SOUTH SAN FRANCISCO BAY SHORELINE STUDY

Monitoring and Adaptive Management Plan for Ecosystem Restoration

TABLE OF CONTENTS

TABLES

FIGURES

GLOSSARY

Adaptive management action. Actions undertaken to improve performance if restoration targets are not met. Actions may consist of assessments, construction, phasing, and operations and maintenance.

Conceptual Model. A simple, qualitative model that describes general functional relationships among essential components of a system.

Consideration. A statement of conditions the alternative plans should avoid, minimize, or mitigate, as possible. Considerations are less restrictive than constraints.

Constraint. A restriction that limits the extent of the planning process. It is a statement of things the plan should avoid.

Monitoring metric. A measure for assessing change with respect to a specific restoration target. Each restoration target has at least one metric that would be measured during monitoring and is expected to provide insight into the project's progress towards that target.

Objective. Statement of project purpose.

"Staircase." Terminology adopted from the SBSP Restoration Project. The SBSP Restoration Project uses a "staircase" analogy to describe the proposed project, with each step on the staircase representing one phase of tidal restoration implementation. Adaptive management determines how far up the "staircase" the project proceeds. The "staircase" issues are those that determine whether the Shoreline Study proceeds through the later phases, or halts before all phases are completed.

Target. A performance measure that provides quantifiable restoration metrics used to assess project performance with respect to project objectives, constraints, and considerations.

Trigger. Management triggers identify the point at which the system may not be performing or progressing as expected.

Uncertainty. Disagreement or lack of knowledge about how a system functions, specifically, how a restoration action may or may not result in the desired outcome.

1. Introduction

This document provides the feasibility-level monitoring and adaptive management plan for the South San Francisco Bay Shoreline Study (Shoreline Study). The Shoreline Study is a flood risk management and ecosystem restoration effort that is recommending a project to reduce tidal flood risk and restore tidal marsh habitat along southern San Francisco Bay.

This plan identifies potential monitoring activities, outlines how results from the monitoring would be used to assess project success and, if needed, adaptively manage the project to achieve the desired ecosystem restoration objectives. The plan specifies who would be responsible for monitoring and adaptive management activities and provides estimated costs.

1.1 Authorization for Monitoring and Adaptive Management

Section 2039 of WRDA 2007 directs the Secretary of the Army to ensure that, when conducting a feasibility study for a project (or component of a project) for ecosystem restoration, the recommended project includes a plan for monitoring the success of the ecosystem restoration. The implementation guidance for Section 2039 (USACE 2009) specifies that ecosystem restoration projects include plans to track and improve restoration success through monitoring and adaptive management.

1.2 Relation to South Bay Salt Pond Restoration Project Adaptive Management and Monitoring

The non-Federal sponsors for the Shoreline Study are currently collaborating to implement the South Bay Salt Pond (SBSP) Restoration Project, which encompasses 15,100 acres in the South Bay and includes the USFWS-owned parts of the Shoreline Study area. In 2009, the SBSP Restoration Project completed program-level planning, program-level NEPA compliance, and program-level permitting for the entire 15,100 acres, including the Shoreline Study project area. The USFWS was the lead agency for NEPA; the USACE was a cooperating/responsible agency.

Adaptive management is an integral component of the SBSP Restoration Project (EDAW et al 2007). The SBSP Restoration Project identifies a range of potential implementation and habitat outcomes, with the endpoint to be determined through phased implementation guided by adaptive management. One of the fundamental project trade-offs is the conversion of existing waterfowl and shorebird habitat in the former salt ponds to tidal wetland habitat for a range of native marsh-dependent species. The two defined project endpoints are a 50:50 ratio of tidal and managed pond habitats or a 90:10 ratio, depending on how successfully the restored and enhanced ponds are able to maintain existing populations of waterfowl and shorebirds. The final habitat mix may be at either endpoint, or somewhere between the two.

The SBSP Restoration Project uses a “staircase” analogy to describe the proposed project, with each step on the staircase representing one phase of tidal restoration implementation. Adaptive implementation determines how far “up the staircase” the project proceeds. Before proceeding with each subsequent phase, the SBSP Restoration Project decision makers would consider the staircase issues. If the restoration is not transpiring as expected and no other solutions (through construction, operations, maintenance, or phasing) are feasible, the decision could be made to halt the project before continuing to subsequent phases.

The SBSP Restoration Project Management Team includes members of the Shoreline Study project delivery team (PDT), who represent the specific needs of the Shoreline Study and its project area. The goals and objectives for the Shoreline Study and the SBSP Restoration Project are very similar; however the geographic footprint of the two efforts is not identical. The Shoreline Study is being conducted as a series of interim feasibility studies, the first of which focuses on Ponds A9-A15 (owned by USFWS) and Pond A18 (currently owned by the City of San Jose and not within the SBSP Restoration Project footprint). Because the current interim feasibility study includes a subset of ponds within the SBSP Restoration Project, this report draws from the monitoring and applied studies being conducted by the larger SBSP Restoration Project.

1.3 Procedure for Drafting the Monitoring and Adaptive Management Plan

This Monitoring and Adaptive Management and Monitoring Plan (MAMP) was prepared by members of the Shoreline Study PDT and SBSP Restoration Project – including staff from the U.S. Army Corps of Engineers (USACE) San Francisco District, staff from the California State Coastal Conservancy, the SBSP Restoration Project Executive Project Manager, and the SBSP Restoration Project Lead Scientist – and staff from the consulting firms ESA PWA and HT Harvey & Associates, under contract to the California State Coastal Conservancy.

The Shoreline Study MAMP is consistent with the plan developed for the SBSP Restoration Project (2007), but reflects Shoreline Study-specific goals, objectives, and geography. The Shoreline Study MAMP was developed to be consistent with the framework for adaptive management in the previously mentioned USACE implementation guidance (USACE 2009).

1.4 Rationale for Adaptive Management

The primary incentive for implementing an adaptive management program is to increase the likelihood of achieving desired project outcomes given project uncertainties. All ecosystem restoration projects face uncertainty due to incomplete understanding of relevant ecosystem structure and function, resulting in imprecise relationships between project actions and corresponding outcomes. Flood protection projects, too, face engineering uncertainties. Given these uncertainties, adaptive management provides an organized and coherent process that suggests management actions in relation to measured project performance compared to desired project outcomes. Adaptive management establishes the critical feedback among project monitoring, and informed project management, and learning through reduced uncertainty.

In the case of the Shoreline Study, cost-shared monitoring and adaptive management will focus on the constructed ecosystem restoration elements of the project to ensure their success. However, the Shoreline Study also fits within the larger context of the SBSP Restoration Project, which examines larger-scale (regional) effects that set the context for site-specific analysis of implemented restoration projects. These include:

- Determining species presence and landscape/ecosystem evolution in response to restoration activities,
- Signaling that the phased restoration can proceed or determine that additional actions are necessary before moving forward, and
- Determining if and when tidal marsh restoration should halt due to undesired consequences on the natural system.

The future project recommended by the Shoreline Study would implement tidal restoration of existing managed ponds in phases. While the expectation is that all phases will be constructed, there are landscape-scale uncertainties that could cause implementation of future restoration features to halt because of undesired changes to ecosystems and populations outside of the project area. In addition, the presence of mercury in the sediments and risk of increasing bioaccumulation of mercury in the food web within the study area is a key project constraint that may delay or halt the restoration of certain ponds. The significance of this risk will be unknown until project implementation is begun. Monitoring for the "phased implementation" and mercury-related aspects of the project are not included as part of the cost-shared Shoreline Study monitoring and adaptive management program, but rather will be conducted by the SBSP Restoration Project.

For flood risk management and public access components of the project, cost-shared monitoring and adaptive management activities are not recommended. Minor adjustments to these features will be covered as routine operation and maintenance performed by the non-Federal sponsors. Major adjustments to such features to adjust to changed conditions after project implementation would require a post-authorization-change process.

Adaptive Management Team

Under the SBSP Restoration Project's organizational structure, the Adaptive Management Team (AMT) is the group responsible for making decisions about adaptive management. The AMT consists of a subset of the SBSP Restoration's Project Management Team (PMT) members. Figure 1 (SBSP Restoration Project Organizational Structure and Functions) shows the participants in the adaptive management process for the SBSP Restoration Project, who would also make adaptive management decisions for the future project recommended by the Shoreline Study.

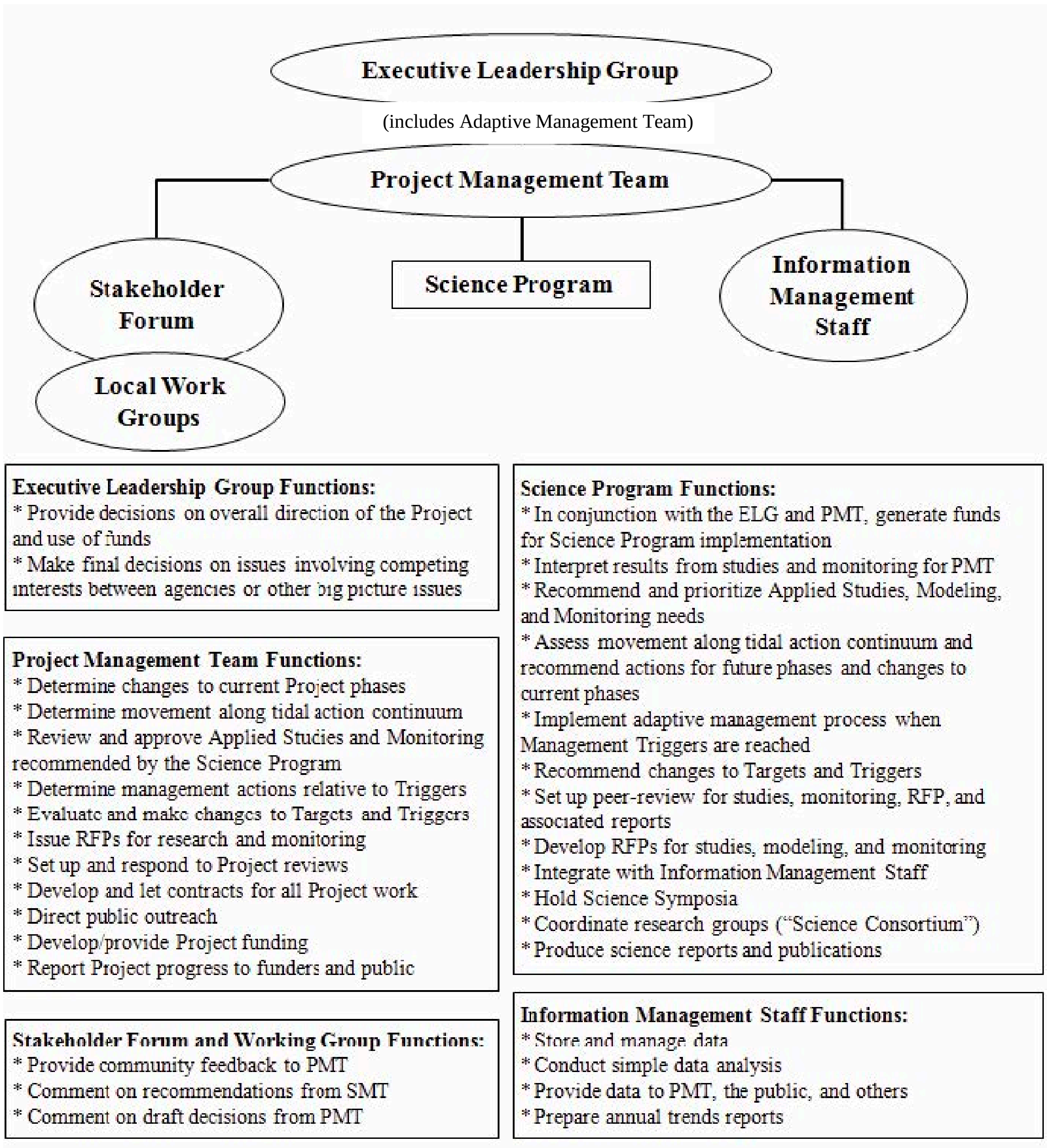

Figure 1. SBSP Restoration Project Organizational Structure and Functions

The AMT considers input from the Science Team (through the Lead Scientist), Stakeholder Forum, and Local Work Groups, as necessary, when making decisions. The Executive Leadership Group provides decisions on overall direction of the future project and on issues involving competing interests between agencies. Information Management Staff provide data management services for the AMT.

Participants in each group are listed below for the SBSP Restoration Project. The SBSP Restoration Project AMMP (2007) provides a detailed description of each group. For the Shoreline Study specifically, the landowners are USFWS and the San Jose/Santa Clara Water Pollution Control Plant, the local flood control district is the Santa Clara Valley Water District, and the Stakeholder Forum and Local Work Groups include only participants relevant to the Shoreline Study project area.

> **Executive Leadership Group** = heads of the Project Management Team agencies, consisting of the California State Coastal Conservancy (SCC), the landowning and management agencies, local flood control districts, the Army Corps of Engineers, and Project funders.
> **AMT** = U.S. Fish & Wildlife Service, California Department of Fish & Wildlife, SCC, local flood control districts, USACE, Lead Scientist, some regulatory staff, and other involved organizations.
> **Science Program** = science directors and contractors, with a Lead Scientist responsible for coordination with the PMT.
> **Information Management** = San Francisco Estuary Institute (or equivalent entity) as a contractor to the SCC.
> **Stakeholder Forum** = core stakeholders with demonstrated, ongoing interest in South San Francisco Bay ecosystem restoration (local business and land owners, environmental orgs, public access/recreation, infrastructure, advocates and institutions, flood management, public works/health), local government staff and elected officials.
> **Local Work Groups** = associated with each pond complex

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Overview of Adaptive Management

Adaptive management is an iterative process that uses regular monitoring and assessments to determine whether follow-up actions are necessary to keep the project on track towards its objectives. For the purposes of this plan, monitoring and adaptive management are presented in four steps. These steps are shown graphically in Figure 2 (Adaptive Management Process) and discussed in the following sections.

Adaptive management planning (Section 4)
Monitoring (Section 5)
Regular assessments (Section 6)
Decision making (Section 7)

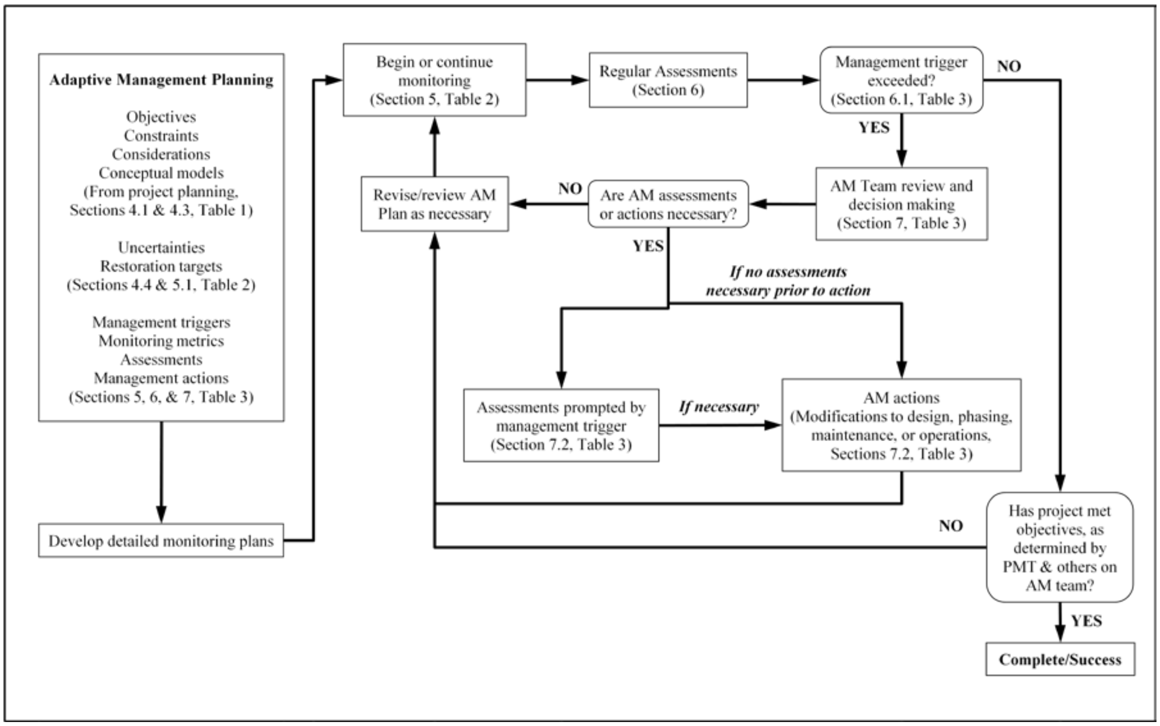

Figure 2. Adaptive Management Process

Adaptive management planning consists of identifying project objectives, constraints, and considerations; describing conceptual models; and identifying key uncertainties. Adaptive management planning sets the stage for determining what monitoring is required to assess whether the project is progressing toward the desired outcome. Regular assessments check monitoring results against restoration targets (desired outcomes) and management triggers (negative outcomes). The decision-making process determines if and when adaptive management actions should be implemented.

The adaptive management steps described in the sections below will be flexible to accommodate lessons learned from the monitoring results. For example, as new information becomes available, the Adaptive Management Team will update the conceptual models and may revise the monitoring metrics and methods to better address the remaining uncertainties. In the event that unanticipated uncertainties are identified, the adaptive management process will be adjusted as needed to support decision-making, so the Adaptive Management Team can continue to steer the project towards the desired outcome.

2. Adaptive Management Planning

This section: (1) identifies objectives, constraints, and considerations identified for the Shoreline Study, (2) outlines ecosystem restoration actions included in the recommended plan, (3) presents conceptual models that relate project actions (and potential adaptive management actions) to desired project outcomes, and (4) lists sources of uncertainty.

2.1 Project Objectives, Constraints and Considerations

During the initial problem identification phase of the feasibility study, the PDT, with stakeholder input, identified planning objectives, constraints, and considerations that would guide the development of ecosystem restoration, flood risk management, and recreation aspects of the future project (Table 1. Planning Objectives, Constraints, Considerations, and Uncertainties).

For these objectives, constraints, and considerations, the team also identified related uncertainties in future conditions, which are described in Section 4.4 below.

Table 1. Planning Objectives, Constraints, Considerations, and Uncertainties

Objectives			Uncertainties
1.	Reduce potential economic damages due to tidal flooding in areas near the South Bay shoreline in Santa Clara County.		• Flood and infrastructure performance • Climate change
2.	Reduce the risk to public health, human safety and the environment due to flooding from tidal sources along the South Bay shoreline in Santa Clara County.		• Flood and infrastructure performance • Climate change
3.	Increase contiguous marsh to restore ecological function and habitat quantity, quality, and connectivity (including transition zones) in the study area for native, resident plant and animal species including special-status species such as steelhead trout, Ridgway's rail, and salt marsh harvest mouse.		• Sediment dynamics • Effects on non-avian species • Ecotones • Climate change
4.	Provide opportunities for public access, education, and recreation in the study area.		• Public access & wildlife
Constraints			Uncertainties
1.	Do not jeopardize any listed species.		• Bird use of changing habitats • Sediment dynamics
2.	Do not significantly increase the potential for bioaccumulation of mercury in the food web within the study area.		• Mercury
3.	Recreational features must be compatible with ecosystem restoration objectives and flood risk management objectives.		• Public access and wildlife
4.	Comply with applicable regulatory requirements.		• No major uncertainties
5.	Do not negatively impact groundwater quality.		• No major uncertainties
6.	No negative permanent impacts on function of existing major infrastructure (wastewater treatment plant, PG&E, railroad, stormwater pump station, landfill, recycling facilities).		• Flood and infrastructure performance
Considerations (Avoid, minimize, or mitigate)			Uncertainties

1.	Loss of existing outboard marshes and mudflats in the study area.		• Sediment dynamics
2.	Reduction in the quality of existing tidal marsh, including fragmentation and increased edge effects.		• Sediment dynamics
3.	Creation of new tidal areas without transition zones.		• No major uncertainties
4.	Negative impacts to threatened and endangered species.		• Bird use of changing habitats□• Effects on non-avian species□• Sediment dynamics
5.	Net reduction of total habitat value for major categories of water birds, including shorebirds, waterfowl, and miscellaneous species that use these habitats within the larger SBSP Project area.		• Bird use of changing habitats
6.	Proliferation of nonnative and/or undesirable species in the study area.		• Invasive and nuisance species
7.	Access by predators to special-status species habitat in the study area.		• Invasive and nuisance species
8.	Negative impacts to cultural resources.		• No major uncertainties
9.	Negative impacts to existing recreational infrastructure function within the study area.		• Public access and wildlife
10.	Increases in vector populations in the study area.		• Invasive and nuisance species
11.	Negative impacts to existing water quality and sediment quality in the study area.		• Mercury□• Sediment dynamics

2.2 Proposed Ecosystem Restoration Actions

The Shoreline Study proposes to restore approximately 2,900 acres of former commercial salt production ponds to tidal marsh and associated habitats. Tidal habitat restoration will be phased and achieved mainly through restoration of natural physical and ecological processes rather than through constructed physical features or plantings. In addition, the project proposes to construct 3.5 miles of levees to provide coastal flood protection.

The proposed project includes construction of outboard levee breaches and internal berm breaches to introduce tidal flows to the ponds. Some of the outboard levees and internal berms would be lowered to reconnect marsh to mudflat, improving water, sediment, and organism exchange. Pilot channels, starter channels, ditch blocks and side cast natural berms will be used to accelerate evolution of the ponds and enhance habitat.

The ecosystem restoration component of the proposed project would occur as three phases of pond breaches to establish tidal connection, with five years between each set of breaches (Figure 3. Project Implementation Schedule). The first phase would breach Ponds A12 and A18 (in 2020), the second would breach Ponds A9, A10, and A11 (in 2025), and the third would breach Ponds A13, A14, and A15 (in 2030). Under the adaptive implementation concept, design and construction of the later phases may be modified based on what is learned in monitoring of earlier phases. In the unlikely event that the results of the earlier phase(s) indicate undesirable outcomes that cannot be avoided by adaptive management actions, project implementation would be halted prior to construction of the later phase(s).

Through its phased implementation approach, it is possible that the Shoreline Study may cease tidal restoration actions after either the first or second phase. This would only take place if the USACE and the Adaptive Management Team decided, based on the latest monitoring and science available on issues such as bird use and mercury contamination, that the highest ecological value of those particular ponds were for them to remain as pond habitat for specific guilds of birds. The proposed phases were selected specifically because they could be implemented as separable elements, although with cumulative synergistic benefits. However, regardless of the ultimate endpoint, the Shoreline Study will have implemented a cost effective restoration project and achieve significant ecological benefits as part of a nationally significant restoration effort.

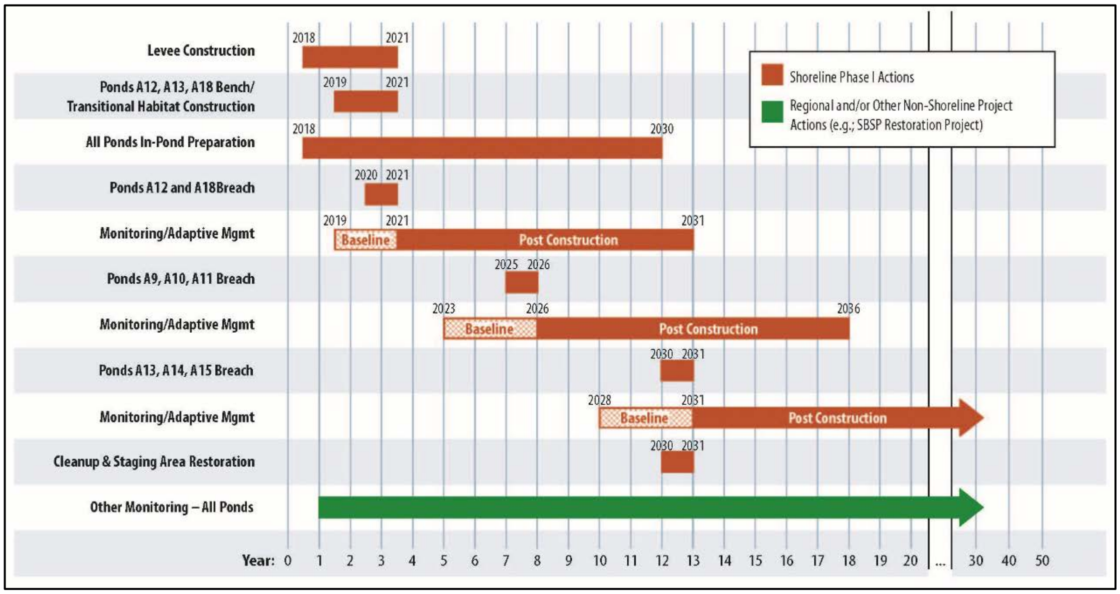

Figure 3 – Project Implementation Schedule

2.3 Conceptual Models

The purpose of the conceptual model is to provide the linkage between project actions and expected system response. Planning for the Shoreline Study used the conceptual ecological model developed for the SBSP Restoration Project (Trulio et al 2007) to represent current understanding of ecosystem structure and function in the project area, identify performance measures, and help select parameters for monitoring. The model illustrates the effects of important natural and anthropogenic activities that result in different ecological stressors on the system. Figures 4, 5, and 6 present the conceptual models for tidal habitat, managed pond habitat, and overall landscape habitat interactions.

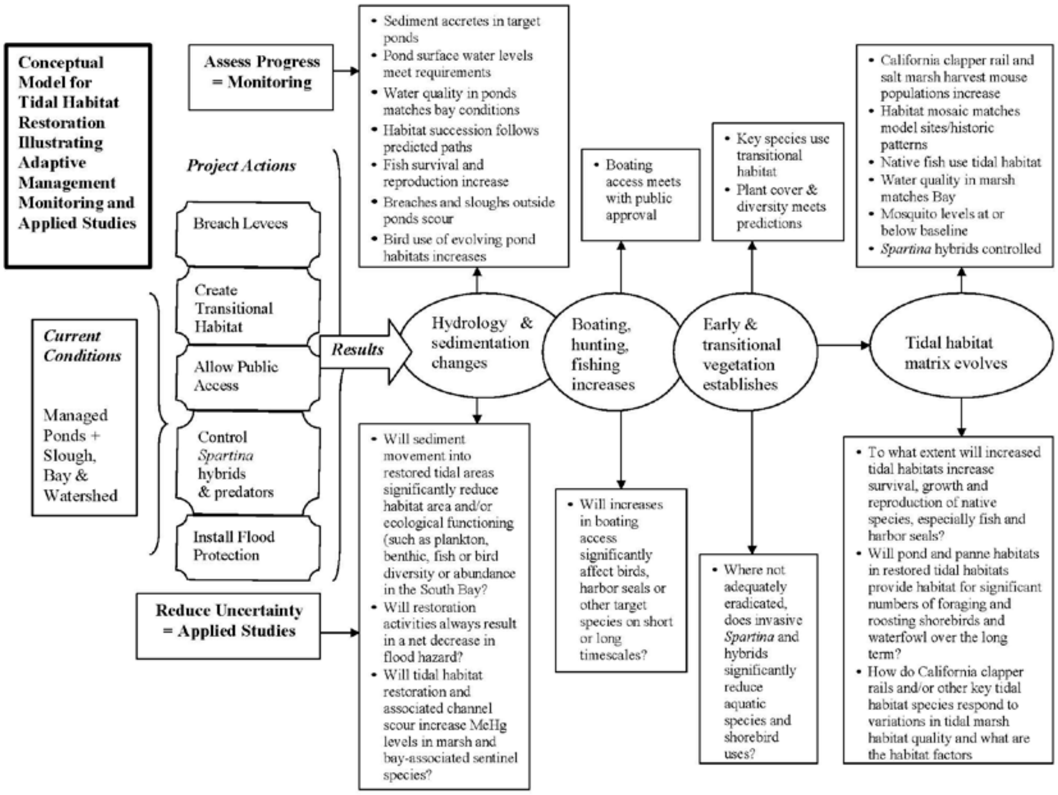

Figure 4. Tidal habitat conceptual model

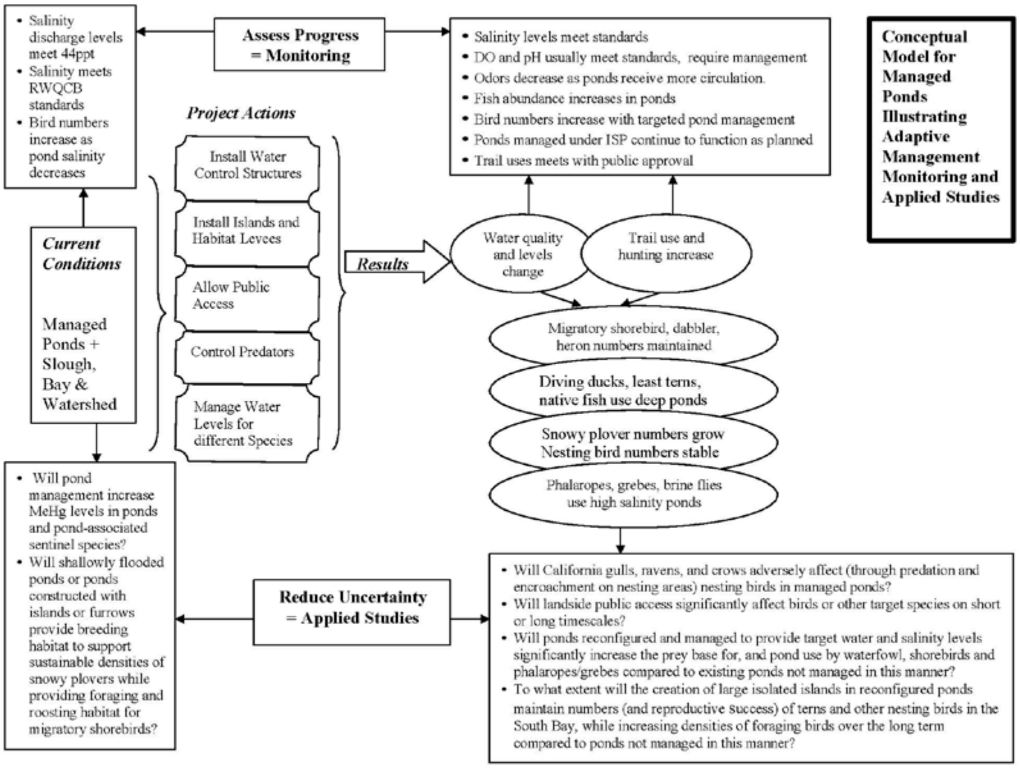

Figure 5. Managed pond conceptual model

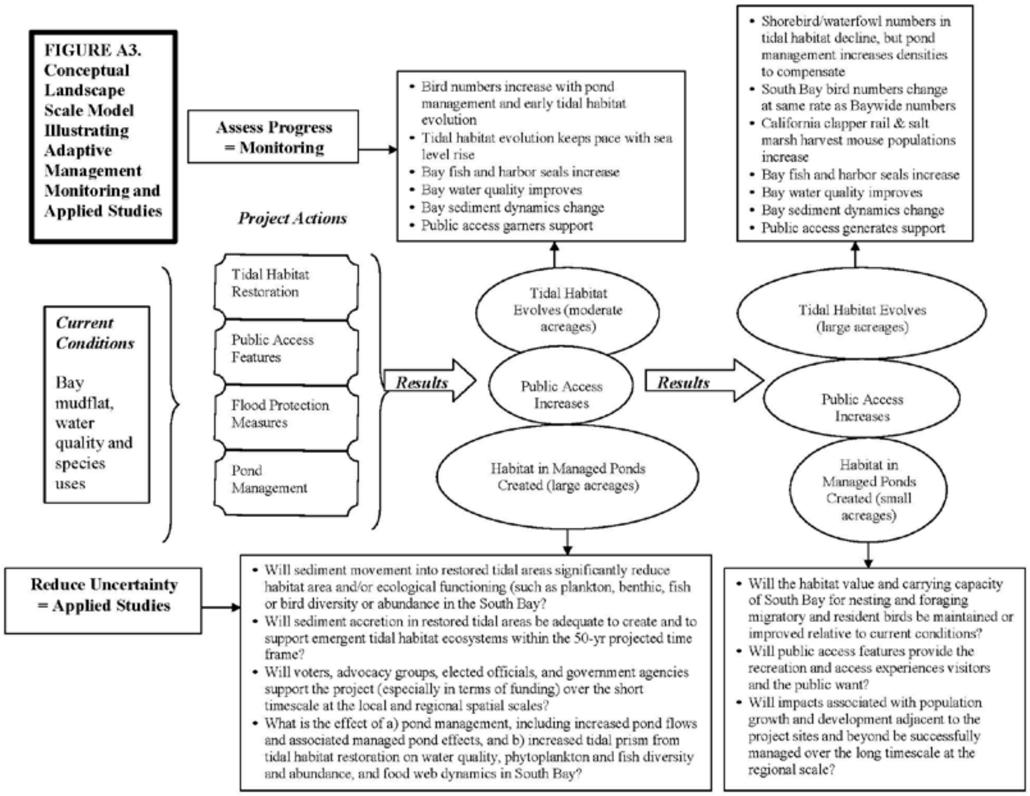

Figure 6. Landscape conceptual model

The tidal habitat conceptual model is directly relevant to the desired habitat type and ecosystem restoration objectives for the Shoreline Study. The managed pond and landscape conceptual models are relevant in that they describe the "staircase" issues (associated with phased implementation), issues that determine whether the project recommended by the Shoreline Study proceeds beyond the first phase of tidal marsh restoration, or halts before all phases are completed (see Section 9).

2.4 Sources of Uncertainty

Gaps in our knowledge about South San Francisco Bay ecosystem function and the landscape-scale effects of restoration actions can influence how we achieve the project objectives over the course of implementation. Key uncertainties associated with ecosystem restoration, flood risk management, and public access were identified so that monitoring could be targeted to reduce these uncertainties and guide future actions, including cost-shared adaptive management.

Sediment dynamics, including the extent to which estuarine sedimentation is sufficient to convert mudflats to vegetated marsh and extent to which tidal habitat restoration might result in the loss of slough and bay tidal mudflat habitat regionally.

Bird use of changing habitats, including the extent to which tidal habitat species can be recovered while maintaining the diversity and abundance of nesting and migratory waterbirds observed during pre-project conditions.

Effects on non-avian species, including the extent to which restoration will affect fish, mammals, and other critical species in the South Bay ecosystem.

Mercury, including the extent to which the future project's ecosystem restoration and other actions might result in an increase in bioavailable mercury in the food chain.

Invasive and nuisance species, including the invasive *Spartina* hybrids, red foxes, California gulls, and mosquitoes.

Public access and wildlife, including the extent to which various forms of public access and recreation can be integrated into the future project without significantly affecting wildlife.

Ecotones, including the extent to which the ecotones (transitional habitat located between tidal marsh and upland habitats) will support desirable vegetation and not support invasive vegetation.

Flood and infrastructure performance, including the extent to which the new infrastructure will perform as designed.

Climate change, including whether sea level rise will be greater than assumed in the design.

Table 1 (Planning Objectives, Constraints, Considerations, and Uncertainties) lists the uncertainties as they relate to each of the project objectives, constraints, and considerations. Some of these uncertainties relate directly to the efficacy of actions being proposed (e.g., ability to meet ecosystem restoration objectives), while others take into account the landscape-scale effects of multiple restoration actions in South San Francisco Bay (thus relating to adaptive implementation).

3. Monitoring

The purposes of monitoring are to assess progress towards project objectives, detect early signs of potential problems, and reduce uncertainties. For each key uncertainty, restoration targets (success criteria) were developed to identify the desirable outcome, and then monitoring metrics defined for measuring each restoration target (Table 2. Monitoring topics, targets, and metrics associated with ecosystem restoration objectives). The monitoring elements included in this table have been limited to activities associated with ecosystem restoration project objectives. The restoration targets and success criteria define how the project will know when ecosystem restoration success has been achieved and monitoring activities can cease.

Table 2. Monitoring topics, targets, and metrics associated with ecosystem restoration objectives

Primary Monitoring Topics		Category	Restoration Targets/Success Criteria	Monitoring Metrics
1.	Sediment dynamics	Sedimentation Inside the Ponds	Water levels inside the ponds are similar to just outside the ponds, allowing full exchange of water and sediments (Years 1-3 of breaching phase only). Accretion rate of the breached ponds is sufficient to reach marsh vegetation colonization elevations within the planning time frame (Years 1-5 of breaching phase only). Initial modeling projects that the ponds will reach marsh plain elevation within 15-20 years after breaching. Since this is beyond the monitoring period for the project, the restoration target for the first 10 years will be that the accretion rates are on a trajectory toward meeting that criterion. Specific elevation targets for each pond will be refined based on the ponds' initial bottom elevation, and the sediment accretion curves developed from the previous restoration of adjacent Ponds A6, A19, A20 and A21.	• Water levels in ponds • Sedimentation rates in ponds • Suspended sediment concentrations in ponds

		Restored Tidal Marsh Habitat (Inside the Ponds)	Tidal marsh vegetation is on a trajectory toward other successful marsh restoration sites in South San Francisco Bay. Native tidal marsh species, including pickleweed (both annual and perennial species) and cordgrass, are expected to begin naturally colonizing the marsh plain within 2 years of pond bottom reaching the appropriate elevations through natural sedimentation (typically an elevation between Mean Tide Level and Mean Higher High Water).	• Tidal marsh habitat acreage in ponds
2.	Bird use of changing habitats	Ridgway's Rail	• Contribute to the recovery of the Ridgway's rail by providing new tidal marsh habitat and ensuring restored marshes are on a trajectory toward vegetated marsh.	• Tidal marsh habitat acreage in ponds (see Item 1 above)
3.	Non-avian species	Salt Marsh Harvest Mouse	• Contribute to the recovery of the salt marsh harvest mouse by providing new tidal marsh habitat by providing new tidal marsh habitat and ensuring restored marshes are on a trajectory toward vegetated marsh.	• Tidal marsh habitat acreage in ponds (see Item 1 above)
4.	Invasive and nuisance species	Invasive and Nuisance Plants	• Habitat trajectory toward native/non-native composition of a reference marsh and other restoration sites. Qualitative inspections for invasive species (especially *Spartina hybrids* and *Lepidium latifolia*) will occur annually, quadrant or transect sampling once marsh has 20% vegetation cover. Any hybrid *Spartina* presence will be reported to the regional control effort, and any marsh containing over 30% *Lepidium* will trigger control activities.	• Abundance of non-native species

5.	Ecotones	Transition zones	• Transition zone habitat comprising wide, gently-sloped vegetated terrain with a diverse habitat mosaic dominated by (>50% relative cover) perennial native grassland and for species interspersed with salt panne and seasonal wetland habitats transitioning along a salinity gradient to native salt marsh community representative of historic transition zone habitats.	• Plant species composition in transition zones

Monitoring activities associated with flood risk management, adaptive implementation, or permit compliance for the recommended project will not be cost shared by the USACE, but will be funded and implemented by the non-Federal sponsor through the SBSP Restoration Project. However, information collected through these types of monitoring activities may result in future cost-shared activities (e.g., changes to the authorized project).

Monitoring and activities that address regional changes from the combined effects of Shoreline Study and SBSP Restoration Project will not be cost shared by the USACE unless they are also linked directly to the Shoreline Study's ecosystem restoration objectives and are conducted within the Shoreline project footprint. These activities related to regional changes will be conducted as the continuation of ongoing activities currently performed under the SBSP Restoration Project. Coordination of the future Shoreline Project with the SBSP Restoration Project will allow for more complete and consistent information to guide decision-making as bay-wide effects are considered. Regional monitoring includes monitoring of changes to mudflat and tidal marsh acreages, changes to bird populations and abundance, and mercury bioavailability.

Each monitoring metric was detailed in terms of monitoring methods, locations, frequency and duration in order to develop a cost estimate (See Table 3. Monitoring Cost Estimate). The monitoring cost estimate is $968,000 (First Cost October 2014 price level).

Although the monitoring cost estimates presented in this document display activities during the proposed ten years of cost-shared monitoring after construction, monitoring will continue beyond the initial ten years, funded by the non-Federal sponsor, if the criteria for ecosystem success have not yet been met (see Table 2. Monitoring topics, targets, and metrics associated with ecosystem restoration objectives).

Table 3. Monitoring Cost Estimate

Restoration Target Category	Monitoring Metric (Brief)	Monitoring Metric & Method	Which Years?	# Years	Cost/Unit (before SS adjustment)	Cost/Unit *	Unit	# Units	Total Cost*	Notes
Sedimentation Inside the Ponds	Water levels in ponds	• Water levels inside the ponds collected using pressure transducers in the ponds and adjacent sloughs. Monitor until no damping observed.	0+, 1, 2 after each phase	9	$ 50,000	$ 50,000	1 phase (3 yrs/phase, 2 wks/yr)	3	$ 150,000	Approximately $16,700 per year for three years per phase (2-3 tide gages). Note: SBSP is not monitoring water levels currently.
Sedimentation Inside the Ponds	Sedimentation rates in ponds	• Sedimentation rates inside ponds: Transects or SETs in breached ponds, annually at first and then less frequently as rates of accretion slow. Consider using Regional Sediment Dynamics monitoring data, such as LiDAR surveys if sufficiently detailed for use inside ponds.	0+, 2, 5, 10 after each phase	12	$ 25,000	$ 25,000	1 event	12	$ 300,000	Assume same methods as at Island Ponds and Pond A6. Investigate using bathymetry or LiDAR inside the breached ponds.
Sedimentation Inside the Ponds	Suspended sediment concentrations in ponds	• Suspended sediment concentration monitoring • See related monitoring in Regional Mudflat Habitat and Sediment Dynamics	10	1	$ 150,000	$150,000	1 event	1	$ 150,000	Estimate is cost for conducting sampling for input variables to model, and running marsh sustainability model. Assume model is run at Year 10, though timing may vary.
Restored Tidal Marsh Habitat (Inside the Ponds)	Tidal marsh habitat acreage in ponds	• Tidal marsh habitat acreage inside the ponds. Collect acreages via remote imagery with limited ground-truthing.	5, 10	2	$ 300,000	$ 54,000	2	1	$ 108,000	Included in Regional Tidal Marsh Habitat. No costs for vegetation community surveys since these will not be conducted within 10 years of breaching.
Ridgway's Rail	Presence of tidal marsh habitat	• Tidal marsh habitat acreage inside the ponds. Collect acreages via remote imagery with limited ground-truthing (as above).							$ -	cost already covered by tidal marsh acreage monitoring
Salt Marsh Harvest Mouse	Presence of tidal marsh habitat	• Tidal marsh habitat acreage inside the ponds. Collect acreages via remote imagery with limited ground-truthing (as above).							$ -	cost already covered by tidal marsh acreage monitoring
Invasive and Nuisance Plants	Abundance of non-native species	• Abundance of non-natives such as non-native Spartina spp. (Qualitative assessments for invasive species will occur annually.)						N/A (see note)	$ -	Covered by SBSP and transition zone monitoring.
Transition zones	Plant species composition in transition zones	• Plant species composition including abundance of native species. • Annual habitat monitoring during a 3-year plant establishment period to ensure establishment of native plant species. • Annual qualitative assessments for invasive species.	0, 1, 2, 5, 7, 10	6	**No Fill** - $8,000 - $10,00/year; **30:1 Fill** - $25,000 - $30,000/yr; **100:1 Fill** $66,000 -	$8,000 - $10,000/year	1 event	6	$ 54,000	6 Years Monitoring (Total) includes habitat monitoring, species composition, and qualitative assessments; Estimate based on total transition zone acreage.
		SUBTOTAL							$ 762,000	
		27% Contingency							$ 205,740	
		TOTAL (First cost Oct 2014 price levels)							$ 967,740	
		AVERAGE ANNUAL COST (APPROX)							$ 48,387	
		*Assumes Shoreline Study cost is 18% of entire cost estimate for SBSP Restoration Project, based on relative acreages to be monitored.								
		Assume project constructed in three phases from 2017 to 2031, with monitoring and adaptive management 2021 to 2041 (10 years following each phase for a total of 20 years).								
		Note: Year 0+ means immediately after breaching.								
		Any monitoring that occurs after 10 years post construction will be a 100% non-Federal responsibility								

3.1 Targets

Table 2 (Monitoring topics, targets, and metrics associated with ecosystem restoration objectives) lists the restoration targets as related to the project uncertainties, which are directly linked to the project objectives, constraints, and considerations (Table 1. Planning Objectives, Constraints, Considerations, and Uncertainties) and indicate how the project will know when ecological success has been achieved and monitoring activities can cease. Typical data sources for developing these targets are the published academic literature, quantitative baseline data, or requirements set by a regulatory agency. Targets include both long-term goals and intermediate conditions as the ecosystem changes. Quantitative targets, such as minimum numbers or ranges of variability, do not yet exist for all restoration targets. These targets will be developed using existing data or regulations and many are expected to evolve as monitoring and assessments are conducted. References to “significant impacts” in the target descriptions are related to National Environmental Policy Act and California Environmental Quality Act significance, which will be identified in the Environmental Impact Statement/Report.

Restoration targets are intended to hold the Shoreline Study to levels of performance that are under the Shoreline Study’s control, and not to levels controlled by external factors.

The monitoring is organized by “Restoration Target Categories,” which are specific sub-categories within each of the key uncertainties. Categories are the basic elements of the ecosystem that must be monitored to determine whether the project objectives are being met, or are likely to be met in the future. Use of the Restoration Target Categories helps in cross-referencing the monitoring to later assessment and decisions-making steps by allowing cross-referencing between tables.

3.2 Monitoring Metrics

Specific, measureable monitoring metrics, or parameters, to assess change with respect to the restoration targets are presented in Table 2 (Monitoring topics, targets, and metrics associated with ecosystem restoration objectives). Note that while habitat creation for the Federally protected Ridgway’s rail (formerly the California clapper rail, *Rallus longirostris obsoletus*) and the salt marsh harvest mouse (*Reithrodontomys raviventris*) is a project objective, the monitoring metrics for these species within this MAMP only includes the establishment of the target habitat. The timing of adequate habitat development to support these species varies greatly between the individual ponds, depending on their initial bottom elevations. For example, in the nearby Pond A21 (restored in 2006), rails were detected using the restored marsh habitat in Year 8 post-restoration.

3.3 Monitoring Methods

Table 3 (Monitoring Cost Estimate) describes the monitoring metrics and methods in additional detail, such as timing relative to restoration phases, spatial extent, and frequency. Each of the three pond breaching phases will have its own timeframe for baseline monitoring, construction, post-construction monitoring and adaptive management, and turnover to the non-Federal sponsor for operation and maintenance. For each phase of pond breaching, baseline monitoring would begin three years prior to breaching and post-construction monitoring would continue until ecological success criteria are met. Extensive monitoring that has already occurred in these areas indicates that bird use has a high degree of inter-annual variability. Therefore, to understand the immediate, as well as cumulative, effects of the restoration actions, continued baseline monitoring is essential. Although previous and ongoing monitoring results are available and will inform the proposed project, this information provides a general understanding of what will happen within the restored ponds, but the bigger picture of cumulative effects across multiple ponds, is unknown. The period of cost-shared monitoring will not exceed ten years (Figure 3. Project Implementation Schedule). Section 7.3 provides additional discussion of monitoring duration as related to project close out.

The monitoring method summaries in Table 3 (Monitoring Cost Estimate) are described in enough detail to make the approach clear, but do not fully describe the monitoring regime. A monitoring plan with detailed methods, protocols, timing, and responsible parties will be developed prior to start of monitoring, as each monitoring study is contracted.

3.4 Database Management

Database management will be provided by the SCC, who will likely contract with the San Francisco Estuary Institute (SFEI) or other similar entity for this role. The database manager will be responsible for storing final monitoring reports and other Shoreline Study documentation (decisions, agendas, reports) and making them available on the SBSP Restoration Project website. Monitoring reports will be searchable by topic and principle author.

The database will be designed to store and archive the Shoreline Study monitoring data. The format of each monitoring data set will vary as appropriate to the type of monitoring. Therefore, data are expected to be archived separately by study, rather than collated in one master database. Each dataset will include:

- Data and metadata transfer and input policies and standards
- Data validation procedures
- Mechanisms to ensure data security and integrity

Monitoring data sets will be available to the public upon request.

4. Regular Assessments

The assessment phase compares the results of the monitoring efforts to the desired project performance targets. The SBSP Restoration Project Science Program has been the primary group responsible for these assessments, for the regional monitoring and adaptive management effort. The Lead Scientist for the SBSP Restoration Project will facilitate regular communication of assessment results from the Science Program to the AMT, who will make recommendations to the USACE. The USACE will be the decision maker for any adaptive management actions undertaken on projects that it is responsible for constructing.

This section defines the assessment process, acceptable variances between monitoring results and targets, the frequency and timing for comparison of monitoring results to the selected targets, and assessment documentation.

4.1 Assessment Process

The SBSP Restoration Project Science Program will identify methods for comparing the restoration targets/ triggers with monitoring data. These methods will include appropriate statistical comparisons (e.g., hypothesis testing, ANOVA, multivariate methods). The results of these assessments will be documented and stored in the data management system.

The SBSP Restoration Project Science Program members will collaborate with the AMT to define magnitudes of difference (statistical differences, significance levels) between measured and desired values that will constitute variances. These variances will be used to recommend adaptive management actions to the USACE.

Note that, while there are no assessments specific to sea level rise, any predictions of tidal habitat evolution will incorporate the most up-to-date sea level rise information and guidance at the time of assessments.

4.2 Frequency of Assessments

An annual meeting will be held between the AMT and the SBSP Restoration Project Science Team to discuss monitoring and research findings, management triggers, and implications for adaptive management. Assessments may be more frequent, depending on the relevant physical or ecological scale of each restoration target. Table 3 (Monitoring Cost Estimate) includes two columns describing the frequency and timing of monitoring. The temporal scale of the system responses was one of the main considerations in determining frequency and timing of monitoring. For example, inspections for levee erosion should be conducted monthly at first, then annually and after major rainfall and tidal events. In this case the frequency of assessments will be greatest during the first year, with decreasing frequency after the first year.

4.3 Documentation and Reporting

Project assessment documentation will be prepared following each annual meeting in the form of detailed meeting notes. The meeting notes will describe progress towards project objectives as characterized by the restoration targets. The database manager will be responsible for storing the meeting notes and making them available on the SBSP Restoration Project website.

5. Decision Making

The AMT will receive input from the SBSP Restoration Project Science Team in an annual meeting that will focus on relevant monitoring findings, management triggers, and implications for future project phases. If the AMT believes that small management actions need to happen, they would recommend to the USACE that those actions be implemented immediately. If a larger change to the project approach or a substantial action is necessary, the AMT would vet this change or action publicly through the SBSP Restoration Project's PMT and its working groups such as the Stakeholder Forum, Alviso Regional Working Group, and/or the Regulatory Work Group, depending on the scale and type of issue. The AMT would report the results of the vetting process to the USACE, who will decide whether to take action.

For each management trigger there is a list of potential adaptive management actions the AMT and Science Team might recommend that the USACE take if a management trigger is reached. Table 4 (Adaptive Management Decision Matrix) describes the assessments and potential management actions associated with each restoration target category.

Table 4. Adaptive Management Decision Matrix

Restoration Target Category	Monitoring Metrics	Management Triggers/ Conditions Requiring Assessment	Assessments Prompted by Management Trigger	Potential Management Action
Sedimentation Inside the Ponds	• Water levels in ponds • Sedimentation rates in ponds • Suspended sediment concentrations in ponds	• Projections based on the rate of mudflat accretion suggest vegetation colonization elevations are not likely to be achieved within the planning time frame.	• Convene study session to review findings and assess whether colonization is compromised. [A] • If tidal marsh is not meeting projections, assess biological significance of slower tidal flat evolution. [A]	• If vegetation colonization is compromised and deemed biologically detrimental, widen breaches to encourage better tidal exchange [C] • Adjust to increase pond mudflat accretion. Potential management actions include adding wave breaks, placing fill, or in-bay material placement to "feed" the restored ponds. [C] • Implement management or adjust design (e.g., remove more levees to increase connectivity between ponds and adjacent sloughs) based on study results [C] • Reconsider movement up staircase. [P]
Restored Tidal Marsh Habitat (Inside the Ponds)	• Tidal marsh habitat acreage in ponds	• No vegetation within 10 years of monitoring	• Identify causes of slow vegetation establishment [A] • Review sediment dynamics [A]	• Remove impediment to vegetation establishment. [C] • See Potential Management Actions for Sedimentation Inside the Ponds.
Invasive and Nuisance Plants	• Abundance of non-native species	• Presence of other non-native plant species that is greater than 5% of vegetation cover. • Presence of new invasive plants with high potential to spread. • Presence of non-native *Spartina* or hybrids	• Continue to re-evaluate what is meant by "control" of invasive species and adjust monitoring and management triggers based on the latest scientific consensus [A] • If invasive species cannot be controlled, study biotic response to non-native vegetation [A]	No construction actions proposed. • Control invasive Spartina in future restored tidal marsh [I]
Transition zones	• Plant species composition in upland transition zones	• Dominant native plant species cover does not establish • Invasive species constitute >10% of habitat	No additional assessments proposed.	• Active seeding/planting to revegetated bare areas [C] • Control invasive *Lepidium* in transition zone [I] • Weed control [M]

* A = Assessment; C = Construction; I = Invasive and Nuisance Plants; P = Phasing (not cost shared); M = Operations & Maintenance (not cost shared)

Figure 7 (Adaptive Management Assessment and Decision Making: Sediment Dynamics Example) steps through the decision-making process for one of the Shoreline Study uncertainties: Sediment Dynamics. This example is used to illustrate adaptive management decision making throughout Section 7.

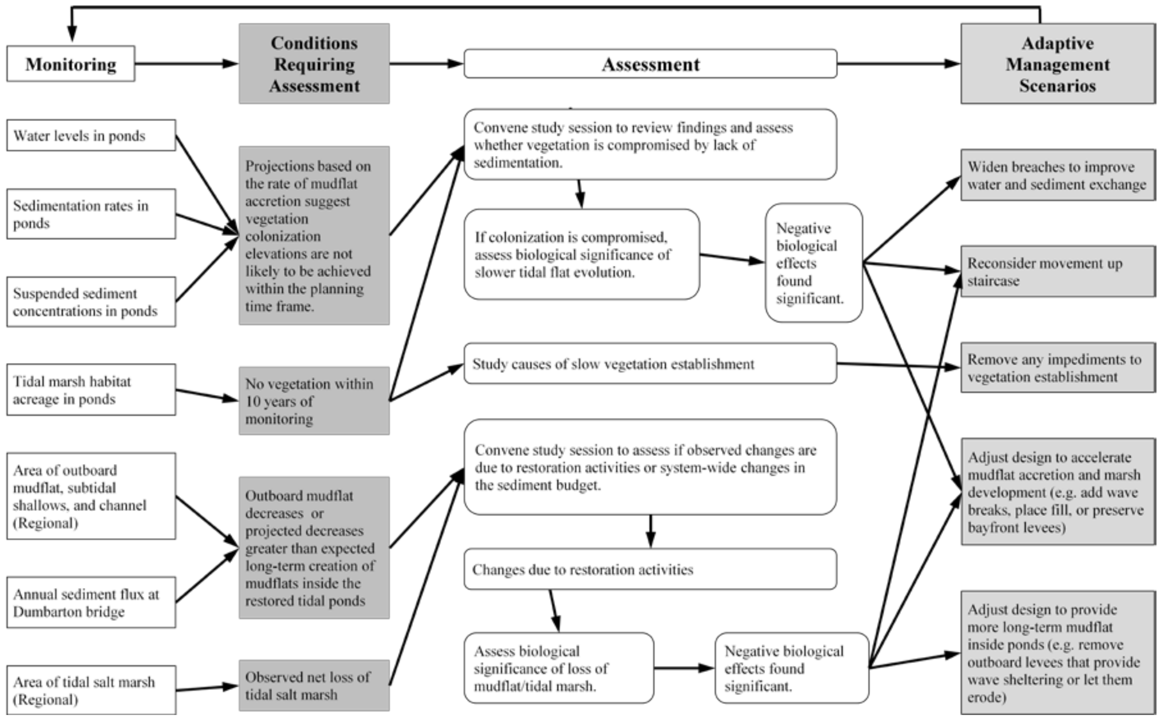

Figure 7. Adaptive Management Assessment and Decision Making: Sediment Dynamics Example

5.1 Triggers

Each restoration target has a management trigger for action if the system is not performing well. A trigger (also known as "Conditions Requiring Assessment") is a threshold that, when reached, indicates that the Shoreline Study may be diverging from a restoration target. The intent of the triggers is to anticipate problems before they cause significant impacts to the system. This advance notice would provide project managers with time to investigate the causes and take action, as necessary, to put the system back on track.

Each management trigger has a corresponding list of potential actions the project team may take if a trigger is reached (discussed in Section 7.2 Potential Adaptive Management Actions). Like the restoration targets, the triggers will be reviewed and updated regularly as additional information becomes available.

5.2 Potential Adaptive Management Actions

Potential management actions are taken when the project is not progressing towards restoration targets as planned and a management trigger has been reached. Typically, the first action would be to conduct an assessment of available monitoring data and consult with external and internal experts to inform subsequent management actions. For this plan, potential management actions are categorized as either (1) as-needed assessments, (2) construction (adjustments to design), or (3) changes to operations, and maintenance. Changes to restoration phasing (adaptive implementation) are also a potential outcome, but those actions are not included as cost-shared activities under the Shoreline Study MAMP.

5.2.1 As-Needed Assessments Triggered by Monitoring

When the cause for tripping a management trigger or the appropriate response is not immediately apparent, these additional assessments use available data (monitoring or other) to better understand what is causing the system to respond differently from target. These assessments typically occur prior to other adaptive management actions and involve convening an assessment team of experts and decision makers to advise the USACE on how to proceed (Table 5. As-needed assessments).

For example, if regular monitoring finds that there is no vegetation establishment within 10 years of monitoring the assessment team would assess whether vegetation establishment is, in fact, caused by sediment dynamics (lack of sedimentation) (Figure 7. Adaptive Management Assessment and Decision Making: Sediment Dynamics Example). If this is the case, the team would assess the biological significance of slower tidal flat evolution. If sediment dynamics is not the cause, the team would examine other potential reasons for slow vegetation establishment.

Table 5. As-needed assessments

Restoration Target Category	Potential Management Action	Type*	Shoreline Study Cost Estimate (unadjusted**)	Cost Estimate *	Notes
Sedimentation Inside the Ponds	• Convene study session to review findings and assess whether colonization is compromised.	A	$ 25,000	$ 4,500	All reviews @$25,000, adjusted by 18%*.
Sedimentation Inside the Ponds	• If tidal marsh is not meeting projections, assess biological significance of slower tidal flat evolution.	A		$ -	Already covered in applied studies
Restored Tidal Marsh Habitat (Inside the Ponds)	• Identify causes of slow vegetation establishment	A	$ 50,000	$ 9,000	
Restored Tidal Marsh Habitat (Inside the Ponds)	• Review sediment dynamics	A		$ -	Already covered in monitoring
California Clapper Rail	• Assess habitat suitability	A		$ -	Already covered in monitoring
Salt Marsh Harvest Mouse	• Assess habitat suitability	A		$ -	Already covered in monitoring
Invasive and Nuisance Plants	• Continue to re-evaluate what is meant by "control" of invasive species and adjust monitoring and management triggers based on the latest scientific consensus	A		$ -	Already covered in monitoring
Invasive and Nuisance Plants	• If invasive species cannot be controlled, study biotic response to non-native vegetation	A	$ 25,000	$ 4,500	All reviews @$25,000, adjusted by 18%*.
	SUBTOTAL			**$ 18,000**	
	27% Contingency			**$ 4,860**	
	TOTAL (First Cost Oct 2014)			**$ 22,860**	

5.2.2 Construction (Adjustments to Design)

Most construction actions involve adjusting the tidal restoration design (e.g. widening breaches or placing fill) when the project is not progressing towards the objectives as planned (Table 6. Adaptive Management Construction Activities). Design adjustments would be tailored to the specific problem as identified through the assessment. The majority of the proposed actions have been implemented elsewhere in San Francisco Bay for similar marsh habitat restoration projects.

For example, if the sediment dynamics study session (described above) finds that slower tidal flat evolution is biologically significant, the design could be adjusted to encourage faster tidal evolution. This might involve widening breaches, placing wave breaks or additional fill, or preserving bayfront levees (Figure 7. Adaptive Management Assessment and Decision Making: Sediment Dynamics Example).

Table 6. Adaptive Management Construction Activities

Restoration Target Category	Potential Management Action	Type*	Cost Est.	Basis for Cost Estimate
Sedimentation Inside the Ponds	• If vegetation colonization is compromised and deemed biologically detrimental, widen breaches to encourage better tidal exchange	C	$ 230,000	Assume 25% widening
Sedimentation Inside the Ponds	• Adjust to increase pond mudflat accretion. Potential management actions include adding wave breaks, placing fill, or in-bay material placement to "feed" the restored ponds.	C	$ 2,610,000	Assume sidecasts are 50% of 36,000 ft of starter channel at $145/LF
Sedimentation Inside the Ponds	• Implement management or adjust design (e.g., remove more levees to increase connectivity between ponds and adjacent sloughs) based on study results	C	$ 840,000	Assume lowering 7,500 ft of levee at $112/ft
Restored Tidal Marsh Habitat (Inside the Ponds)	• Remove impediment to vegetation establishment.	C		
California Clapper Rails	No construction actions proposed.			
Salt Marsh Harvest Mouse	No construction actions proposed.			
Invasive and Nuisance Plants	No construction actions proposed.			
Transition zones	• Active seeding/planting to revegetated bare areas	C	$ 25,000	Assume 20% replating @ $7,000/acre (no irrigation; grassland seeding; plug planting @ 400-500 plants/acre). Estimate does not include any soil amendments, maintenance, or irrigation costs.
	SUBTOTAL		**$ 3,705,000**	
	27% Contingency		**$ 1,000,350**	
	TOTAL (First Cost Oct 2014)		**$ 4,705,350**	

5.2.3 *Invasive and Nuisance Plant Control*

These adaptive management activities are for the removal of invasive species that may accidentally enter the future restored tidal marsh and transition zones and are beyond the normal operation and maintenance activities that will be performed by the USFWS or non-Federal sponsor. These activities will ensure the establishment of native species, which is a key component of the project's ecosystem restoration objectives.

Monitoring for invasive species will not be cost shared by the USACE, but will performed by existing efforts related to invasive plants and routine operation and maintenance activities.

Within the future tidal marsh areas, this category of proposed cost-shared adaptive management would involve spot control for *Spartina* hybrids whose propogules may enter the project area from the bay through the natural sedimentation that will establish this type of habitat. These spot-control activities will address the possibility that the proposed project will contribute to potential area of infestation of a bay-wide eradication effort (Invasive *Spartina* Project).

Within the future transition zones, the cost-shared adaptive management would address invasive *Lepidium*. The transition areas are more prone to invasion because *Lepidium* thrives in areas of physical disturbance. The transition areas would be a physically disturbed area because they would be constructed by moving large volumes of soil.

Table 7. Invasive and Nuisance Plants

Restoration Target Category	Potential Management Action	Type*	Cost Estimate
Invasive and Nuisance Plants	• Control invasive *Spartina* in future restored tidal marsh	M	$ 250,000
Invasive and Nuisance Plants	• Control invasive *Lepidium* in transition zone	M	$ 900,000
	SUBTOTAL Option		**$ 1,150,000**
	27% Contingency		**$ 310,500**
	TOTAL (First Cost Oct 2014)		**$ 1,460,500**

5.3 Project Close Out

Closeout of the project would occur after the period of cost-shared monitoring and adaptive management. Additional monitoring and adaptive management needed to determine when the project has successfully met its objectives will be conducted by the non-Federal sponsor as part of the operation and maintenance project phase. The project will be determined a success if the restoration targets (Table 2. Monitoring topics, targets, and metrics associated with ecosystem restoration objectives) have been met to the satisfaction of the USACE South Pacific Division Commander. The Division Commander will take into account the recommendations of the San Francisco District Commander and AMT, who will consult with the Executive Leadership Group, South Bay Salt Pond Restoration Project Stakeholder Forum and Science Program, Federal and State resource agencies, and others as appropriate.

Cost-shared monitoring is proposed for a period ten years following each phase of pond breaching. Monitoring beyond this ten-year period will be funded solely by the non-Federal sponsor. Conversely, if the restoration targets are met before the end of the ten-year period, monitoring may be discontinued.

6. Costs for Implementation of Monitoring and Adaptive Management

Cost-shared monitoring and adaptive management actions by the USACE will be limited to actions conducted within the project footprint that are associated with meeting the project's ecosystem restoration objectives, and will not extend beyond 10 years after construction.

The costs for cost-shared monitoring and adaptive management are summarized in Table 8 (Monitoring and Adaptive Management Cost Summary Table). Detailed cost estimates are described in the following sections. The total estimated cost for monitoring and adaptive management for the Shoreline Study, including a 27% contingency, is $8.7 million (First Cost October 2014 price level).

The individual cost elements are approximate and are intended to provide a reasonable basis for budgeting potential costs. Because uncertainties remain in the project elements, monitoring, and adaptive management actions, the cost estimates provided in this report will need to be refined before these actions are implemented.

6.1 Costs for Implementation of Monitoring

Table 3 reports the cost estimates for Shoreline Study monitoring. The costs are based on the frequency of monitoring and the amount of monitoring. All costs assume the monitoring plan is executed in full. The total estimated cost for Shoreline Study monitoring, including a 27% contingency, is $968,000 (First Cost October 2014 price level).

Many of the monitoring and assessment costs are estimated based on previously-estimated costs for the SBSP Restoration Project AMMP (Trulio et al 2007). The SBSP Restoration Project costs are scaled based on relative project areas. This assumes that costs can be estimated on a per-acre basis and reapplied for different regions in the South Bay.

The Shoreline Study's estimated share of monitoring and adaptive management costs is 18% of the combined Shoreline Study and SBSP Restoration Project costs. This calculation is based on the ratio of the Shoreline Study area to the combined Shoreline Study and South Bay Salt Pond area (2,891 acres/15,926 acres). Monitoring costs for the Shoreline Study would likely be higher if monitoring and adaptive management for the Shoreline Study were not coordinated with the SBSP Restoration Project.

6.2 Costs for Implementation of Adaptive Management

The costs for adaptive management are organized into the three adaptive management action categories. The costs of as-needed assessments, construction, and phasing, operations, and maintenance are reported in Table 5, Table 6, and Table 8, respectively. The construction cost estimates were provided in part by USACE. Many of the cost estimates were derived from other South Bay pond restoration projects. The total estimated cost for Shoreline Study adaptive management, including a 27% contingency, is $6,189,000 (First Cost October 2014 price level) for Ponds A9 - A15 and A18, with the potential construction actions contributing approximately three fourths of the costs. This total cost assumes that all adaptive management actions are implemented and likely overestimates total costs. The relatively significant cost of adaptive management compared to initial construction of ecosystem restoration features is associated with the potential need to mobilize and demobilize for additional construction.

For management triggers where multiple adaptive management actions may be considered and only one implemented, we estimated costs for one representative action. The actual action selected during decision-making may not be the one assumed in the cost estimate and costs may differ. Total costs, however, are expected to be equal to or lower than the costs estimated here.

Table 8. Monitoring and Adaptive Management Cost Summary Table

		Adaptive Management				
Restoration Target Category	**Monitoring**	**Assessment**	**Construction**	**Invasive and Nuisance Plants**	**Adaptive Management Total**	**Total Cost**
Sedimentation Inside the Ponds	$600,000	$4,500	$3,680,000		$3,684,500	$4,284,500
Restored Tidal Marsh Habitat (Inside the Ponds)	$108,000	$9,000			$9,000	$117,000
CA Clapper Rail	$0				$0	$0
Salt Marsh Harvest Mouse	$0				$0	$0
Invasive and Nuisance Plants		$4,500		$1,150,000	$1,154,500	$1,154,500
Upland transition zones	$54,000		$25,000		$25,000	$79,000
Subtotal for Monitoring & Adaptive Management	$762,000	$18,000	$3,705,000	$1,150,000	$4,873,000	$5,635,000
Overhead for regular assessments, meetings, data management ($75K/year)						$1,500,000
TOTAL (Including 27% contingency) (First Cost Oct 2014)	**$967,740**	**$22,860**	**$4,705,350**	**$1,460,500**	**$6,188,710**	**$8,656,450**

Note: Adaptive Management column includes assessments triggered by monitoring results, construction, and invasive and nuisance plant costs.

References

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