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MONITORING AND ADAPTIVE MANAGEMENT PLAN

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I. BASIS FOR MONITORING AND ADAPTIVE MANAGEMENT

A. Introduction

The Napa Salt Marsh Restoration (NSMR) project proposes to restore approximately 9,460 acres of formerly commercial salt ponds and associated habitats to a mix of tidal habitats and managed open water ponds. Tidal habitat restoration will be achieved mainly through reliance on natural processes, such as tidal action and sedimentation, to restore habitat rather than through constructed physical features or plantings. Managed pond enhancement will be achieved with water control structures and levee repairs.

After initial construction activities are complete, adaptive management and monitoring are necessary to address uncertainties and ensure project success. Success criteria were defined based on specific hypotheses, which were formed based on the three project planning objectives. Monitoring activities were identified to determine whether the project met these success criteria and adaptive management actions were designed to redirect the restoration effort in the event that the system does not evolve as predicted.

B. Project Planning Objectives

The three planning objectives are:

1. To create a mix of tidal habitat and managed pond habitat to serve a broad range of wildlife, including endangered and threatened species, fish and other aquatic species, and migratory shorebirds and waterfowl;

2. To restore large areas of tidal habitats in a band along the Napa River to maximize benefits to fish and other aquatic animals, and ensure connections between the patches of tidal marsh (within the project site and with adjacent sites) to enable the movement of small mammals, marsh-dependent birds, and fish and aquatic species; and

3. To improve the ability to manage water depths and salinity levels in the managed ponds to maximize feeding and resting habitat for migratory and resident waterfowl and shorebirds.

C. Hypotheses to be Tested by Monitoring and Assessment

Two broad and six specific hypotheses were formed from the planning objectives. The broad hypotheses are that:

1. The project planning objectives can be achieved employing selected salinity reduction and habitat restoration measures, and
2. A mix of tidal habitat restoration and enhancement of managed ponds in the Napa-Sonoma Marshes is an important contribution to the recovery of sustainable populations of native fish, wildlife, and plants, including threatened and endangered species.

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The specific hypotheses below fall into three categories:

1. <u>Salinity Reduction Hypotheses</u>: Salinity reduction of the former commercial salt ponds can be achieved using Napa River water;
2. <u>Tidal Marsh Hypotheses</u>: After salinity reduction, ponds can successfully be restored, using natural sedimentation, to self-sustaining tidal marsh and associated tidal habitats that support wildlife species and complex food webs; and
3. <u>Managed Ponds Hypotheses</u>: The depths and salinities of non-tidal ponds can be sustainably managed to provide habitat for migratory shorebirds and waterfowl.

<u>Salinity Reduction Hypotheses</u>

1. The salinities of ponds can be reduced to allow for tidal restoration or continued management as ponds, without negatively impacting aquatic species in the receiving waters (Napa River and neighboring sloughs):
   a. Salinities in Pond 3 can be reduced using breaches;
   b. Salinities in Ponds 4, 5, 6 and 6A can be reduced over a relatively short period of time using water control structures or breaches that allow for the intake of Napa River water and the discharge of diluted pond water;
   c. Short-term discharge of water in Ponds 3, 4, 5, 6, and 6A via breaches or water control structures will not result in adverse effects to beneficial resources in the receiving waters;
   d. The bittern pond (Pond 7) can be diluted over 8 to 10 years using Napa River water and a dilution ratio of 1:100; and
   e. Release of bittern into the Napa Slough will not result in chronic adverse effects or a build-up of bittern in the slough system.

<u>Tidal Marsh Hypotheses</u>

2. Restoration of tidal habitats in Ponds 3, 4, and 5 will be an important contribution to the recovery of sustainable populations of native fish, wildlife, and plants, including endangered and threatened species:
   a. Increased tidal habitat will increase primary productivity and increase the volume and diversity of aquatic and benthic invertebrates, creating more robust populations and more complex food webs and benefiting a wide range of native fish and wildlife species;
   b. Increases in subtidal, intertidal, and tidal marsh habitats will benefit special-status anadromous fish, specifically Central Coast steelhead trout and chinook salmon, which could benefit from the tidal habitats during their upriver migration or in the smoltification process by having more places to take refuge and more food sources;
   c. Increases in tidal marsh habitat will benefit special-status resident fish, such as Sacramento splittail, by providing more places to take refuge and more food sources;
   d. Increases in tidal marsh habitat will benefit special-status birds and mammals that depend upon tidal wetlands in the San Francisco Bay, specifically California clapper rail, salt marsh harvest mouse, San Pablo song sparrow, and black rail, by providing increased foraging and nesting habitat;
   e. Increases in subtidal and intertidal habitat will benefit migratory shorebirds

and dabbling ducks by providing feeding and resting areas; and

f. Tidal restoration projects in the Napa-Sonoma Marshes are less susceptible to invasions of introduced *Spartina* (cordgrass) species, due to salinity regimes and because initial introductions and the majority of the current infestation of *Spartina* are in the South San Francisco Bay.

3. Large-scale tidal marsh restoration can be conducted using natural sedimentation:
   a. Natural sedimentation will be adequate to restore the slightly and moderately subsided Ponds 3, 4, and 5;
   b. Sedimentation rates are dependent on the suspended sediment concentration, wind-wave resuspension, vegetation colonization, and elevation of the area to be restored, parameters that were included in the modeling effort and have been accounted for in the design features; and
   c. Mare Island Strait is the primary source of sediment, and locations closer to the primary source (Pond 3) will accrete faster than locations farther from the source (Ponds 4 and 5).

4. The proposed tidal restoration design features will accelerate and enhance tidal habitat formation, will compensate for short-term loss of tidal marsh in the project area, and will minimize negative impacts of increased tidal prism:
   a. Starter channels will promote reestablishment of historic slough/channel networks;
   b. Long fetch resulting in wind-driven waves can be controlled through the use of berms to achieve adequate rates of sediment deposition;
   c. Borrow ditch blocks will promote the reestablishment of historic slough/channel networks by inhibiting existing borrow ditches from capturing the tidal supply;
   d. Historic channel networks will reestablish and marsh vegetation will colonize formerly farmed baylands (the ponds were used as agricultural lands prior to conversion to commercial salt ponds);
   e. Levee lowering to high marsh elevations will compensate for the loss of tidal marsh as slough channels deepen and widen due to increased tidal prism, and will reduce predator pathways; and
   f. Breach locations and phasing will minimize impacts to adjacent levees, properties, and utilities, and will reduce predator pathways.

<u>Managed Pond Hypotheses</u>

5. The depths and salinities of former commercial salt ponds can be sustainably managed, using predominately tidally driven water control structures:
   a. Functioning water control structures that enable the intake and discharge of Napa River and San Pablo Bay water will allow for resource managers to better control pond depths and salinities while keeping salt from accumulating in the ponds;
   b. Water control structures that do not require pumping, and instead rely on the tides, are more sustainable and economical, while still allowing for active management of water depths and salinities; and

   c. Intake and discharge of water from the managed ponds will not negatively impact aquatic species in the Napa River, sloughs, and ponds.

6. Managed ponds will provide habitat for resident and migratory shorebirds and waterfowl:
   a. Resident and migratory dabbling waterfowl and shorebirds will use the managed shallow-water ponds or ponds that are drawn down to shallow levels during the migration season (such as Ponds 1 and 1A) for feeding and resting;
   b. Migratory diving waterfowl will use the managed deep-water ponds (such as Pond 2) for feeding and resting; and
   c. Food sources (invertebrates and plants) in the ponds will increase with improved water management and water quality.

D. Project Uncertainties

<u>Analysis of Salinity Reduction and Habitat Restoration</u>
Several analysis methods were used to predict salinity reduction and habitat restoration impacts and timelines. These analyses examined the following parameters and drew the following conclusions:

Salinity Reduction Time Period
A hydrodynamic model of the pond system was developed to determine the feasibility and effectiveness of salinity reduction options. Salinity reduction of the ponds was modeled to analyze time periods for salinity reduction and impacts on the Napa River, San Pablo Bay, and local sloughs. In addition, a mass balance analysis was conducted for bittern reduction in Pond 7. The analyses indicated that:

- Salinity reduction in the Lower Ponds is expected to occur within very short time frames (1 month for Pond 3; 2 months total for Ponds 4 and 5; 6 to 12 months for Ponds 6 and 6A) using Napa River water and a combination of breaches and water control structures; and
- With a 1:100 bittern to water discharge ratio and use of neighboring waters (Napa River and sloughs), salinity and bittern reduction in Pond 7 could take 8 to 10 years.

Tidal Marsh Evolution
To analyze the predicted evolution and impacts of habitat restoration options, a habitat evolution assessment was conducted, which consisted of geomorphic analysis and hydrodynamic modeling. The habitat evolution assessment, based on the sediment budget, vegetation rates, wind-wave analysis, and analysis of other natural processes, predicted the following estimated time periods for tidal marsh development:

- Pond 3 is expected to evolve from intertidal habitat to tidal marsh within 20 to 30 years post construction;
- Pond 4, which is more subsided than Pond 3, is expected to evolve from predominantly intertidal habitat to tidal marsh within approximately 40 years post construction; and

- Pond 5, which is also more subsided than Pond 3 and is relatively isolated from sediment sources, is expected to take longer than 50 years to evolve from predominately intertidal habitat to tidal marsh.

Uncertainties in Project Outcome

The analyses identified sources of uncertainty in the salinity reduction and habitat restoration, which will be addressed through monitoring and adaptive management activities:

Pond Discharges, Habitat Quality and Usage

Monitoring of the discharge from ponds will be needed to ensure the project is not negatively impacting beneficial resources in the Napa River, San Pablo Bay, and sloughs. The water quality of the ponds will need to be monitored to determine if applicable surface water quality standards supportive of aquatic life are being met. Use of the managed ponds by birds, fish, and invertebrates will need to be monitored, in order to determine whether the project objective of providing pond habitat for shorebirds and waterfowl to feed and rest has been met. If necessary, adaptive management would involve the construction of additional water control structures and/or changes in water management.

Habitat Endpoint in Tidal Ponds

Due to the long time frame for tidal marsh evolution and the difference in wildlife values of various types of tidal habitats, it is difficult to determine the end-point for project success. The project incorporates post-construction monitoring and adaptive management to assess: 1) whether natural processes, such as sedimentation, will accomplish the long-term evolution of ponds to tidal marsh, and 2) the use of the tidal habitats by wildlife (birds, mammals, fish, and invertebrates). Adaptive management could include an increase or decrease in design features.

This project is the first large-scale restoration of salt ponds to tidal marsh in the United States and if successful, may serve as a model for future U.S Army Corps of Engineers tidal marsh restoration projects. Because there are no precedents to guide this restoration, there are a number of uncertainties that could affect the project's outcome, including:

1. Project scale: the Napa Salt Marsh project is approximately 9,460 acres (14 square miles), including restoration accomplished solely by the local sponsor ;

2. Time periods and impacts of salinity reduction may deviate from modeled predictions, due to weather patterns, salinities, intake capacity, discharge impacts, other unpredictable factors, and/or limitations of predictive models;

3. Sediment accretion rates for tidal marsh evolution are dependent on river flow rates and sediment supply which are driven by unpredictable weather patterns; and

4. Wildlife use of evolving tidal habitats and managed ponds is subject to unpredictable fluctuations based on site-specific conditions.

E. Project Success Criteria

Due to the size of the area to be restored and the timeline for restoration, acreages for specific tidal habitats (subtidal, intertidal, and marsh) have not been established as quantified project success criteria, although acreages have been predicted using modeling and other quantitative analysis tools, as described above and shown in the anticipated marsh evolution table below. The project targets a broad range of wildlife, including endangered and threatened species, fish and other aquatic species, and migratory shorebirds and waterfowl. Quantitative changes to wildlife populations and densities are not identified as project success criteria; instead, the qualitative project success criteria to be used as the basis for adaptive management decisions consist of the following, with the anticipated habitat acreages and wildlife species shown in tables:

<u>Water Quality</u>

1. Salinity in Ponds 3, 4, 5, 6, 6A, 7, 7A and 8 is reduced to salinity levels that meet discharge criteria as established by the Regional Water Quality Control Board and allows for tidal restoration or continued management as ponds.

2. Applicable surface water quality standards as established by the Regional Water Quality Control Board are achieved in the receiving waters and beneficial resources in the receiving waters are not impacted.

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Wildlife

3. The project area provides beneficial wetland habitat for an array of targeted native wildlife species resulting in a net increase in biological diversity and productivity.

Potential Wildlife by Habitat

Managed Ponds (1/1A, 2, 6/6A, 7/7A, 8)		Tidal Ponds (3, 4, and 5)	
Managed Shallow-Water Ponds	Managed Deep-Water Ponds	Subtidal and Intertidal Habitats	Low, Middle, and High Marsh
Fish (examples: striped bass, sculpin spp., goby spp., longjaw mudsucker) Invertebrates (examples: nematodes, clams, polychaetes, shrimp) Shorebirds (examples: American avocet, black-necked stilt, western sandpiper, dunlin) Dabbling Waterfowl (examples: northern shoveler, northern pintail, green-winged teal, mallard, gadwall)	Fish (examples: striped bass, sculpin spp., goby spp., longjaw mudsucker) Invertebrates (examples: nematodes, clams, polychaetes, shrimp) Diving Waterfowl (examples: scaup, canvasback, bufflehead, ruddy duck) Other Waterbirds (examples: American white pelican, double-crested cormorant, eared grebe, tern spp.)	Resident Estuarine Fish (examples: striped bass, Sacramento splittail, topsmelt, sculpin spp., perch spp., goby spp.) Anadromous Fish (steelhead trout, Chinook salmon) Invertebrates (examples: Dungeness crabs and other crabs, polychaetes, shrimp, isopods, mussels, clams) Shorebirds (examples: American avocet, black-necked stilt, western sandpiper, dunlin) Diving Waterfowl (examples: scaup, canvasback, bufflehead, ruddy duck) Dabbling Waterfowl (examples: northern shoveler, northern pintail, green-winged teal, mallard, gadwall)	Resident Estuarine Fish (examples: striped bass, Sacramento splittail, topsmelt, sculpin spp., perch spp., goby spp.) Invertebrates (examples: Dungeness crabs and other crabs, polychaetes, shrimp, isopods, mussels, clams) Special Status Birds and Mammals (Salt Marsh Harvest Mice, California Clapper Rail, California Black Rail, San Pablo Song Sparrow) Other Birds (examples: Virginia Rail, great-blue heron, great egret, snowy egret, northern harrier)

4. Invasive plant species and introduced predators are not negatively impacting populations of targeted native wildlife.

Marsh Evolution

5. A stable sediment deposition process is established in the ponds opened to tidal action and quantifiable evolution to tidal marsh habitat is occurring in Ponds 3, 4 and 5.

6. Fringe tidal marsh that is lost due to widening of external slough channels is replaced by the formation of new vegetated tidal marsh within the ponds opened to tidal action.

Anticipated Habitat Evolution

Year	Present	10	50
Pond Interiors			
Subtidal	0	140	150
Intertidal Mudflat	0	2410	1550
Lower Marsh	0	260	50
Middle Marsh	0	100	1170
Managed Pond	6460	3550	3550
Upland/Transition	200	190	190
External Sloughs			
Subtidal	430	620	630
Intertidal Mudflat	80	80	80
Lower Marsh	30	30	30
Middle Marsh	1210	1020	1010

II. MONITORING AND ADAPTIVE MANAGEMENT DECISION-MAKING

A. Introduction

This section describes the monitoring and adaptive management decision-making process, which consists of the following steps (also see Figure 1 – Monitoring Justification and Figure 2 – Adaptive Management Decision Matrix):

1. Evaluate in-field monitoring data and assess progress of restoration compared to qualitative and quantitative (water quality) success criteria;

2. If restoration effort is not progressing as expected, identify potential adverse conditions impacting progress of restoration;

3. Assess factors and determine appropriate adaptive management options;

4. Implement the appropriate adaptive management action, as required; and

5. Monitor the effects of adaptive management actions.

As part of the adaptive management process, the project team and a panel of senior scientists/engineers will first confer to assess the results of the monitoring effort and determine whether adaptive management actions are necessary. Recommended actions could include modifications of construction measures, changes in the order of construction implementation, schedule changes or changes in operations, particularly water management. All monitoring proposed in this plan is required to ensure that the project is meeting its success criteria, and to enable any necessary adaptive management decisions to be made.

B. Monitoring Objectives and Categories

Monitoring Objectives

Monitoring activities are linked to the project success criteria (as shown in Figure 1 – Monitoring Justification) and their results will help determine potential adaptive management activities (as shown in Figure 2 – Adaptive Management Decision Matrix). The primary objectives of the project monitoring are to:

1. Assess water quality in the ponds, sloughs, and Napa River;
2. Gauge compliance with applicable water quality standards in receiving waters;
3. Evaluate the changes in wildlife use of restored tidal habitats and managed ponds; and
4. Monitor and evaluate the physical evolution of restored tidal habitats and the external slough channels.

In general, monitoring of managed ponds (1,1A, 2, 6, 6A, 7, 7A and 8) will focus on salinity and general water quality parameters within the ponds, water elevation in the ponds, water quality in the receiving waters, and wildlife use in the ponds (invertebrates, fish, and birds). Water quality parameters will be monitored to determine the success of salinity reduction and pond management. Invertebrates, fish, and bird use will be monitored to characterize wildlife use of the managed ponds, and occasional contaminant surveys of wildlife will be used to identify the presence and/or distribution of pollutants in wildlife species using the ponds, and determine whether more definitive actions are required to manage the effect of pollutants on wildlife.

Monitoring of ponds opened to tidal action (3, 4, and 5) will focus first on salinity reduction (water quality in ponds and receiving waters), and then on tidal habitat evolution and wildlife use (invertebrates, fish, mammals, and birds). Water quality parameters will be monitored to determine the success of salinity reduction and changes to water circulation patterns. Aerial surveys, bathymetric surveys, sedimentation measurements, tidal level surveys, vegetation surveys, and levee breach and external slough cross sections surveys will be used to evaluate marsh evolution rates and internal and external channel development. Vegetation surveys will also be used to understand vegetation colonization by species and identify introduced species. Invertebrate, fish, mammal, and bird use will be monitored to understand wildlife use of the restored tidal ponds, and occasional contaminant surveys of wildlife will be used to identify the presence and/or distribution of pollutants in wildlife species using the ponds, and determine whether more definitive actions are required to manage the effect of pollutants on wildlife.

Monitoring information will be used to determine whether success criteria are being achieved and project hypotheses are correct, which will indicate whether the three project planning objectives are being met. The three project planning objectives are, in short, to 1) create a mix of tidal habitat and managed pond habitat to serve a broad range of wildlife; 2) restore large areas of tidal habitats; and 3) improve the ability to manage water depths and salinity levels in the managed ponds.

Monitoring Categories

If success criteria are not being achieved, the monitoring data will be used to assess whether adaptive management measures need to be implemented and to determine the type, extent and duration of adaptive management measures. Monitoring activities can be grouped into four categories:

1. Water quality monitoring in the ponds;
2. Water quality monitoring in the receiving waters;
3. Monitoring of wildlife use/presence in the managed and tidal ponds; and
4. Monitoring of habitat evolution in tidal ponds.

Each of these types of monitoring will be used in the adaptive management decision-making process described above. Figure 2, the Adaptive Management Decision Matrix, shows the decision/analysis process for each category of monitoring.

Monitoring is needed to collect data to make adaptive management decisions, and is also be required to document compliance with applicable state and federal environmental requirements. Table 3 illustrates how each monitoring topic applies to compliance with state and federal environmental law. The discharge from the ponds to receiving waters will be regulated under a Waste Discharge Requirements (WDR) order or National Pollutant Discharge Elimination System (NPDES) permit from the Regional Water Quality Control Board (RWQCB). The possible impacts of construction activities on federally listed threatened and endangered species will require biological monitoring. Biological, hydrodynamic, and bathymetric monitoring will be required to satisfy mitigation requirements under the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA), the Biological Opinion (BO) issued by the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS), the 401 certification issued by the RWQCB, and the Consistency Determination issued by the San Francisco Bay Conservation and Development Commission (BCDC).

C. Responsibility for Monitoring

Monitoring will be cost-shared between the Federal Government and local sponsor. As described in Chapter 5 of the Feasibility Report, the Corps has determined that there is a Federal interest in the restoration of Ponds 4 through 7A, and that Pond 8 is also required to implement the restoration at Pond 7. Thus, monitoring at Ponds 4 through 8 will be cost-shared with the local sponsor (referred to as cost-shared monitoring in this appendix); monitoring for Ponds 1 though 3 will be paid for by the local sponsor, and is not described in this plan. Monitoring efforts will be coordinated to ensure that data are consistent (e.g., collected during the same time period), and to minimize mobilization costs, where possible.

D. Adaptive Management Scenarios

Adaptive management could be used to address the following potential conditions, which would be revealed through monitoring:

1. Tidal marsh is evolving faster than predicted;
2. Tidal marsh is evolving more slowly than predicted and/or scour of fringe marsh is greater than expected;
3. Salinity reduction of the ponds is slower or more difficult than anticipated;
4. Management of depths and salinities in the managed ponds is more difficult than anticipated;
5. There are unacceptable adverse impacts to receiving water (sloughs, Napa River) or pond water quality;
6. Introduced plants are reducing the value of the habitat in the project area, or predators are significantly impacting native wildlife populations; and/or
7. Wildlife use/presence in project area is decreasing for targeted groups of wildlife.

These conditions would be identified through the monitoring program. Possible adaptive management actions for responding to the conditions outlined above are summarized below. The decision-making process for adaptive management decisions is illustrated in Figure 2 (Adaptive Management Decision Matrix) and a description of the adaptive management process applicable to each category of monitoring is provided below.

E. Adaptive Management Process by Monitoring Category

Water Quality Monitoring in the Ponds

Basic water quality parameters in Ponds 4, 5, 6, 6A, 7A, and 8 will be monitored as salinity reduction is being conducted. Water quality will continue to be monitored for 5 years after completion of construction in the ponds that remain as managed ponds (Ponds 6, 6A, 7A, and 8). Pond 7 (the bittern pond) will be monitored for water quality for 10 years after completion of construction.

Water quality monitoring in the ponds (combined with wildlife monitoring in the ponds) will determine whether modifications to pond operations to meet salinity reduction objectives or improve pond management for wildlife are required. In addition to salinity, water quality parameters to be monitored include temperature, dissolved oxygen, and pH. Monitoring will also include water level (depth) in the ponds. If water quality parameters are not acceptable, the most likely cause is lack of water circulation. The project team will determine whether inadequate circulation or flow is the cause of the poor water quality before beginning adaptive management efforts. The first step in the adaptive management process is to modify the water flows as much as possible in the desired direction using existing water control structures. If running the water control structures at maximum flow does not fully resolve the impaired water quality, then additional water control structures may be required to meet water quality objectives. Changes in the total discharge flow, whether through existing water control structures or through additional water control structures, will be monitored to ensure that there are no adverse consequences on the receiving waters due to changes in water management.

Water Quality Monitoring in the Receiving Waters

The discharge from the ponds to receiving waters will be monitored to establish whether applicable surface water quality standards are being met and to ensure that beneficial resources are not being negatively impacted. Monitoring of surface water quality will determine whether modifications in salinity reduction operations or to managed pond operations are required. For example, if water quality standards in the receiving water are not being met, the most likely cause is excess discharge flow. In this case, the adaptive management measure is to reduce discharge flows. If discharge rates must be altered, pond water quality will be monitored to ensure that the alterations do not result in adverse consequences to water quality within the ponds, a decrease in wildlife habitat values, or slowing or reversing salinity reduction. If discharge criteria cannot be met without reducing flows at the discharge point, and reducing the flows results in adverse water quality in the ponds, then additional discharge locations (water control structures) will be added on Pond 6/6A, 7, and/or 7A.

Habitat Evolution Monitoring in Tidal Ponds

Habitat evolution monitoring (changes in bathymetry, tidal range, and vegetation) will be used to assess whether tidal habitat is developing at the projected rate. If habitat evolution is slower than anticipated, the data collected will be used to determine whether there is an overall sediment deficit, or whether re-suspension of sediment is causing the slow rate of accretion. In addition, the project team will assess whether the reduced rate of habitat formation, in combination with fringe marsh erosion, could lead to unacceptably high interim losses of tidal marsh habitat. If the projected interim loss of tidal marsh habitat is unacceptably high, then additional levee lowering will be constructed in Ponds 4 and 5 to increase areas that are at the proper elevations for rapid vegetation colonization. Vegetation colonization in these areas will increase the total tidal marsh acreage quickly, and will also increase sediment trapping rates. Additional starter channels and berms may also be constructed in Pond 5 to increase water flow and thus sediment loads to the interior of the pond, to provide sacrificial sources of sediment, and to increase areas at the proper elevations for rapid vegetation colonization. If sediment re-suspension is the cause of slow habitat formation, then additional starter channels and berms will be constructed in Pond 5 to reduce wind-wave action in the ponds.

If monitoring indicates that habitat evolution in Pond 3 is happening faster than anticipated, then the extent of habitat design features in Ponds 4 and 5 may be reduced prior to construction.

Fish and Wildlife Use and Presence in the Monitoring Area

The project is designed to provide improved habitat to a wide range of species. Fish and wildlife monitoring will be conducted to ensure that there are no unacceptable losses of certain wildlife types (e.g., diving ducks and shorebirds) due to changes in habitat. Monitoring will also address potential effects to sensitive and endangered species (e.g., salmonids, clapper rail) due construction activities and short-term habitat losses. In addition, monitoring will be used to document the benefits of the project. If monitoring shows that fish and wildlife use is stable and/or increasing, then no adaptive management actions are required. If monitoring indicates that fish and wildlife use/presence is decreasing or that food sources are not available, then the cause for the decrease will be identified.

When evaluating population data in the project area, consideration will be given to regional population trends for the species of interest, if appropriate (e.g., Canvasback Ducks). If a decrease in project-area species population is associated with changes in pond management (e.g. water level or salinity), then pond management will be modified so that the pond(s) will become more attractive to fish and wildlife. If the decrease is associated with landscape-level changes (e.g. the loss of pond habitat and creation of tidal habitat), then regional patterns of fish and wildlife use/abundance will be evaluated to assess whether the affected species have migrated to another area.

III. MONITORING ACTIVITIES

A. Timing of Monitoring During Project Phases

Proposed monitoring activities vary according to pond and project phase (see Table 1 – Proposed Monitoring Schedule), but can be summarized as follows and are further described below:

<u>Pre-Construction and Construction Monitoring</u>

- Cost-shared construction monitoring will take place prior to and during construction.
- Construction time for each pond ranges from 1 to 5 years.

Pre-construction monitoring included in this plan refers to monitoring conducted after the Project Cooperation Agreement (PCA) has been signed.

<u>Post-Construction Monitoring</u>

- The first five years of post-construction monitoring for Ponds 6, 6A, 7A, and 8 will be cost-shared.
- The first ten years of post-construction monitoring for Ponds 4, 5, and 7 will be cost-shared.
- Receiving waters will be monitored for up to five years off the lower pond discharge and up to ten years off the upper pond discharge. The actual monitoring timelines will be determined by the RWQCB pursuant to the applicable permits. Specific monitoring requirements are described the self-monitoring program in the permits.

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Adaptive Management

- The adaptive management period runs concurrent with the monitoring period, with two additional years added for adaptive management measures to be completed for each pond after cost-shared monitoring ends.
- The cost-shared adaptive management period for Ponds 6, 6A, 7A, and 8 is seven years post-construction.
- The cost-shared adaptive management period for Ponds 4, 5, and 7 is twelve years post-construction.

Pre-Construction and Construction Monitoring

Baseline information regarding wildlife use, bathymetry, hydrology, and water quality in the project area will be based upon related past and present monitoring (see Section II.C.) that has not been cost-shared. A minimal amount of cost-shared, baseline monitoring of wildlife use and water quality in the ponds is required prior to commencement of construction and during the construction period to augment the baseline information and provide a continuous picture of wildlife use and water quality in the system. In addition, pre-construction breeding surveys will be conducted for Western snowy plovers and California clapper rails, consistent with the conservation recommendations in the U.S. Fish and Wildlife Service's Biological Opinion. These pre-construction surveys will be cost-shared. Other required construction monitoring (i.e. archaeological monitoring, monitoring of dust concentrations, and surveys of power towers) will also be cost-shared. These types of monitoring are required to comply with the mitigation requirements in the EIS.

Post-Construction Monitoring

Post-construction monitoring is required to determine whether the project is achieving the success criteria and to support the adaptive management decision-making process. Post-construction monitoring data will be used to determine the necessity for and timing of adaptive management actions. Post-construction monitoring will be performed concurrently with the adaptive management phase. Post-construction monitoring is planned for five years after construction for managed ponds (Ponds 6, 6A, 7A and 8), ten years for ponds opened to tidal action (Ponds 4 5), and ten years for Pond 7 (the bittern pond), as described below. The level of monitoring will not be the same each year and will be phased and conducted differently for tidal ponds, which will be slowly evolving systems, than for managed ponds, which will not be evolving systems and will need early analysis and refined development of water management regimes.

Water Quality Monitoring in Ponds

During salinity reduction, water quality monitoring will be conducted in all of the ponds to ensure that the salinities of the ponds are decreasing and water quality is improving. Monitoring is required to ensure that ponds have met the salinity and water quality targets before they are converted to managed ponds or opened to tidal marsh restoration. Water quality monitoring within the ponds is also required to ensure that discharges will meet comply with surface water quality standards, and to allow for management of the discharge (e.g., to adjust the discharge rates if there are changes in water quality).

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Water Quality Monitoring in Receiving Waters

During salinity reduction, there will be two discharge points. For the lower ponds, there will be a combined discharge to the Napa River from Ponds 4, 5, 6, and 6A, and for the upper ponds there will be a combined discharge to the Napa Slough for Ponds 7, 7A and 8 from the mixing chamber. Monitoring of receiving waters is necessary to ensure that discharges from the ponds do not adversely affect the water quality in the receiving waters. Monitoring of receiving water quality is required to allow adjustments to the discharge rate to protect aquatic resources, if necessary. Receiving water monitoring adequate to achieve these goals will be cost-shared. A longer monitoring period is required for the Upper Ponds because the discharge form the Upper Ponds has the potential to have toxic effects at excess concentrations, and because the discharge will occur over a longer period of time.

Both of the discharge points will be permitted by the RWQCB under a NPDES permit or WDR order. While the receiving water data will be available to permitting agencies, the project does not propose to cost share the administrative and reporting costs associated with compliance with WDR or NPDES requirements. It may take longer than ten years to reduce bittern and salinity in the upper ponds, but any monitoring conducted after year 10 will be considered to be OMRR&R and will not be cost-shared.

Habitat Evolution and Wildlife in Tidal Ponds (Ponds 4 and 5)

Like all other wetland restoration projects, the project area will evolve over a long period of time. The monitoring program for the tidal ponds is designed to track the initial development of the project area to ascertain that the tidal ponds are developing as projected, and that any adverse wildlife impacts are within the expected ranges. Development of new marsh in the ponds opened to tidal action is a necessary (but not sufficient) component of overall project success. If tidal marsh is not evolving in the expected manner, there may be adverse impacts to existing wildlife populations, and fewer project benefits will be realized.

Understanding marsh evolution and the likely long-term success of the project requires understanding both the physical and vegetation parameters, as both physical processes (sediment deposition and resuspension) and the extent of vegetation (through sediment trapping, rootmass, and vegetative detritus) contribute significantly to overall marsh plain development. Marsh development in the tidal ponds must proceed at the projected rates to avoid excessive interim loss of marsh habitat in the project area. The rate of marsh development will be predicted from the physical and vegetation monitoring. Vegetation monitoring is required because the specific types of vegetation present in the new marsh will affect the types of wildlife likely to be present. Additionally, vegetation surveys are required to ensure that potential habitat due to invasive plants are minimized or avoided.

In addition to physical and vegetation monitoring, direct monitoring of wildlife is also required. Direct monitoring of wildlife is required both to verify the hypothesis that increasing the tidal marsh acreage will result in increases in target wildlife populations, and to ensure that interim changes in habitat configuration are not harming existing wildlife populations.

APPENDIX E
MONITORING AND ADAPTIVE MANAGEMENT PLAN

An aerial survey documented with digital photography to assess vegetation rates in the tidal ponds and erosion rates in the neighboring sloughs will be conducted annually, along with annual vegetation transects and annual monitoring of sediment pins. Wildlife and bathymetric surveys will take place one year after the initial breach of each pond to characterize wildlife responses and physical changes, and the schedule for additional wildlife and bathymetric surveys will be based upon the development of vegetation within the restored ponds. For planning and cost-estimating purposes, these surveys have been scheduled every two years after construction, for a total of no more than five years of wildlife and bathymetric surveys during the ten-year post-construction monitoring period. Wildlife surveys for tidal ponds will include invertebrates, fish, mammals, and birds, including contaminant monitoring of indicator wildlife. The marsh evolution surveys will include a bathymetric survey along the vegetation transects and levee breach and internal and external slough channel cross-section surveys. Based upon monitoring results, adaptive management measures, such as additional levee lowering or starter channel creation, may be implemented, as described in Section II.

Water Quality and Wildlife Use in Managed Ponds (Ponds 6, 6A, 7, 7A, and 8)
An important factor in the overall project is the need to preserve existing populations of waterfowl and shorebirds. The goal of the managed ponds is to enhance existing, low quality pond habitat so that a much smaller acreage of ponds can support the same or a greater bird population. Monitoring of water quality and salinity in the managed ponds is essential to ensure that the ponds are maintained within the optimal ranges for target birds species (the target species may vary by pond and season).

As with tidal marsh development, monitoring the condition of the habitat is a necessary but not sufficient condition of determining overall project success. Wildlife monitoring is required to assess whether target populations are using the ponds, determine which combinations of salinity and water depth are most attractive to various species of birds, to evaluate food resources in the ponds, and to define the effects of pond management on food resources within the ponds. Understanding the complex system of direct and indirect effects of pond management on target species requires that \ the basic parameters (water quality), intermediate parameters (food resources), and output parameters be measured. Finally, wildlife impacts could also occur as a result of contamination; thus limited monitoring of contaminants in the food chain is required to ensure project success.

Monitoring will occur in the managed ponds during the five years after construction. Once levees are repaired and water control structures repaired or replaced, and after a water management regime is in place, ponds will be monitored for basic water quality parameters, water depths, and wildlife use (invertebrates, fish, and waterbirds) for five years post-construction. Based upon monitoring results, adaptive management measures, such as changes in water management regimes or additional water control structures, may be implemented, as described in Section II.

Operations and Maintenance
Activities and monitoring associated with operations and maintenance (OMRR&R) will not be cost-shared and will commence at the conclusion of the construction phase for each pond. OMRR&R will occur primarily at managed ponds and will consist of operating water control structures and maintaining levees and water control structures. OMRR&R is generally not required for the areas opened to tidal action, although limited removal of non-native invasive cordgrass *(Spartina spp.)* may be conducted.

Post-construction monitoring is not considered to be part of OMRR&R except for routine monitoring of levee repairs, operation and maintenance of new water control structures and monitoring that exceeds the scope of this monitoring program or exceeds the five-year monitoring time period for Ponds 6, 6A, 7A, and 8 or ten-year time period for Ponds 4, 5, or 7. For example, NPDES or WDR monitoring required in excess of the 10-year time period for the combined discharge from Ponds 7, 7A, and 8 will be considered to be OMRR&R and will not be cost shared.

The post-construction monitoring and adaptive management periods will begin when construction is completed at each group of interrelated ponds. There are three groups of interrelated ponds: Ponds 4 and 5; Ponds 6 and 6A; and Ponds 7, 7A, and 8. For example, the post-construction monitoring and adaptive management period for Ponds 4 and 5 will commence once salinity reduction is complete, and all habitat restoration features, including habitat restoration breaches, have been complete.

B. Specific Monitoring Activities

Water Quality in the Receiving Waters
A comprehensive water-quality monitoring program will be prepared and implemented for the duration of the salinity reduction process. The monitoring will have well-defined data quality objectives, monitoring procedures, and data analysis and reporting protocols. Monitoring of the receiving waters will ensure surface water quality standards are met, and that there are no impacts to beneficial resources. Monitoring at specific locations will be completed and phased out as each successive pond is restored and salinity has been reduced to ambient levels. Cost-shared monitoring of the receiving waters will occur for five years off the lower ponds and ten years off the upper ponds.

Monitoring of basic water quality parameters (flow, water level stage, salinity, dissolved oxygen, pH, temperature, and TSS/turbidity) will be conducted at several receiving water locations. Grab samples will be used to conduct the water quality monitoring and may also periodically include analysis of metals and/or priority pollutants. Aquatic toxicity tests may also be conducted on a periodic basis, to determine if the bittern discharge rate could be increased.

Monitoring of Wildlife Use/Presence
Tidal Ponds (Ponds 4 and 5)
Macroinvertebrate, fisheries, mammalian, and avian species data will be collected at locations within the tidal ponds during the ten-year post-construction phase of the

project. This monitoring will be conducted approximately every two years post-construction, based upon vegetation colonization rates, and will be compared to a reference site within the system (such as Pond 2A or Coon Island) to determine progress towards the success criteria for wildlife presence/use. Pre-construction and construction surveys in Ponds 3, 4, and 5 will include invertebrates, fish, and birds as described in the Managed Pond section below.

Invertebrates
Invertebrates will be sampled in the water column by net sweeps and in the benthos with Eckmann grab samples twice per year every two years during the ten-year post-construction period. Ten sweep and ten grab samples will be taken in each pond (60 samples total during each sample period); sweep sampling will consist of 3 sweeps per sample, and each benthic sample will be a composite of 5 cores. Biomass (dry weight) and diversity of invertebrates will be measured.

Fish
Fish species assemblages will be surveyed seasonally every two years during the ten-year post-construction period. Multiple sampling gear will be used to assess distribution and relative abundance of juvenile and adult fishes. Captured fish will be identified to species with taxonomic keys and counted. The first 25 of each species will be measured for standard length and weight. Twenty-five individuals from selected species will be analyzed for stomach contents. A small number of individuals from selected species will also be analyzed for contaminants, particularly mercury.

Mammals
Once marsh vegetation begins establishing, live trapping for small mammals will be conducted to determine absence/presence of salt marsh harvest mice and other small mammals. U.S. Fish and Wildlife Service protocols for trapping will be followed.

Birds
Ponds will be overlaid with 250 m Universal Transverse Mercator (UTM) grids (6.25 ha cells), and all integrated samples will be located within this grid. Locations of flocks, species identification and densities will be mapped in the grid overlay and displayed in GIS maps. A small number of individual birds will also be analyzed for contaminants, particularly mercury. Once tidal marsh vegetation begins colonizing, vocalization surveys for rail species and point count or breeding surveys for selected passerine species (such as song sparrows) will be conducted in the spring during the same years as the general avian surveys.

Managed Ponds (Ponds 6, 6A, 7, 7A, and 8)
Macroinvertebrate, fisheries, and avian species data will be collected at locations within the managed ponds during the pre-construction and post-construction phases of the project. This data will be collected as part of the intensive monitoring surveys conducted to assess the impacts of the restoration upon wildlife through time. This survey

information will be collected for five years post-construction in Ponds 6, 6A, 7A, and 8 and ten years post-construction in Pond 7.

Invertebrates
Invertebrates will be sampled in the water column by net sweeps and in the benthos with Eckmann grab samples twice per year. Ten sweep and ten grab samples will be taken in each pond (60 samples total during each sample period); sweep sampling will consist of 3 sweeps per sample, and each benthic sample will be a composite of 5 cores. Biomass (dry weight) and diversity of invertebrates will be measured.

Fish
Fish species assemblages will be surveyed seasonally. Multiple sampling gear will be used to assess distribution and relative abundance of juvenile and adult fishes. Captured fish will be identified to species with taxonomic keys and counted. The first 25 of each species will be measured for standard length and weight. Twenty-five individuals from selected species will be analyzed for stomach contents. A small number of individuals from selected species will also be analyzed for contaminants, particularly mercury.

Waterbirds
Ponds will be overlaid with 250 m Universal Transverse Mercator (UTM) grids (6.25 ha cells), and all integrated samples will be located within this grid. Locations of flocks, species identification and densities will be mapped in the grid overlay and displayed in GIS maps. A small number of individual birds will also be analyzed for contaminants, particularly mercury.

<u>Monitoring of Habitat Evolution in Tidal Ponds (Ponds 4 and 5) and Sloughs</u>
Pre-breach monitoring will include some additional surveys for consistency with post-project monitoring locations, plus installation of sedimentation markers. Post-construction (post-breach) monitoring of tidal ponds will focus on geomorphic evolution to document rates and patterns of habitat evolution or fringe marsh erosion and key underlying physical processes (e.g. sedimentation rates, water velocity) and vegetation colonization and spread. Post-construction monitoring will last for ten years in Ponds 4 and 5.

Geomorphic Evolution
Sedimentation will be monitored to understand rates and patterns of marsh evolution within breached ponds. Digital aerial photography of Ponds 4 and 5 and neighboring sloughs will be taken during annual aerial flights. The digital photography will be rectified and habitat delineated for Ponds 4 and 5 and neighboring sloughs on an annual basis, to determine trends in marsh evolution within the ponds and amount of fringe marsh erosion in neighboring sloughs. Trends in sedimentation processes will be ground-truthed with the use of annual monitoring of sedimentation markers, and topographic/bathymetric surveys of vegetation transects conducted every two years during the ten-year post-construction monitoring time period.

Levee Breach and Slough Channel Cross Sections
Every two years, cross-section surveys of levee breaches, external sloughs, and pond-internal sloughs and adjacent berms will be conducted to understand patterns of tidal scour and drainage and to determine when the widths and depths of the breaches and external and internal sloughs reach equilibrium in response to the tidal prism.

Tidal Surveys
For ponds opened to tidal action, the progress of the tidal regime towards reference conditions will be monitored using appropriate recording equipment. Measurements of tide elevations will be recorded periodically at locations within the site and at a nearby reference location. The tidal regime and tidal prism will be determined from these measurements.

Vegetation Colonization
Vegetation transects will be conducted once per year at the end of the growing season within breached ponds to document rates and patterns of vegetation colonization. This data will be used to ground-truth the results of annual aerial photography surveys and identify plant species. Vegetation data will also play a major role in determining when and how to conduct wildlife monitoring, as wildlife changes will primarily correspond to vegetation rates.

Introduced Vegetation
Vegetation surveys will also include monitoring for introduced species of cordgrass *(Spartina spp.)* and other invasive species of concern such as *Lepidium*. The project team will work with the San Francisco Estuary Invasive *Spartina* Project to monitor and control introduced and invasive *Spartina,* in order to ensure regional coordination.

C. Past and Current Monitoring

<u>Wildlife Use of Ponds</u>
U.S. Geological Survey has been monitoring six ponds of varying salinities (Ponds 1, 2, 2A, 3, 4, and 7) since 1999. This interdisciplinary study, involving biologists and hydrologists, has included avian, macroinvertebrate, and fish surveys, along with collection of salinity and other water quality data in the ponds and collection of hydrodynamic, salinity, and suspended sediment concentration data in the sloughs. (Takekawa, *et al.* 2001). The ongoing nature of this monitoring effort will allow for before and after comparisons of wildlife use, water quality, and physical processes.

<u>Hydrodynamics</u>
U.C. Davis, in collaboration with USGS, conducted an intensive hydrologic and water quality data collection project in the Napa-Sonoma Marsh tidal slough network and in the Napa River and Sonoma Creek to determine the physical processes controlling circulation patterns of water and suspended sediment (Warner, *et al.* 1999). Velocity, water level, conductivity, temperature and suspended sediment concentration were

measured at 17 sites from September 1997 to March 1998. Future monitoring of physical processes can be compared to this baseline data.

<u>Wildlife Use and Habitat Evolution of Pond 2A</u>
Marsh evolution and wildlife use in the restored Pond 2A site was monitored first by Philip Williams and Associates and then by MEC Analytical Systems, Inc. from 1996 to 2000 (PWA, 1997 and MEC, 2000), and funded by the California Department of Fish and Game. The physical and biological evolution of the 550-acre Pond 2A marsh was monitored through surveys of levee breach and natural slough channel width equilibrium, sediment chemistry and grain size, sedimentation rates, tidal range and response, fish usage, avian usage, and plant colonization. Although Pond 2A has different characteristics than the remaining ponds (Pond 2A was slightly less subsided and was never farmed prior to conversion to a salt pond), it can be used as one point of comparison. Comparisons can also be made to other restoration projects in the North Bay that are currently being monitored (such as Guadalcanal and Tolay Creek), and to the fringing marsh that exists along the slough channels within the salt pond complex.

<u>Topographic and Bathymetric Survey</u>
A topographic and bathymetric survey of the salt ponds, slough channels, and associated marsh plain was conducted by Towill, Inc. as part of the Feasibility Study (Towill, 2001). The survey included a very accurate primary control level loop through the site, which was connected to high confidence benchmarks outside the site. This survey was used in the development of the hydrodynamic model by Philip Williams and Associates and will be useful for before and after comparisons of elevations.

<u>Water Quality</u>
Water and sediment samples from 40 sites within the pond complex, along with sites in the Napa River, Napa Slough, and San Pablo Bay were collected in October, 2001, by Hydroscience, after development of a Sampling and Analysis Plan and Quality Assurance Project Plan approved by the RWQCB (Hydroscience, 2002). Samples were analyzed by MEC Analytical Laboratories for volatile and semi-volatile organics, pesticides, PCBs, heavy metals, dioxins, and general water quality parameters, including nutrients, TDS, TSS, pH, temperature, salinity, and DO. Additional sampling for metals was conducted in October 2003. Samples were collected from Ponds 4, 7, 7A, and 8, and Napa Slough. Samples were analyzed by Frontier Geosciences, using a proprietary methodology for analyzing metals in high-salinity brines.

III. MONITORING AND ADAPTIVE MANAGEMENT COSTS

A. Introduction

Current USACE guidance states that monitoring costs should not exceed 1% of the first cost of the ecosystem features and adaptive management costs should not exceed 3% of total project costs excluding monitoring costs. For the NSMR project, the total monitoring costs are approximately 3% of total project first costs (not including monitoring or adaptive management) and adaptive management costs are also 3% of total project first costs, not including monitoring or adaptive management.

B. Justification for Monitoring Costs

Although the monitoring costs exceed the current USACE guidance, they can be justified by the following:

1. Monitoring is necessary to meet the specific objectives of this large-scale restoration project,
2. The cost effectiveness of project construction skews the allowable percentage of monitoring downward, actual monitoring costs are less than $300 an acre for the five to 10 year monitoring period,
3. Monitoring is required to ensure that the project benefits used in the planning process measured in AAHU's (annual average habitat units) are achieved as project endpoints,
4. Adequate monitoring is essential to the proper application of adaptive management and in determining when, where and why specific adaptive management actions are necessary,
5. Monitoring is required under the EIS and/or Biological Opinions for the project.

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C. Monitoring Costs

The costs for monitoring and adaptive management are summarized below and shown in more detail in Table 2 – Monitoring and Adaptive Management Costs
Totals cost for monitoring, with 20% in administration and supervision costs added, is approximately $1,580,000. Monitoring costs can be broken down by the four major categories of monitoring. Monitoring of water quality in the receiving waters (Napa River and neighboring sloughs) totals approximately $620,000. Monitoring of water quality within the ponds totals approximately $50,000. Monitoring of habitat evolution, including sedimentation, bathymetry, hydrology, and vegetation, totals approximately $310,000. Monitoring of fish and wildlife presence and use totals approximately $580,000. All costs include 20% for administration and supervision.

D. Adaptive Management Costs

The estimated cost of evaluation activities is approximately $56,000, and the total estimated cost of adaptive management is approximately $1,510,000, including 15% in administration. Costs for adaptive management tasks and personnel are summarized in Table 2 (Monitoring and Adaptive Management Costs) and include those associated with the evaluation of monitoring results and the construction of additional features. Adaptive management actions are divided into actions for tidal areas and managed pond areas. Costs associated with changes in operation would be the responsibility of the local sponsor under OMRR&R.

APPENDIX E
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Tidal Area Adaptive Management Actions and Costs (Ponds 4 and 5)
The greatest concern for the project's future tidal areas is that habitat evolution may occur more slowly than expected. This condition could be caused by: 1) an overall lack of sediment in the system; 2) excess sediment re-suspension due to wind-wave action; or 3) inadequate vegetation colonization. Constructing additional starter channels and berms and lowering additional levees would enhance sediment deposition, reduce sediment re-suspension, and create additional areas at high marsh elevation (Table 2 – Monitoring and Adaptive Management Costs).

Lengthening the starter channels and berms would decrease wave action and erosion and address the problem of inadequate sediment deposition in Pond 5. Additional levee lowering in Ponds 4 and 5 would improve connectivity between existing and developing tidal marsh areas and encourage tidal marsh formation. The estimated adaptive management cost for the tidal areas is approximately $01,240,000 (including evaluation activities). Pond bottom elevations at Pond 3 are higher than elevations at Ponds 4 and 5, and Pond 3 is closer to the sediment source than Ponds 4 and 5. No adaptive management is expected to be required at Pond 3; however, should adaptive management be required, any costs would be borne by the local sponsor.

No adaptive management features are included to address vegetation colonization because the rate of vegetation colonization will probably be adequate (Pond 2A, which was opened to tidal action in 1995, vegetated rapidly, and there are other seed sources in the area). Vegetation colonization is more likely to be function of the acreage of pond area at elevations suitable for vegetation colonization; thus adaptively managing sediment deposition indirectly addresses vegetation colonization. Similarly, adaptive management actions such as importing fill were not included in the adaptive management plan because the overall sediment supply is believed to be adequate although habitat evolution may occur more slowly during dry years, when the sediment supply may be lower.

Managed Pond Adaptive Management Actions and Costs
The greatest concern for the future managed ponds is that control of salinity and water levels might be more difficult than anticipated. This problem would occur if the water control structures installed during the salinity reduction phase are not adequate for long-term management of the water levels and salinities in the ponds, after salinity reduction is complete. This concern would be addressed by increasing the number of water control structures at Ponds 6, 6A, 7, 7A, and 8, since they present the greatest potential need for adaptive management.

It is unlikely that additional water control structures will be required for Ponds 1, 1A, and 2 under the adaptive management plan, since these ponds currently function effectively as managed ponds and the proposed project replaces the unreliable existing water control structures with new structures of the same size/capacity. Any adaptive management required at Ponds 1, 1A, and 2 would be conducted by the local sponsor at its own cost. The costs associated with fine-tuning operations at Ponds 1, 1A, and 2 would be included in the OMRR&R costs.

Similarly, Pond 8 is operating successfully with the new intake structures installed by the California Department of Fish and Game. Because the operation of Pond 8 also affects the ability to operate Pond 7, long term management and oversight of the water control structures at Pond 8 is required.

Ponds 6 and 6A are relatively shallow and large, which means that moving water through these ponds by gravity flow can be difficult. Additional discharge capacity may be required to maintain this pond at the desired water levels. The adaptive management cost for Ponds 6 and 6A is based on adding a weir to Pond 6 to serve as an additional discharge point during high water levels in Ponds 6 and 6A.
Adaptive management measures for Ponds 7 and 7A include additional outfalls to the mixing chamber from both Ponds 7 and 7A. Although these ponds will probably be more manageable within a desired salinity and depth range because they are smaller and deeper than most of the ponds in the system, past operations suggests that discharges from the ponds may at times not be as effective as intakes, and that additional outfalls might be necessary.

In addition to these constructed features, Ponds 6/6A might be used as an additional outfall point for the upper ponds, and changes in the bittern discharge ratio based upon additional testing and assimilative capacity of the receiving waters. These adaptive management measures would allow the project team to increase the rate of discharge of bittern from Pond 7, should a greater discharge rate or change in discharge ratio be permissible following the on-going testing. No additional features are required for this potential adaptive management action.

The estimated cost for adaptive management for the managed ponds is approximately $270,000, including administration and evaluation activities.

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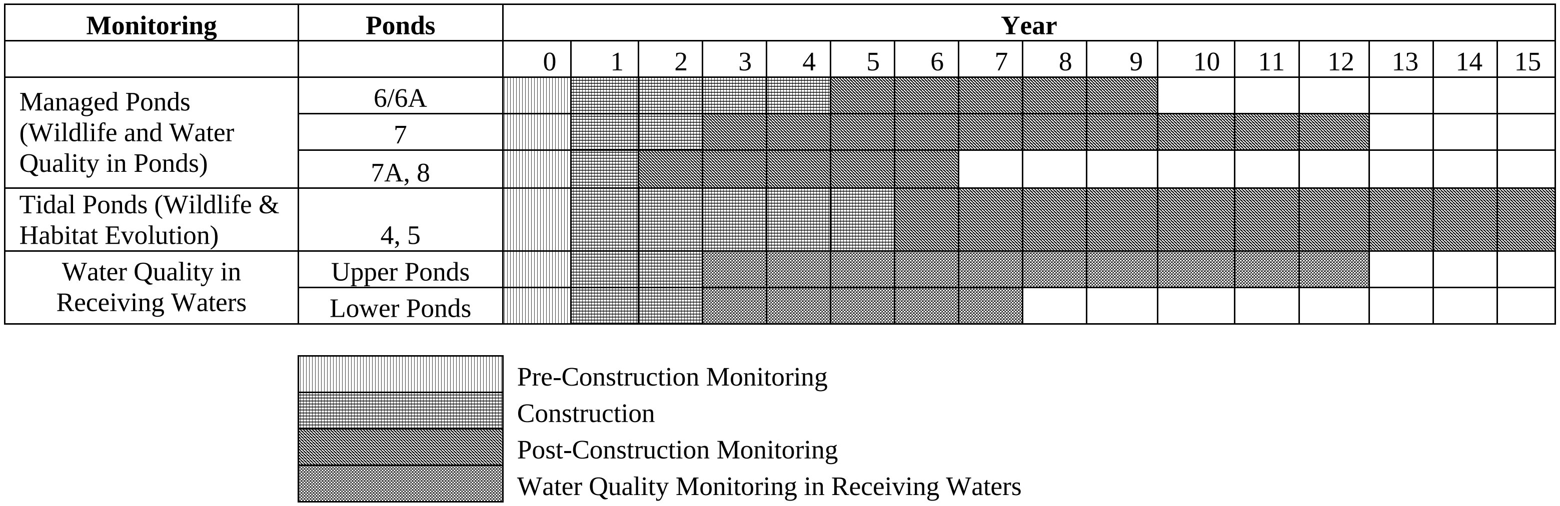
TABLE 1 – MONITORING AND ADAPTIVE MANAGEMENT SCHEDULE



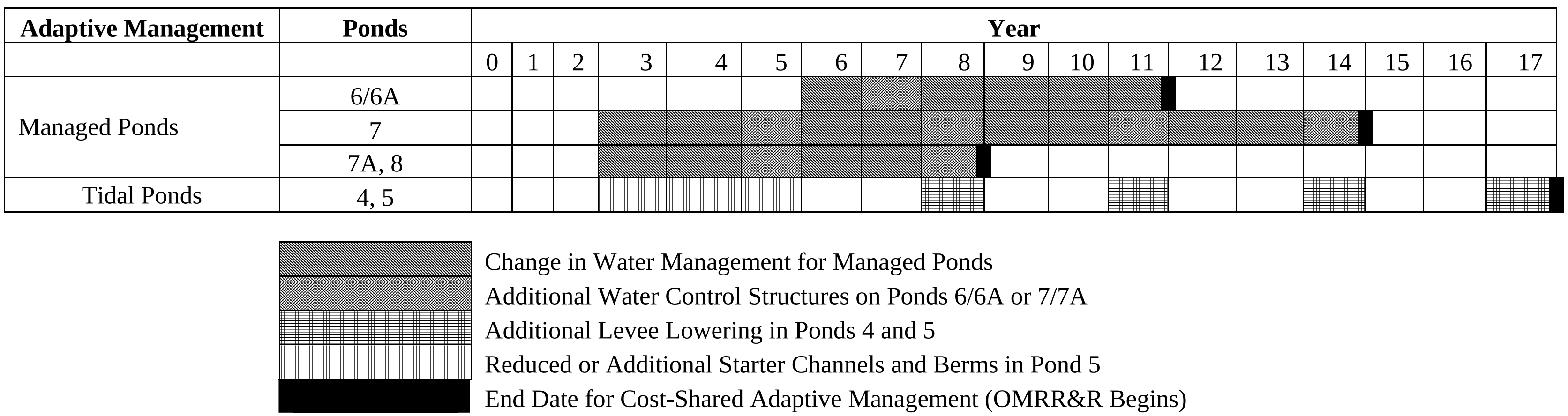


TABLE 2– MONITORING AND ADAPTIVE MANAGEMENT COSTS[1]

MONITORING ACTIVITY	# Times/Year	Which Years?	# Years	Cost/Unit	Unit	# Units	Total Cost for Activity	Notes
Pre-Construction Endangered Species Surveys								
Clapper Rail Nest Surveys	1	0 - 4	5	$2,000	1 event	5	$10,000	
Snowy Plover Nest Surveys	1	0 - 4	5	$2,000	1 event	5	$10,000	
Water Quality in Receiving Waters								
Combined Discharge of Ponds 4, 5, 6, and 6A	12 (years 3-4); 6 (years 5-7)	3-7	5	$4,500	1 event	42	$189,000	Water quality monitoring of points outside ponds, in receiving waters
Combined Discharge of Ponds 7, 7A, and 8	12 (years 3-4); 6 (years 5-12)	3-12	10	$4,500	1 event	72	$324,000	
Habitat Evolution: Physical Surveys								
Tidal Level Surveys in Ponds 4 and 5 and Sloughs	2	0, 2, 4, 6, 8, 10, 12, 14	8	$700	1 event	16	$11,020	
Levee Breach and Channel Cross Section Surveys	1	0, 2, 4, 6, 8, 10, 12, 14	8	$1,621	1 event	8	$12,121	
Monitoring of Sediment Pins in Ponds 4 and 5	1	2-14	13	$1,350	1 event	13	$17,550	
Bathymetric Surveys of Vegetation Transects	1	2, 4, 6, 8, 10, 12, 14	7	$2,000	1 event	7	$14,000	
Habitat Evolution: Vegetation Surveys								
Aerial Surveys for Sedimentation/Vegetation Colonization in Ponds 4 and 5, Reference Site	1	3-15	12	$4,150	1 event	12	$50,000	includes rectification and assessment of habitat types
Vegetation Transects in Ponds 4 and 5	1	6, 8, 10, 12, 14	5	$14,000	1 event	5	$70,000	on-ground transect, verification of aerial photography, identification of plant species
Vegetation Transects in Reference Site	1	4, 6, 8, 10, 12, 14	6	$14,000	1 event	6	$84,000	
Water Quality Indicators in Ponds								
Ponds 4 and 5	4	0-2	3	$240	1 event	12	$2,880	
Ponds 6 and 6A	4	0-9	10	$240	1 event	40	$9,600	
Pond 7	4	0-12	13	$240	1 event	52	$12,480	
Pond 7A	4	0-6	7	$240	1 event	28	$6,720	
Pond 8	4	0-6	7	$240	1 event	28	$6,720	
Toxicity Testing of Pond 7	1	unknown	2	$5,000	1 event	2	$10,000	Toxicity testing of the bittern in Pond 7 could allow for changes in the discharge ratio.
Wildlife and Productivity								
Avian Surveys								
Pond 4	6 (yrs 0,4,8,12); 3 (yrs 2,6,10,14)	0, 2, 4, 6, 8, 10, 12, 14	8	$600	1 event	36	$21,600	
Pond 5	6 (yrs 0,4,8,12); 3 (yrs 2,6,10,14)	0, 2, 4, 6, 8, 10, 12, 14	8	$600	1 event	36	$21,600	
Ponds 6 and 6A	6 (yrs 0,2,4,6,8); 3 (yrs 1,3,5,7,9)	0 – 9	10	$600	1 event	45	$27,000	
Pond 7	2 (yrs 3 - 7); 4 (yrs 8-12)	3 – 12	10	$600	1 event	30	$18,000	
Pond 7A	6 (yrs 0,2,4,6); 3 (yrs 1,3,5)	0 – 6	7	$600	1 event	33	$19,800	
Pond 8	6 (yrs 0,2,4,6); 3 (yrs 1,3,5)	0 – 6	7	$600	1 event	33	$19,800	
Vocalization Surveys for Rails in Ponds 4 and 5	1	0, 2, 4, 6, 8, 10, 12, 14	8	$420	1 event	42	$17,640	
Breeding Surveys for passerines in Ponds 4 and 5	1	0, 2, 4, 6, 8, 10, 12, 14	8	$420	1 event	42	$17,640	
Reference Site (Avian, Rail, and Passerine Surveys)	6	0, 2, 4, 6, 8, 10, 12, 14	8	$1,800	1 event	48	$86,400	
Contaminant Monitoring in birds	1	0, 2, 4, 6, 8, 10, 12, 14	8	$2,500	1 event	8	$20,000	In years 0, 2, 4, and 6, a small number of birds using tidal and managed ponds will be monitored for contaminants. In years 8, 10, 12, and 14, only a small number of birds in the tidal ponds will be monitored for contaminants.
Small Mammals								
Pond 4	1	6, 8, 10, 12	4	$1,000	1 event	4	$4,000	
Pond 5	1	6, 8, 10, 12	4	$1,000	1 event	4	$4,000	
Reference Site	1	4, 6, 8, 10, 12	5	$1,000	1 event	5	$5,000	
Invertebrates								
Pond 4	1	0, 2, 4, 6, 8, 10, 12, 14	8	$1,700	1 event	8	$13,600	
Pond 5	1	0, 2, 4, 6, 8, 10, 12, 14	8	$1,700	1 event	8	$13,600	
Ponds 6 and 6A	1	0 – 9	10	$1,700	1 event	10	$17,000	
Pond 7 and 7a	1	3 – 12	10	$1,700	1 event	10	$17,000	
Pond 8	1	0 – 6	7	$1,700	1 event	7	$11,900	
Reference Site	1	0, 2, 4, 6, 8, 10, 12, 14	8	$1,700	1 event	8	$13,600	

Fish								
Pond 4	1	0, 2, 4, 6, 8, 10, 12, 14	8	$1,800	1 event	8	$14,400	
Pond 5	1	0, 2, 4, 6, 8, 10, 12, 14	8	$1,800	1 event	8	$14,400	
Ponds 6 and 6A	1	0 – 9	10	$1,800	1 event	10	$18,000	
Pond 7 and 7A	1	3 – 12	10	$1,800	2 events	10	$18,000	
Pond 8	1	0 – 6	7	$1,800	1 event	7	$12,600	
Reference Site	1	0, 2, 4, 6, 8, 10, 12, 14	8	$1,800	1 event	8	$14,400	
Contaminant Monitoring	1	0, 2, 4, 6, 8, 10, 12, 14	8	$1,500	1 event	8	$12,000	In years 0, 2, 4, and 6, a small number of fish using tidal and managed ponds will be monitored for contaminants. In years 8, 10, 12, and 14, only a small number of fish in the tidal ponds will be monitored for contaminants.
TOTAL for surveys							**$1,313,868**	
Administrative Costs	1	0 to 15	8	$32,847	year	8	$262,774	Includes supervision and administration based on 20% of total cost of monitoring surveys
TOTAL for monitoring							**$1,576,642**	

ADAPTIVE MANAGEMENT COSTS								
Evaluation Activities	**Item**	**Which Years?**	**# Years**	**Cost/Unit**	**Unit**	**# Units**	**Total Cost for Activity**	**Rationale**
Evaluation of Monitoring Data		3, 7, 11, 14	4	$100	hour	160	$16,000	To assess effects of restoration and progress with tidal habitat evolution, to validate modeling efforts and to test model projections. Year 3 assessment is required to verify habitat restoration features required for Ponds 4 and 5.
Identification of Response Options and Recommendations								
	Experts' and Senior Management Staff time	3, 7, 11, 14	4	$100	hour	160	$16,000	To fund participation of a panel of experts in a yearly meeting to review monitoring data and project progress. Panel will identify appropriate plan of action, if any.
	Project Team Labor	3, 7, 11, 14	4	$100	hour	160	$16,000	To prepare for each panel meeting
	Report	3, 7, 11, 14	4	$100	hour	40	$4,000	Documents response options and recommendations
Budget Assessment		3, 7, 11, 14	4	$100	hour	40	$4,000	To determine ability to act on preferred plan of action
TOTAL for Evaluation Activities							**$56,000**	
Implementation Activities (Potential Physical Construction)								Includes only actions that would incur additional costs
	Location	**Item**		**Cost/Unit**	**Unit**	**# Units**	**Total Cost for Activity**	**Rationale**
TIDAL PONDS								
	Pond 4	Levee Lowering		$54	linear foot	3,500	$189,000	
	Pond 5	Starter Channels and Berms		$200	linear foot	3,500	$700,,000	To increase rate of habitat evolution (starter channels and berms) and provide additional habitat connectivity (levee lowering) if tidal marsh evolution is slower than projected. Quantities listed would increase the extent of these measures to the level the represented by Habitat Restoration Option 4 (accelerated restoration).
		Levee Lowering		$54	linear foot	2,900	$156,600	
MANAGED PONDS								
	Pond 6	Weir		$6,200	lump sum	1	$6,200	Pond management is not meeting project goals of salinity reduction or water depth, due to water circulation issues. Proposed budget is based on doubling the design-level water flows.
	Pond 7	Additional discharge into mixing chamber		$100,000	lump sum	1	$100,000	
	Pond 7A	Additional discharge into mixing chamber		$100,000	lump sum	1	$100,000	
TOTAL for adaptive management implementation							**$1,251,800**	
Administrative Costs							**$187,770**	15% construction supervision and administration
TOTAL FOR ALL ADAPTIVE MANAGEMENT							**$ 1,511,570**	

[1] **Note: Tables show cost-shared monitoring and adaptive management costs only.**

TABLE 3 – COMPLIANCE MONITORING BREAKDOWN

Monitoring Topics	**Monitoring Requirements**				
	RWQCB NPDES/ WDR	**RWQCB 401 Cert**	**BCDC**	**FWS and NMFS (Section 7 Biological Opinions)**	**EIR/S Mitigation Monitoring Requirements**
WQ and Sediment within Ponds		Water and sediment quality			Monitor depths of managed ponds (need to be 2 feet below levee crest)
WQ and Sediment in Sloughs, Napa River, and Restored Tidal Habitats	Discharge Monitoring (water quality and sediment)	Water and sediment quality			Continuous recording devices for key parameters (flow, water level stage, salinity, temp, TSS/turbidity), and/or periodic grab samples for specific constituents of concern (DO, pH, selected inorganic ions and trace metals).
Wildlife in Tidal Habitats and Ponds		Monitor major wildlife groups from Goals Report (plants, fish, invertebrates, amphibians and reptiles, mammals, waterfowl and shorebirds, other birds); Wildlife (special status species and general abundance and diversity)	Presence/absence of wildlife (don't typically require wildlife surveys)	Pre-construction surveys for California clapper rails during nesting season using FWS 1/21/00 draft survey protocol. Avoid construction February through July or conduct pre-construction survey up to 72 hours in advance 150-300 feet from construction area. Develop survey protocol for snowy plover and conduct during breeding season (March 1 through September 30). Notify FWS within 24 hours of any injured or dead rail, smelt, splittail, harvest mouse, snowy plover or any harm caused by monitoring	Collect water quality and sediment samples periodically to document that accumulation of trace metal and inorganic compounds does not occur in restored wetlands. Conduct 10 years of monitoring for waterfowl and shorebirds after restoration of Ponds 3, 4, and 5, due to loss of open water habitat. Monitor exposure of wildlife to contaminants in restored wetlands over next 10 years. Monitor for entrainment of fish in ponds to assess whether measures could be implemented to reduce entrainment. Assess water quality changes on listed and sensitive fish species.
Introduced Species		Control of exotic species			Monitor for invasive *Spartina*.
Marsh Evolution in Tidal Habitats		Acreage of habitat types; Vegetation composition and percent cover; Bathymetry and sedimentation rates	Vegetative performance criteria (% cover). Once every 3 years over 10 years		
Hydrology and Channel Geomorphology		Hydrology and channel geomorphology			Monitor expansion of slough channels to ensure expansion does not threaten adjacent levees. Take adaptive management measures (additional levee breaches, phasing of pond breaching, levee repairs or revetment) to protect levees if needed
HazMats					Monitor perimeter dust concentrations in vicinity of Pond 8, to protect residents.
Utilities					Conduct site-specific surveys of power towers to ensure they are not impacted. Possibly encase towers with concrete above high water mark.
Public Health					Consult with Mosquito Abatement District and permit them to monitor and control mosquitoes. Cost-share mosquito control if monitoring and control increase above pre-project levels.

FIGURE 1 – MONITORING BASIS MATRIX

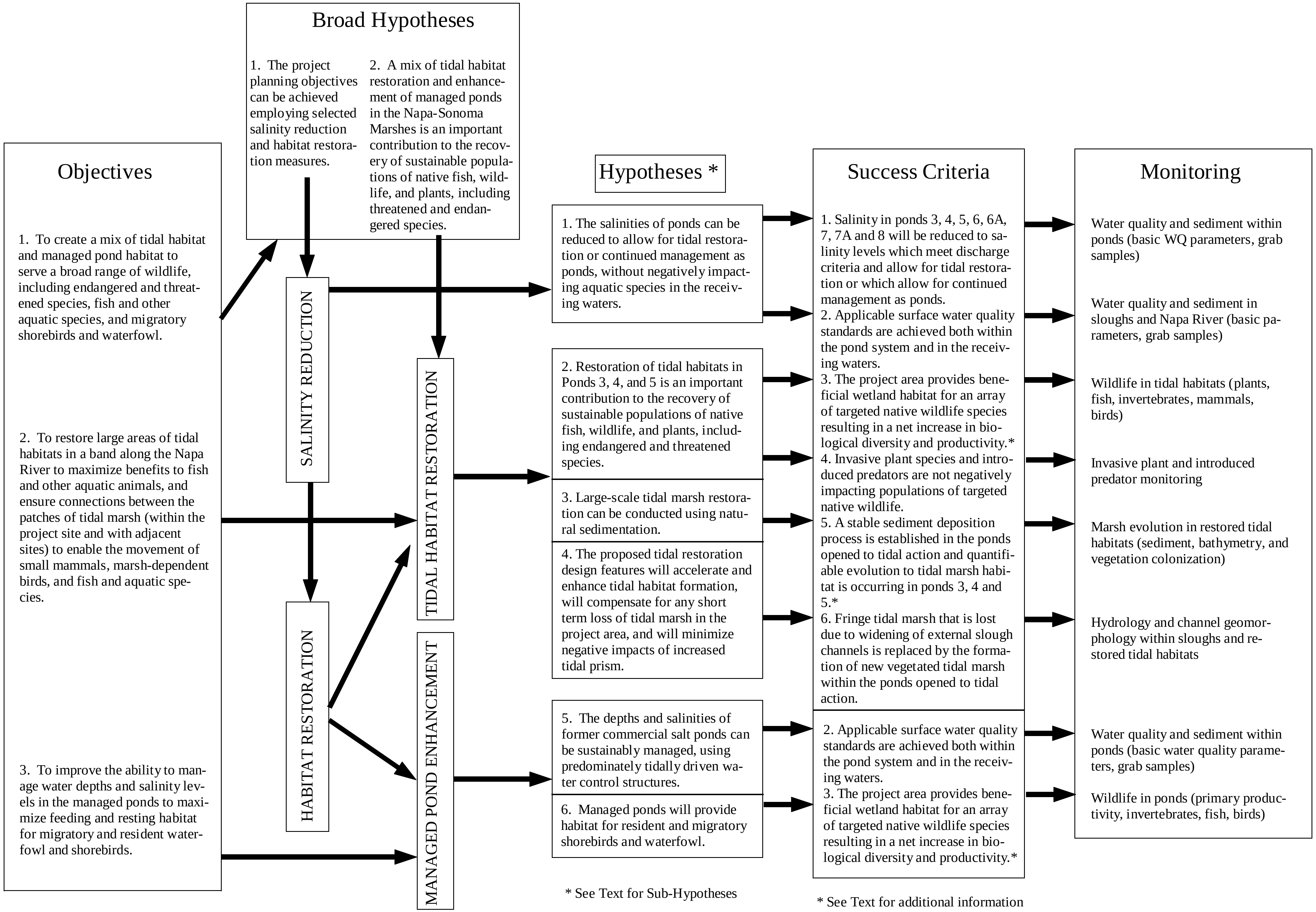


FIGURE 2 – ADAPTIVE MANAGEMENT DECISION MATRIX