygen?
 - c. Are the water quality-based effluent limits established in the 2024 Nutrient Watershed Permit protective of beneficial uses?
2. **What is the risk (including potential future spatial and temporal dissolved oxygen impacts, toxicity, and other direct effects) and potential frequency of future large-scale HAB events in the Bay during the permit compliance schedule and beyond?**
 - a. What factors contributed to the 2022 *H. akashiwo* harmful algal bloom (HAB) event, including mechanisms that led to impacts on fisheries, and why did the 2023 *H. akashiwo* bloom not exhibit similar Bay-wide spread?
 - b. What additional knowledge is required about HAB biology, ecology, and species-specific dynamics to anticipate and mitigate future bloom events?
3. **What are the status and trends of key eutrophication and ecosystem health-related indicators, and what do the trends tell us?**
 - a. What core nutrient, water quality, and phytoplankton monitoring and assessment activities must be maintained, adjusted, or expanded spatially, temporally, or through the collection of new parameters to address evolving priorities?
4. **What are the multiple benefits of nature-based solutions and post-bloom control measures?**
 - a. What specific benefits do wetland restoration, eelgrass restoration, and salt pond management provide in enhancing resilience to nutrient-related impairments?
 - b. How do post-bloom control measures mitigate the effects of nutrient-related impairments on Bay ecosystem health?
 - c. What are the combined long-term benefits when these nature-based solutions and control measures work together to enhance overall ecosystem resilience?