MONITORING & ADAPTIVE MANAGEMENT PLAN

Hamilton Wetland Restoration Project
Novato, California

Prepared for
U.S. Army Corps of Engineers
San Francisco District

March 13, 2013

ESA PWA

BMP Ecosciences

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and
BMP Ecosciences

Project # 1764.04

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1 INTRODUCTION

This report provides a monitoring and adaptive management plan (MAMP) for the Hamilton Wetlands Restoration Project (HWRP). The goal of the HWRP is to create a diverse array of wetland and wildlife habitats that benefit a number of special status species as well as other migratory and resident species. This plan identifies proposed monitoring activities, outlines how results from the monitoring will be used to assess project success and, if needed, adaptively manage the project. The plan specifies who is responsible for monitoring and adaptive management activities.

The HWRP is located at the decommissioned Hamilton Army Airfield in Novato, California, along the western San Pablo Bay (Figure 1). Upon completion of construction, the HWRP will restore approximately 400 acres of tidal wetlands, 76 acres of seasonal wetlands, and 70 acres of transitional habitat (including the wildlife corridor) to this ecologically sensitive part of the San Francisco estuary. The site is owned by the California State Coastal Conservancy.

Planning and design for wetland restoration started in the 1990s when closure of the Hamilton Army Airfield (HAAF) was considered. There have been multiple studies over the years by a range of government departments and private consultants under funding from the Federal Government and the State of California. More recently, The U.S. Army Corps of Engineers (USACE) formed a Project Management Team (PMT) and Project Design Team (PDT) with broad participation including the US Army Corps of Engineers, California State Coastal Conservancy and the San Francisco Bay Conservation and Development Commission (BCDC). The PMT and PDT have led the process of securing dredged material from the Port of Oakland as part of the deepening and maintenance dredging activities.

The large size and complexity of the project, the multiple contributors and the phased design and construction have resulted in a large volume of planning and design documents. The most recent design summary is provided in the Basis of Restoration Design for Seasonal and Tidal Wetlands (USACE and others, 2008). This monitoring and adaptive management plan is based upon site designs and understanding of construction and fill conditions as of winter 2012. Design and construction continues on the site, and as such, the requirements for project monitoring may change. It is recommended that the first monitoring assessment should include an update to monitoring locations based upon site conditions at time of breach.

The monitoring components of this plan outline physical and ecological requirements to track evolution of tidal wetlands, seasonal wetlands, and associated transitional and upland areas created through the placement and grading of dredged material. The monitoring plan sets forth a program to meet the requirements of consultation by the USACE with the U.S. Fish and Wildlife Service (USFWS), the BCDC and the Regional Water Quality Control Board (RWQCB). The adaptive management components of this plan outline use of the monitoring results to support decision making by an Adaptive Management Working Group. This plan was prepared by ESA PWA and BMP Ecosciences (BMP), on behalf of the USACE.

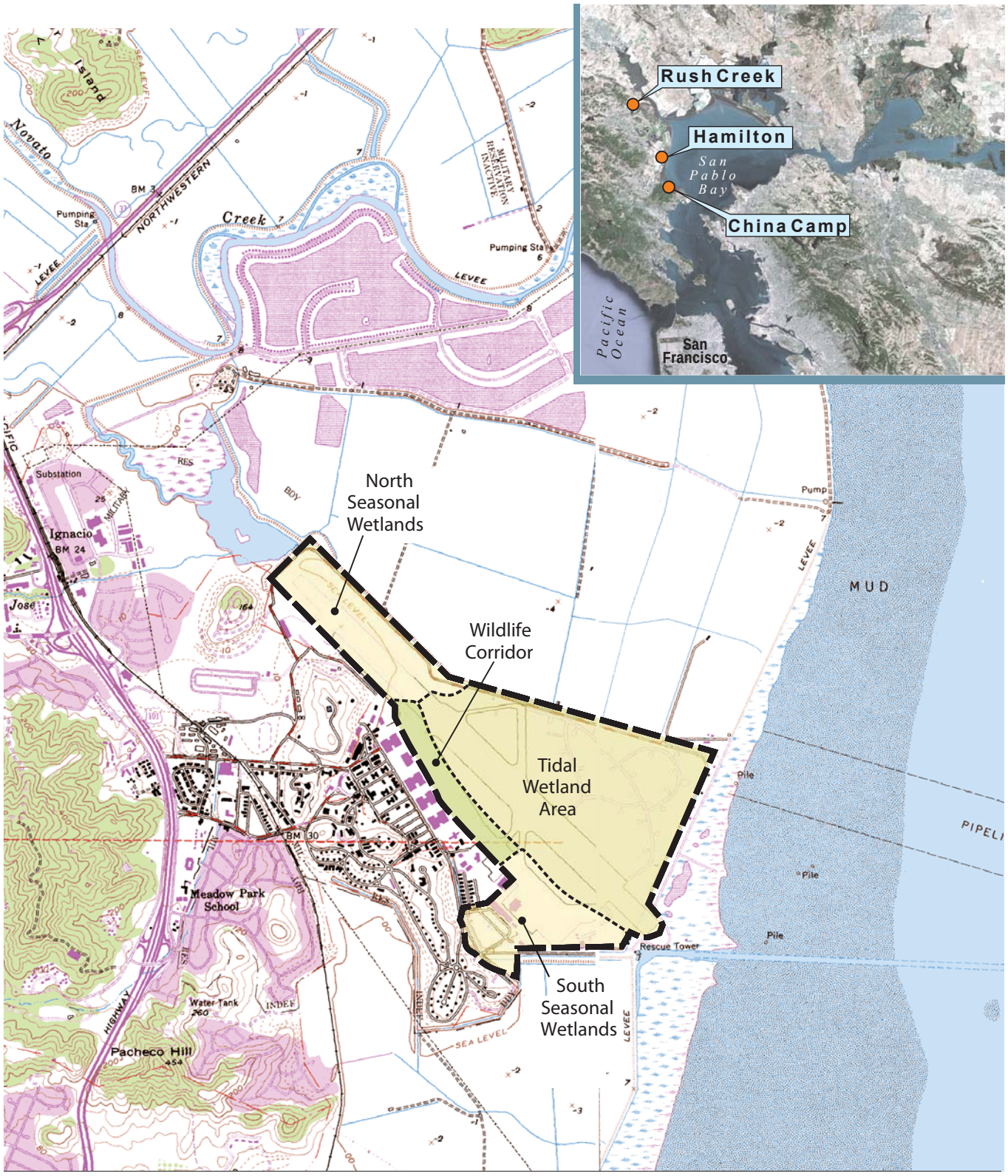

figure 1

Hamilton Wetlands Restoration MAMP

Regional and Site Location Map

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2 OVERVIEW OF MONITORING AND ADAPTIVE MANAGEMENT

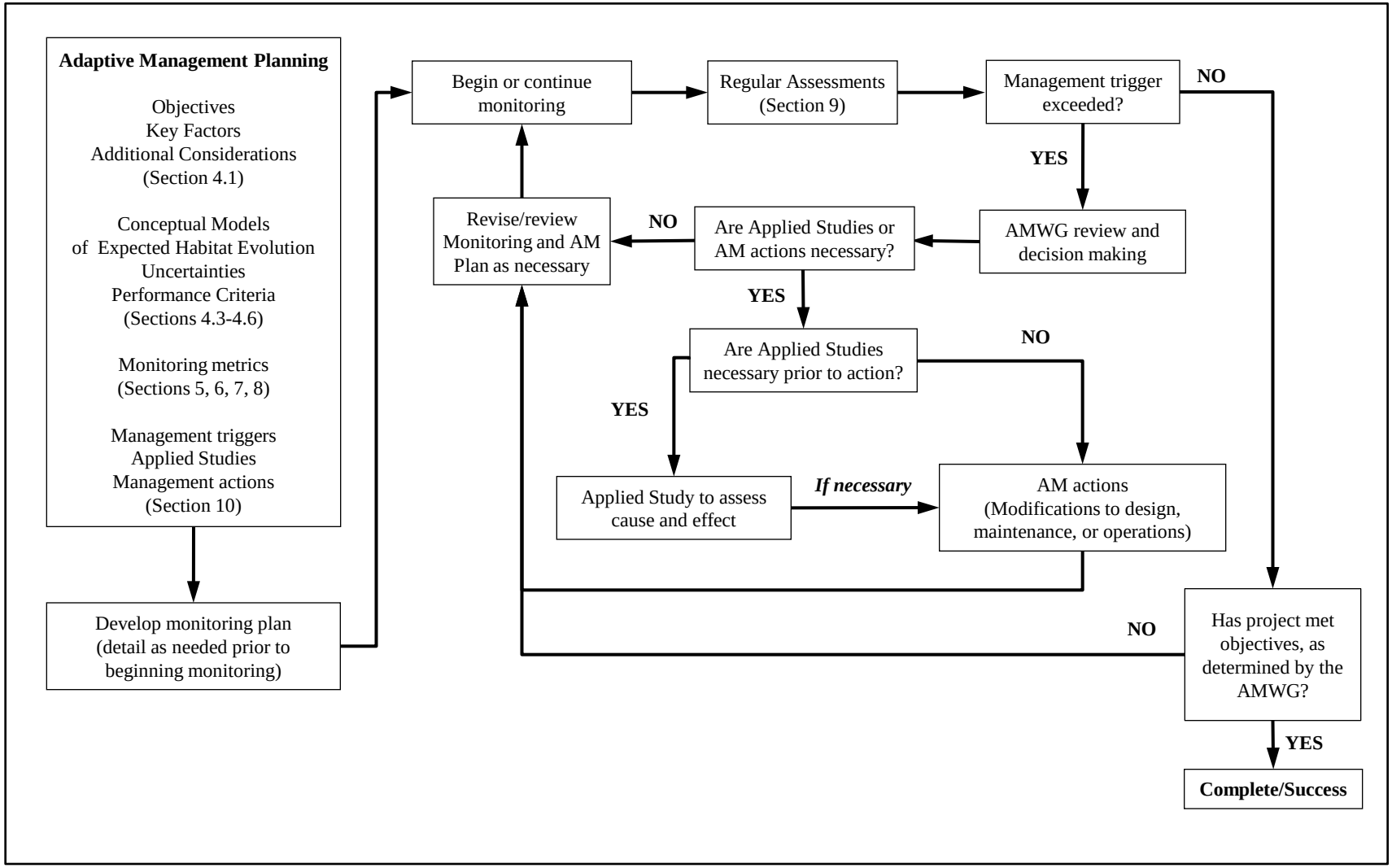
Monitoring and adaptive management is an iterative process that uses regular monitoring and assessments to determine whether follow-up management actions are necessary to keep the project on track towards its objectives. The organizational structure and participants in the adaptive management process are described in Section 3, with the steps in the adaptive management process described in subsequent sections.

For the purposes of this plan, monitoring and adaptive management are presented in four steps, consistent with USACE implementation guidance (USACE 2009). These steps are shown graphically in Figure 2.

1. Adaptive management planning (Section 4)
2. Monitoring (Sections 5-8)
3. Regular assessments (Section 9)
4. Decision-making and adaptive management actions (Section 10)

The first step, adaptive management planning, sets the stage for determining the type of monitoring that is required. It consists of identifying project objectives; describing conceptual models of project outcome; identifying uncertainties in the conceptual models, and setting specific performance criteria considered necessary to achieve the project objectives. The second step, monitoring, is used to assess progress towards project objectives, to detect early signs of potential problems, to help frame effective adaptive management actions (if needed), and to satisfy regulatory requirements. Regular assessments (step 3) check monitoring results against restoration performance criteria (desired outcomes) and management triggers (negative outcomes). The last step, the decision-making process, determines if and when adaptive management actions should be implemented to improve project performance.

The adaptive management steps will be flexible to accommodate lessons learned from the monitoring results. For example, as new information becomes available, the Adaptive Management Work Group (Section 3.1) 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 Work Group can continue to steer the project towards the desired outcome.



Note: AM = Adaptive Management

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Hamilton Wetland Restoration MAMP

Figure 2

Steps in Adaptive Management

3 MONITORING AND ADAPTIVE MANAGEMENT ORGANIZATIONAL STRUCTURE

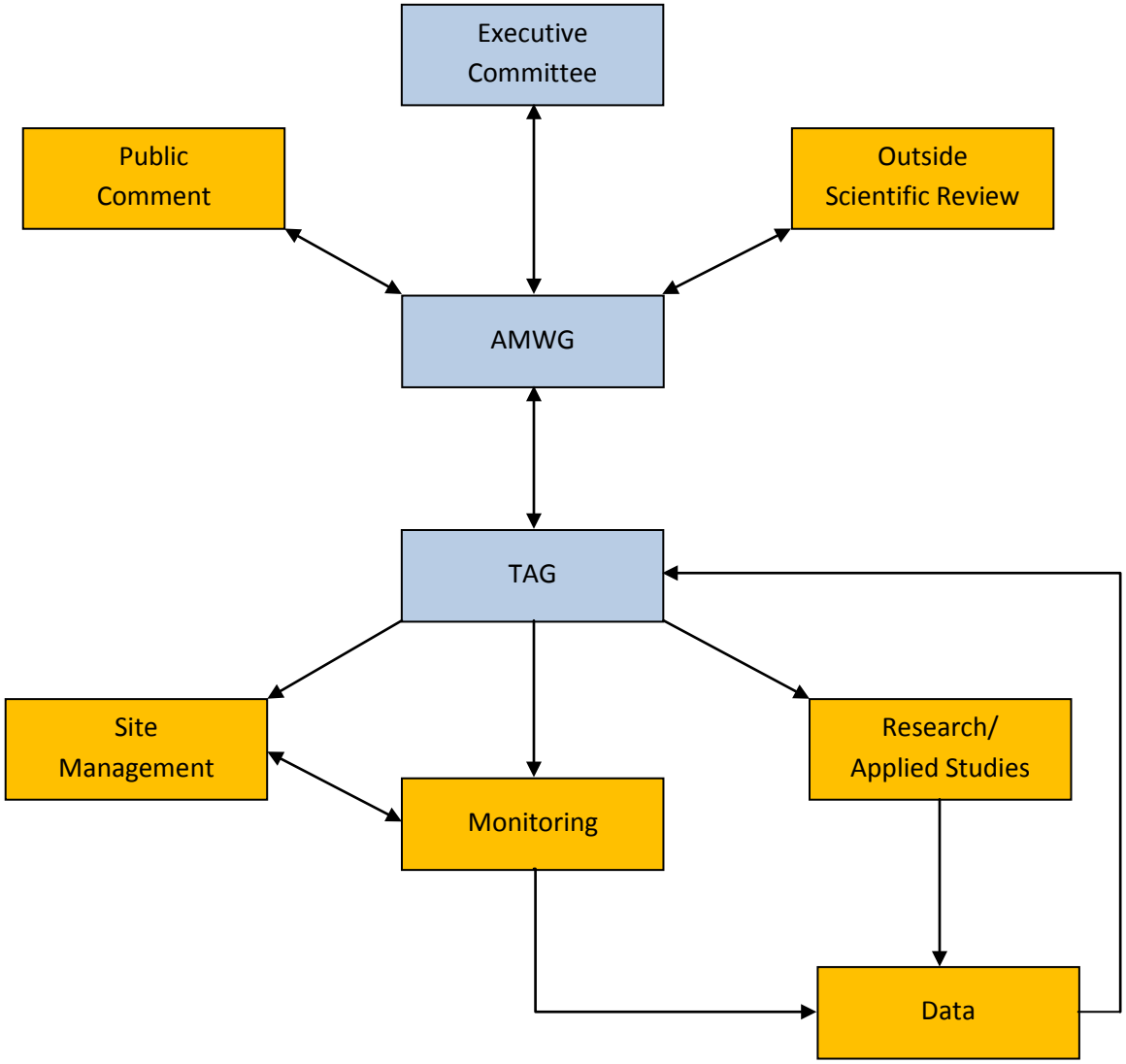
The adaptive management program is structured to invite wide participation among stakeholders, good communication, and robust decision-making. This section describes the participants in the adaptive management process, also shown graphically in Figure 3. Additional information on the roles of these participants in assessment and decision-making is provided in later sections of the report.

3.1 Adaptive Management Working Group

The Adaptive Management Working Group (AMWG) will be tasked with resolution of scientific, logistic and political issues that will confront such a complex project, and is the group responsible for making decisions about adaptive management. The AMWG will consider input from the Technical Advisory Group, Site Manager, and others, as necessary, when making decisions. The AMWG will seek public input and outside scientific review as needed. The AMWG will seek public and private sector support for meeting the vision of the program (Appendix A).

The AMWP will include personnel from public agencies (e.g. California Coastal Conservancy, U.S. Army Corps of Engineers, Regional Water Quality Control Board, U.S. Fish and Wildlife Service, California Department of Fish and Wildlife), private interests (e.g. California Native Plant Society, local homeowners groups), and scientific organizations (e.g. University of San Francisco) (Table 1). The AMWG will be chaired by an individual who understands the adaptive management process and is familiar with the stakeholders and their perspectives.

The HWRP AMWG will be convened by the USACE for the first 13 years of the project before transitioning to Coastal Conservancy for years 14-15. The conveners of the AMWG will be responsible for all AMWG activities and overseeing the decision-making progress. While the USACE convenes the AMWG, they will lead the monitoring activities, too, with funding from the USACE and Coastal Conservancy (cost share). Once the AMWG transitions to the Coastal Conservancy, funding for AMWG activities, including monitoring, will be provided solely by the Coastal Conservancy.



The member participants are shown in blue boxes. The Adaptive Management Working Group (AMWG) is responsible for making decisions about Adaptive Management. Executive officers of AMWG agencies (Executive Committee) and other stakeholders get information through their representatives on the AMWG. The Executive Committee provides overall direction. The Technical Advisory Group (TAG) directly oversees the activities of management, monitoring, and research/applied studies which generate data for decision-making by the AMWG. Other inputs from the public and outside reviewers enter the flow through the AMWG.

Figure 3
Adaptive Management
Organizational Structure

3.2 Technical Advisory Group (TAG)

A subset of the AMWG, known as the Technical Advisory Group (TAG), will convene as directed by the AMWG to address scientific problems associated with developing management actions, designing monitoring, and performing data analysis.[1] The TAG will be led by a chairperson who understands wetland operation, ecological restoration, monitoring, and statistical approaches to project design and data collection.

The TAG will assist in the design, implementation, and evaluation of the monitoring for seasonal wetlands (Section 0). Because the required monitoring is specialized, time-consuming, and relatively expensive, its design would be best developed by the TAG in consultation with the experts who would ultimately conduct the investigations.

3.3 Executive Committee

The Executive Committee provides decisions on overall direction of the project. The Executive committee consists of senior staff of the USACE, State Coastal Conservancy, BCDC and US Fish and Wildlife Service. The Executive Committee is responsible for funding HWRP monitoring and adaptive management activities. The Executive Committee ensures that the AMWG is adequately staffed for conducting required evaluations and decision-making. Major conflicts among stakeholders that cannot be resolved by the AMWG are referred to the Executive Committee for ultimate determination.

3.4 Site Manager

Site management will be provided by the Project Proponents. The site manager will take actions in accordance with the habitat creation objectives of the HWRP and will take instruction from the AMWG with respect to implementation of management actions for the HWRP. The site manager will be a wetland scientist, biologist or horticulturalist by training, with experience in habitat restoration, native plant propagation, outplanting logistics, and monitoring.

Before the site is breached, (expected in 2013 or 2014), the manager will be responsible for the development of plant materials ('founders') used to create vegetation in the upland habitat. This requires the establishment and operation of a native plant nursery (using paid staff and volunteers) and the outplanting, maintenance, and monitoring of outplanted founders (see Pavlik and McWhorter (2010) for more details).

Closer to the year of breach, the site manager will shift emphasis to preparing for adaptive management of the site. The site manager will work with the AMWG to design and implement the outplanting and to implement the seasonal wetland monitoring programs. Weed control will

[1] Note that the Technical Advisory Committee required by BCDC is not the same as the TAG as defined in this document; The BCDC-required committee is the equivalent of the AMWG.

be an important part of the site manager's initial activities. A second paid employee will be under the direction of the Site Manager, performing duties related to plant propagation, volunteer training, basic nursery operations and construction and field work.

3.5 Flow of Information

There will be a structured flow of information between the AMWG, the TAG, the Site Manager, the public, and the Executive Committee. Policy and political issues will be brought to the AMWG for discussion. If a technical solution is appropriate, the TAG would be charged with its development using a science-based approach. The results of the TAG deliberations are then returned to the AMWG for review. The AMWG communicates its decisions and recommendations to the Site Manager who implements management actions and facilitates or conducts the necessary monitoring.

4 ADAPTIVE MANAGEMENT PLANNING

This section: (1) identifies project objectives, (2) summarizes the restoration design, (3) presents expectations (conceptual models) for site evolution after construction, (4) summarizes sources of uncertainty in site evolution, (5) presents the different types of monitoring, and (6) identifies project performance criteria.

4.1 Restoration Objectives

During the initial stages of project development, the PMT, with stakeholder input, developed project objectives to guide development of the design (USACE et al., 2008). Of the complete list, a subset of the objectives is relevant to carry forward from the planning process into monitoring and adaptive management. Relevant objectives are those that have some uncertainty remaining after implementation and those that can be managed through future actions. There are four main ecological objectives of the HWRP relevant to monitoring and adaptive management:

- Create a mix of tidal habitats on 80% of the land available for restoration. This mix will consist of subtidal open water, intertidal mudflat, low, middle and high intertidal marsh, channels, interior tidal ponds, and tidal pannes, with the relative amount of each type changing over time as the site evolves.

- Create a mix of non-tidal habitat on 20% of the land area available for restoration. This mix will consist of shallow seasonal ponds and wetlands, and a limited amount of grassland and upland. If this is not feasible, then at least the minimum acreage necessary to replace existing seasonal wetlands on the site at a 1:1 ratio, about 8%, will be created.

- Ensure no net loss of wetland habitat functions presently provided at the HWRP site.

- Create and maintain wetland habitats that sustain viable wildlife populations, particularly for Bay Area special status species.

The PMT also developed a list of Key Factors to address with the project design and a list of Additional Considerations (USACE et al., 2008). Of the Key Factors and Additional Considerations, the following have been carried forward from the planning phase to inform monitoring and adaptive management:

- *Impacts to Existing Wetlands and Habitat*. The project incorporates measures to minimize impacts to existing wetlands and special status species.

- *Invasive Plants*. The project incorporates measures to prevent the establishment of invasive cordgrass for other problematic invasive salt marsh species such as *Lepidium* on the project site.

- *Future Sea Level Rise*. Future sea level rise has the potential to affect project outcome and will be taken into account in adaptive management decision-making.

- *Mercury Methylation*. Not included in this monitoring plan are details of a site methyl mercury monitoring program that will fall under a regional programmatic monitoring program for the San Francisco Estuary.

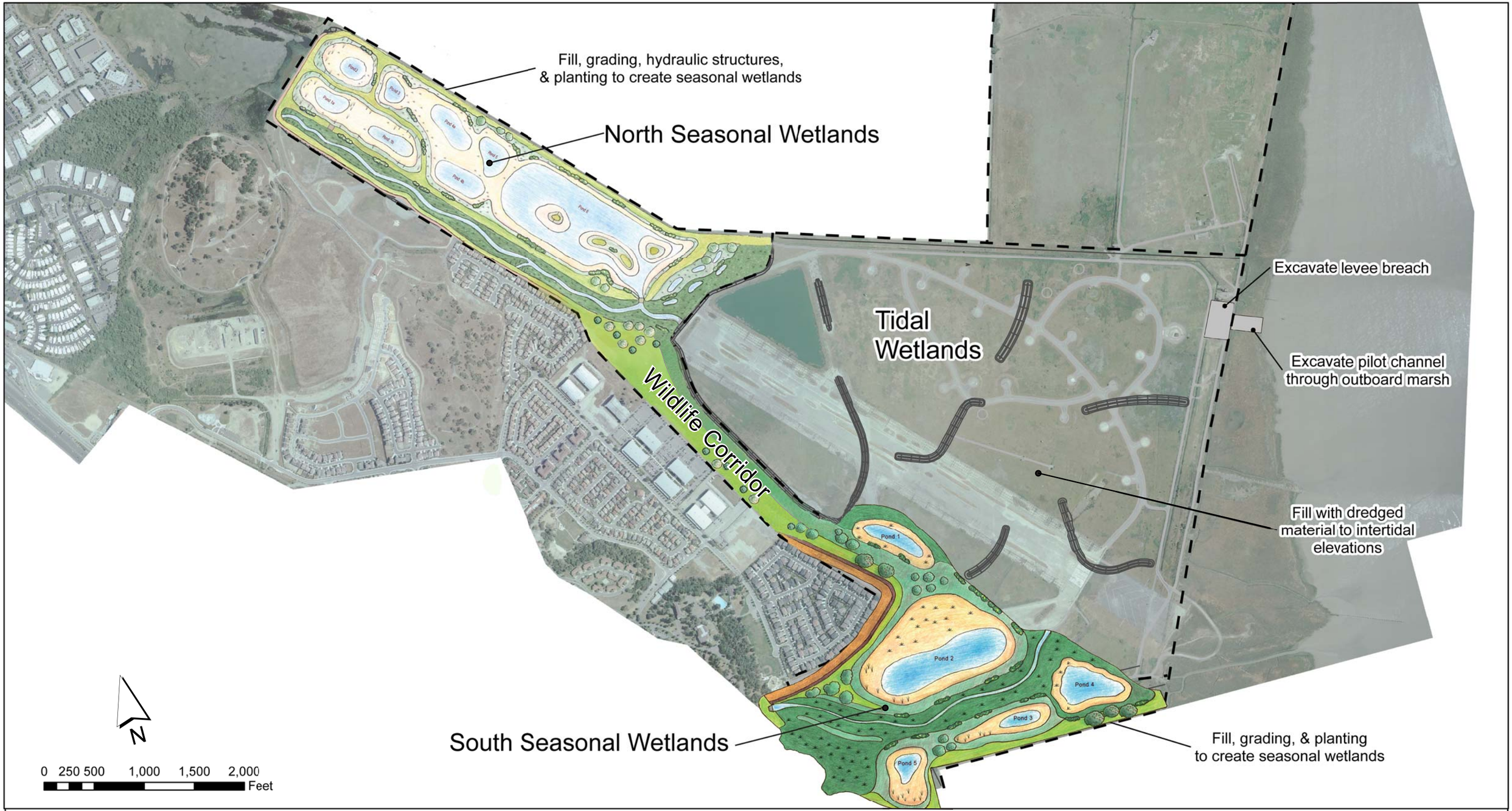
- *Mosquito Production*. Due to the close proximity of the HWRP to residential areas, the project's potential for mosquito production has been considered in the design and will be monitored and adaptively managed as needed.

Objectives related to public access and compatibility with adjacent land uses, while sometimes the subject of adaptive management actions in other projects, are not included for monitoring and adaptive management for the HWRP because the project does not propose any future changes to public access (such as trail realignment or seasonal closure) or changes to adjacent land uses.

4.2 Restoration Design

The HWRP is projected to restore approximately 400 acres of tidal wetland and pannes, 76 acres of seasonal wetland ponds, and 70 acres of transitional habitat (including the wildlife corridor). Dry upland, subject to occasional inundation, and ecotones between the seasonal wetland ponds will comprise a further 70 acres of the site. Figure 4 presents the restoration plan.

The tidal wetland restoration design calls for placement of dredge fill to raise the surface of the site towards a natural marsh plain elevation and then relies on estuarine sedimentation to further raise site grades while also encouraging channel development (Figure 5). Two seasonal wetland parcels are proposed for the restoration, one located to the northwest of the tidal wetland (the "panhandle" or "Cell 1" or "northern"; Figure 6) and the other to the south ("southern" or "Cell 2"; Figure 7). The panhandle seasonal wetlands will be managed through water control structures, while the southern seasonal wetlands will not be actively managed, but defined by their natural flooding regime. The transitional and upland habitats (e.g. the wildlife corridor) will be created by grading the dredge fill to the required slopes and elevations above the edge of the wetlands. Below is an overview of design features, while a full review concerning habitat creation, development and operation are found in Appendix B of this plan.



Note: Overlays for North and South Seasonal wetlands were developed during the preliminary (35%) design phase.

figure 4

Hamilton Wetland Restoration MAMP

Restoration Plan

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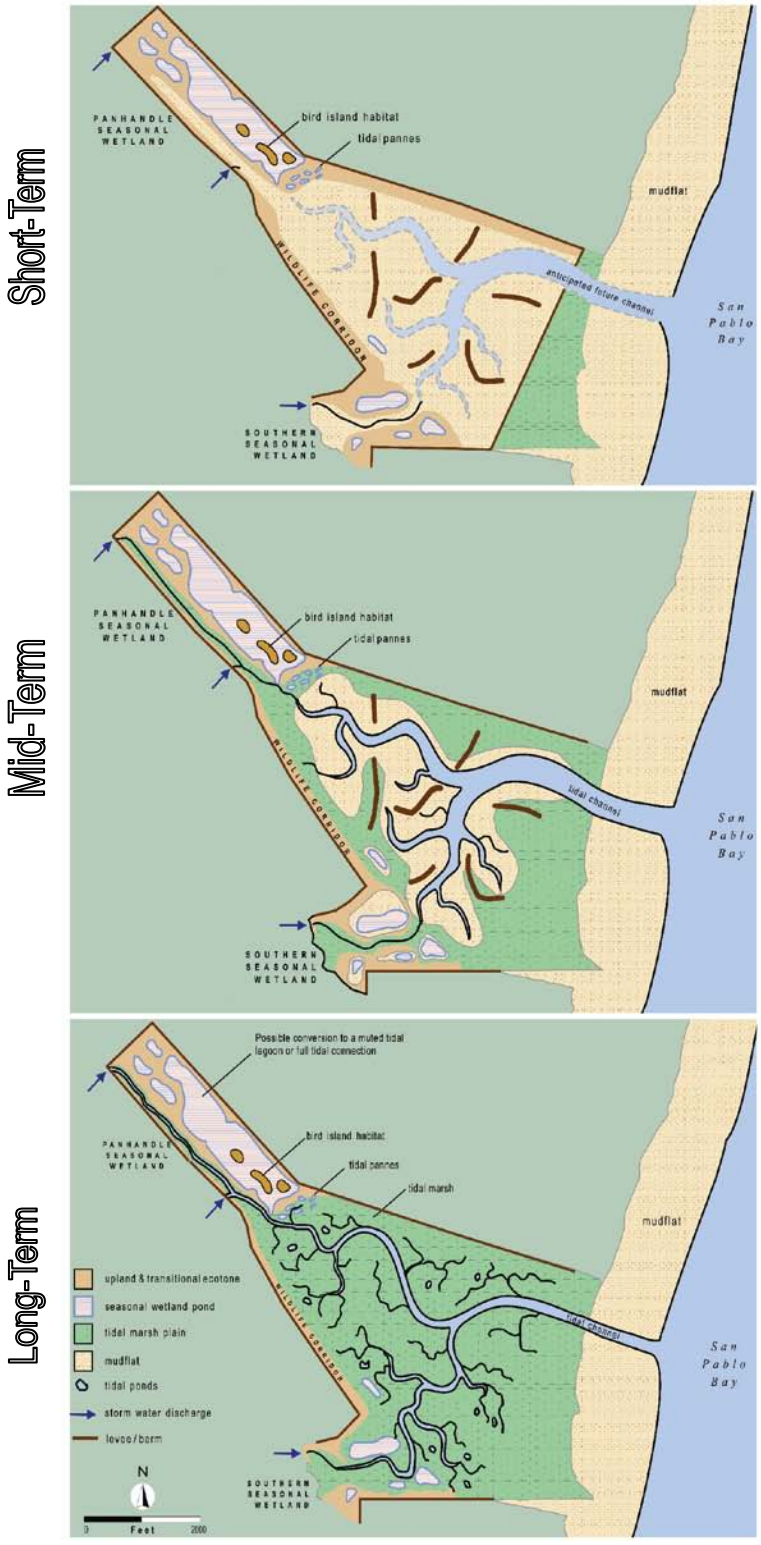
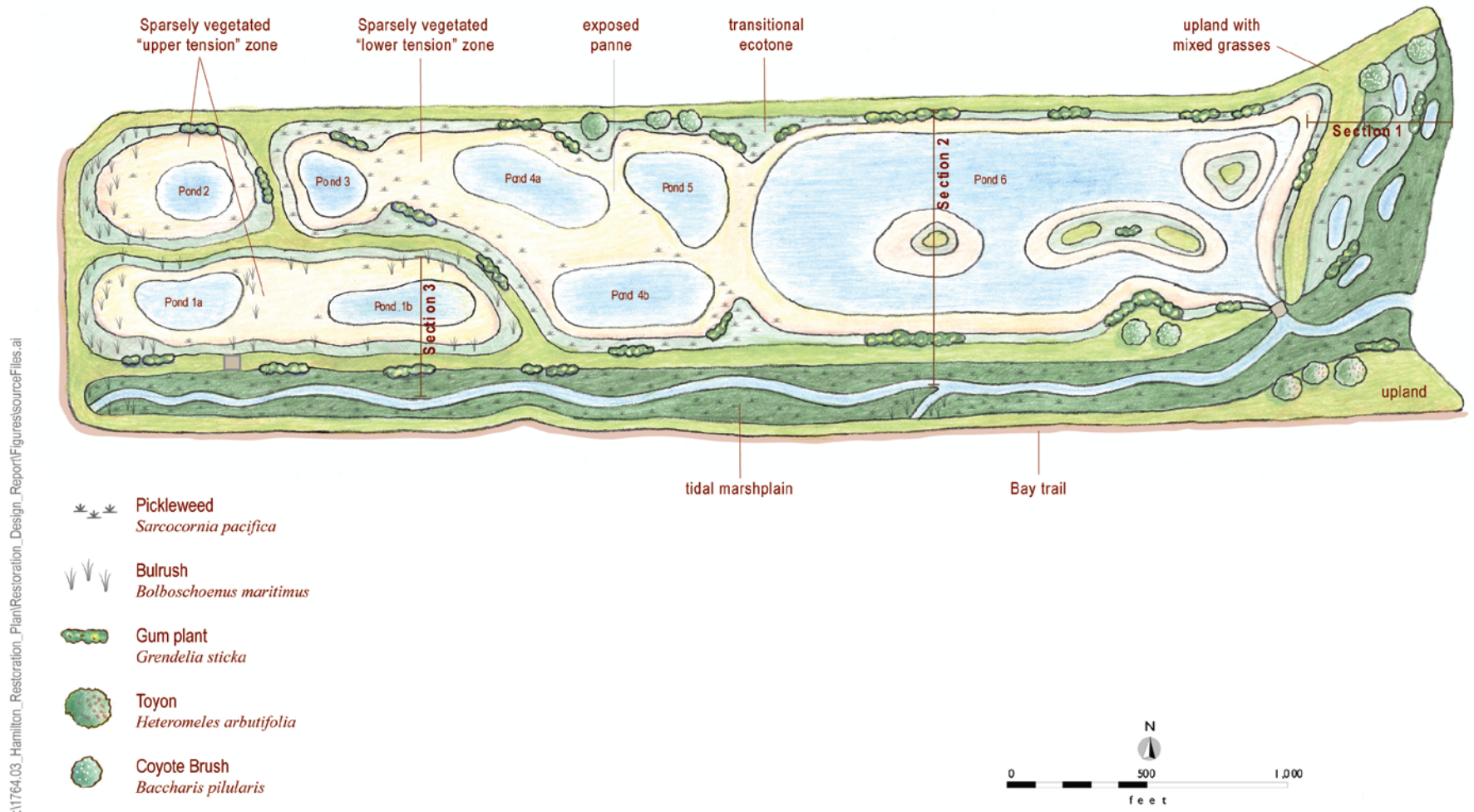


Figure 5
Conceptual Model of Tidal Wetland Habitat Evolution



Note: North Seasonal Wetland figure was developed during the preliminary (35%) design phase.

Figure 6

North Seasonal Wetlands Grading and Vegetation Plan

Note: South Seasonal Wetland figure was developed during the preliminary (35%) design phase.

Figure 7

South Seasonal Wetlands Grading and Vegetation Plan

4.2.1 Tidal Wetlands

The HWRP design template, as specified in the Basis of Design Report (USACE et al., 2008), includes a number of features that will help create tidal wetlands with minimal post-breach management (Figure 4). These include:

- Placement of dredge fill to elevations between 1.0 and 1.5 feet below marsh plain elevation (normally MHHW, which is 6.3 feet NAVD88) to allow for natural marsh development.
- Excavation of a wide breach through the outboard levee to allow full tidal exchange.
- Construction of internal berms (peninsulas) to reduce wind-wave energy, re-suspension of sediment, and erosion of perimeter levees.
- Removal of relict structures that would interfere with natural channel development.

Due to limited dredge material availability during construction, the tidal wetland areas were filled lower than the elevations specified in the 2008 Basis of Design Report. Areas filled with mud were filled to an average elevation of 2.5 ft NAVD, compared to target elevations of 5.3 to 4.8 ft NAVD in the 2008 design. The implemented design includes sand shoals with elevations ranging between 3.5 and 4.5 ft NAVD, closer to the 2008 design elevations. These mounds will provide areas for early colonization by marsh vegetation and morphological diversity.

The ecological trajectory of the tidal wetland system depends upon several factors:

- Construction of a full tidal connection
- Final elevation of the placed dredged material
- Amount and rate of autocompaction of the dredged material over time
- Supply of sediment from San Pablo Bay
- Effectiveness of constructed berms to dampen wind-wave energy
- Arrival, colonization, and growth of wetland plants and effects on sedimentation

4.2.2 Seasonal Wetlands

The seasonal wetlands are designed to consist of a diverse range of higher elevation freshwater to saline ponds and a set of smaller, lower elevation, seasonally hypersaline pannes within a complex of upland and transitional ecotone (unpublished project data; Figure 6 and Figure 7). The Panhandle or Northern Seasonal Wetland (Cell 1) includes simple water control structures for optimizing water and salt conditions (Figure 6 and Appendix C, Figure C1). The southern seasonal wetlands do not currently include these structures, and their flooding regime will be defined by pond sill elevations relative to tidal elevations, annual rainfall, and runoff patterns (Figure 7).

The amount of ponding in the seasonal wetlands will depend upon intra-annual variations in seasonal rainfall and the degree of connectivity to tidal waters. At times, particularly during winter months, all the ponds will fill to near sill elevations. During spring months rainfall events will cease and rates of evaporation and pond drawdown will both increase. By early summer the higher elevation ponds will be dry. Whether the lower elevation ponds in the panhandle dry during the summer will depend upon the settings of the lower water control structure, offering the option to either maintain continued gently fluctuating water levels through the year fed by tidal waters, or to close down the tidal influx and desiccate the site. The ecological trajectory of the seasonal wetland system thus depends upon several factors:

- Final elevations of the constructed ponds, flood surfaces and channels
- Frequency, depth and duration of tidal flooding
- Rates and timing of evaporation and precipitation
- Management of control structures to influence water storage and salt accumulation
- Arrival, establishment and growth of wetland plants

Management of the restored seasonal wetland habitat will focus on actions that influence water storage (inundation, flooding) and salt storage (salinity) in the ponds (Appendix C, Figure C1). Storage of water from precipitation or occasional spring tides will increase pond area, depth, and hydroperiod. Storage of salt from spring tides and evaporation of pond waters will increase soil salinity of the ponds and the areas surrounding them.

4.2.3 Transitional and Upland Habitats

The design template for restoration provides for areas of transitional and upland habitat that link dry upland with the wetlands to accommodate the movement of acceptable fauna (Figure 8). This broad ecotone will absorb freshwater runoff from uplands and be occasionally exposed to extreme high tides, producing a range of soil moisture and salinity conditions.

The transitional habitat in the wildlife corridor will be created by placing dredged sediment (primarily sand) at an angle of 1:125 sloping down to the wetland from either the crest of the perimeter levees or existing adjacent upland. The area will be formed into a natural undulating topography to add diversity in both the surface and its vegetation. After the topography has been created, the soil will be seeded with native grasses and forbs that would naturally occur in this habitat. The seeding will take place quickly after completion of the sculpting to minimize colonization by ruderal non-native species from adjacent areas. Once the seeding is complete, native shrubs and small trees, such as coyote bush, coast live oak, California buckeye, toyon, and wildrose will be outplanted during the first four years of the project to augment vegetation development and plant diversity. Details of the planting plan are found in Pavlik and McWhorter (2010).

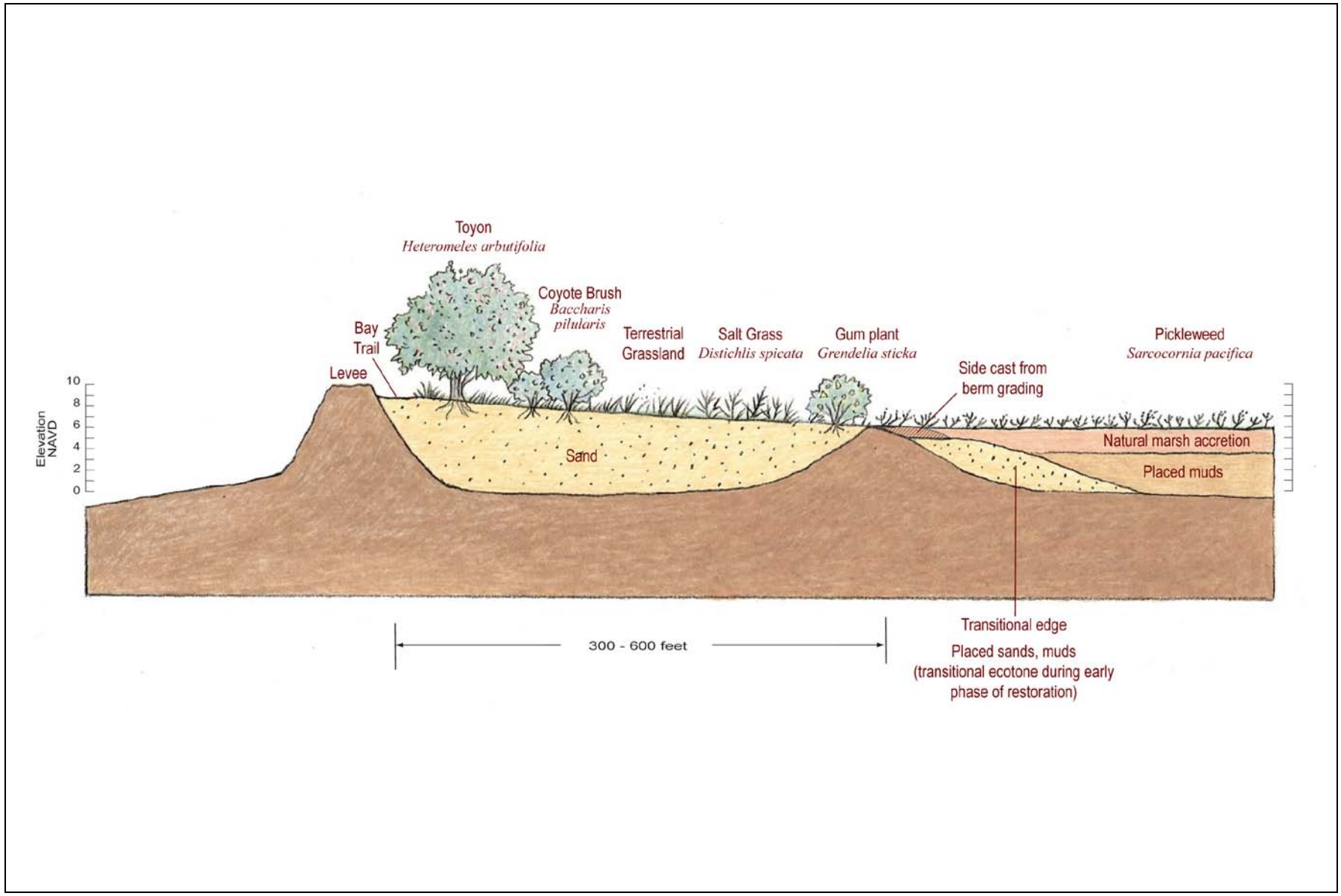


Figure 8

Transitional and Upland Grading and Vegetation Plan

4.3 Expected Habitat Evolution

This section provides a brief description of the conceptual understanding of the three target habitats – tidal wetlands, seasonal wetlands, and uplands – and expectations of how the habitats will develop. Appendix B provides a more detailed discussion.

4.3.1 Tidal Wetlands

When tidal inundation is restored to a subsided bayland site, floodtides carry in suspended estuarine sediments which deposit in the wave-protected areas of the site. As sediment accumulates, intertidal mudflats slowly build up in elevation. As the marsh builds, tidal flows scour a channel network, which evolves as the mudflat develops into marsh. Once the mudflats achieve a threshold elevation relative to the tidal frame, plant colonization and vegetation succession can occur.

The ecological trajectory of the tidal wetlands of the HWRP will depend upon construction of a full tidal connection, the final elevation of the placed dredged material, the amount and rate of autocompaction of the dredged material with time, the supply and sediment from San Pablo Bay and the effectiveness of constructed berms to dampen wind-wave energy. Development from mudflat through to marsh plain will be fastest if average suspended sediment concentrations from the bay are high, if amounts of dredged material autocompaction and low and if wind-wave energies are moderate.

A critical factor in defining the long-term ecological trajectory of the HWRP will be the starting elevation and the rate of long-term accretion of sediment on this surface. The tidal wetland area was filled with soft muds to an average elevation of 2.5 ft NAVD, some 2 ft lower than presented in the Basis of design report (USACE et al., 2008). Consequently, the projections of evolution from mudflat to vegetated marsh must be extended from the original estimates. In areas that are protected from sediment resuspension due to wind waves, the time required for the mudflats to accrete to marshplain elevations is expected to be delayed by about five years due to the underfill. It is anticipated the protected areas will accrete to marshplain elevations 15 to 20 years after breaching. In areas exposed to more wave energy, the sedimentation rates are anticipated to be lower, extending the time required for the mudflats to accrete to marshplain elevations.

The vegetation and other habitat elements of the restored tidal wetlands will reflect biological responses to sedimentation and gradual soil drainage on the mudflats and marsh (Figure 5). Tidal marshes are sustained by plant growth and sedimentation that maintain marsh plain elevations within a narrow band of the high intertidal range even as sea level rises (Orr and others, 2003). When mudflats attain an elevation roughly 1 – 1.5 ft above mean tide elevation, Pacific cordgrass (Spartina foliosa) colonizes the surface and rapidly spreads to build low marsh. With further sedimentation, aided both by the trapping and binding of sediments by stems and roots, as well as through direct soil organic root material accumulation, the marsh eventually gains an elevation 1-0.5 ft below Mean Higher High Water (6.3 ft NAVD88 at Hamilton). Pacific cordgrass is then replaced by pickleweed (Sarcocornia pacifica), thereby creating mid-marsh. The mid-marsh plain

continues to build, up towards high marsh, reaching an equilibrium surface elevation close to the elevation of Mean Higher High Water tides. On higher elevation berms and channel edges, and along the transition between wetland and upland habitats, a gumplant (Grindelia stricta) or alkali seaheath (Frankenia salina)-dominated high marsh should establish.

4.3.2 Seasonal Wetlands

The scientific literature is 'patchy' in its investigation of processes that sustain natural seasonal (or ephemeral) wetlands in California; and almost non-existent on created seasonal wetlands. The storage processes for water and salt dominate formation and succession in seasonal wetlands and depend upon local topography, soil drainage and the nature of any inflowing water (precipitation patterns and amounts, tidal inflows, salt content). Plant species that colonize and persist along the margins of these pannes must not only tolerate prolonged inundation, but also high levels of soil salinity that accumulate with each flood and concentrate with evaporation. See Appendix B for additional detail.

At the HWRP, ponds created above the elevation of tidal flooding will slowly lose salts from their soils and progressively become available for colonization by freshwater plants. The lower ponds, lying within the range of tidal flooding, will progressively concentrate salts as trapped tidal waters evaporate.

4.3.3 Transitional and Upland Habitats

Under local climatic conditions, there will likely be rapid colonization by ruderal plants and animals, some of which are acceptable with respect to project goals (e.g. most non-native grasses and forbs, native rodents, mustelids, procyonids, coyote), some of which are not (e.g. perennial non-native vines and shrubs, red fox). The upland, wildlife corridor, and islands in the seasonal and tidal wetlands will be enriched with native grasses and forbs (hydroseeding) and with container-grown native shrubs and small trees. Long-term weed control will be required.

4.4 Sources of Uncertainty

Gaps in our knowledge about San Pablo Bay ecosystem functioning and restoration performance can hinder our ability to achieve the project objectives. Uncertainties in the conceptual models of habitat development and ecological response are identified so that monitoring could be targeted to reduce these uncertainties and guide adaptive management actions.

Naturally-occurring tidal wetlands are common and well-studied around San Francisco Bay (for example, see PWA 2004, Williams, et.al. 2002). Tidal wetland restoration projects in the region have been broadly successful, achieving vegetated marsh and channel networks that support special status, endemic species. Given previous levels of success, moderate levels of uncertainty are associated with creating tidal wetlands at Hamilton. Perhaps the greatest uncertainty with the restoration of tidal wetlands with a site as large as the HWRP is the impact of wind waves on sediment resuspension and, in turn, the rate of site evolution and the final mix of vegetated marsh and unvegetated mudflat.

Naturally-occurring seasonal wetlands are rare and poorly understood in the San Francisco Bay region. Projects that have attempted to create seasonal wetlands have produced poor- to moderate-quality habitat when viewed over a moderate (decadal) timeframe. The salinity/water inundation conditions required to produce sustainable, high quality habitat appear to be narrow and difficult to achieve (Appendix D). Furthermore, the management actions required to improve outcomes have not been previously tested (e.g. changing weir board elevation to affect inundation, timing of weir board adjustments to affect salinity). Hence, high levels of uncertainty are associated with creating seasonal wetlands.

There are low levels of uncertainty associated with creating transitional and upland habitats. There is little doubt that upland habitats will be created, and existing tools for improving their quality are well-developed and readily implemented (hydroseeding, weed control, landscaping with native plants).

Two important uncertainties are being addressed through separate regional studies. Mercury methylation, and the extent to which the project restoration and management actions might result in an increase in bioavailable mercury in the food chain, is a key uncertainty which will be addressed though a separate regional study. Similarly, the extent to which invasive spartina and its hybrids may establish and the extent to which they can be controlled through management are the subject of the State Coastal Conservancy's Invasive Spartina Project. The HWRP will coordinate with both regional studies.

4.5 Types of Monitoring to Support Decision-Making

The monitoring plan is designed to provide the appropriate level of information for decision-making. Where project outcomes are relatively well-understood (low uncertainty), monitoring can be simpler. Where project outcomes are relatively less predictable (high uncertainty), more detailed monitoring is proposed to support decision-making.

The HWRP MAMP employs the monitoring framework and terminology jointly developed by the US Geological Survey and the US Fish and Wildlife Service (Woodward and Hollar 2011). The types of monitoring and their relation to decision-making are summarized below.

- *Common practices.* This type of monitoring provides a record of management actions taken by the HWRP site manager and is used when the outcomes of those actions have a low level of uncertainty. Weed control in the upland areas is an action that can use common practices monitoring to document its effectiveness.
- *Implementation monitoring.* This type of monitoring provides data on habitat development and if the expected trajectory is being achieved. This type of monitoring is best applied to actions and outcomes with a moderate level of uncertainty. The change in

tidal marsh vegetation cover over time is a process that uses implementation monitoring to document wetland trajectory.

- *Validation monitoring.* This type of monitoring provides cause and effect data that link a management action to a specific outcome. It is used to test management hypotheses in an experimental context, and consequently, requires a sophisticated design to address a higher level of uncertainty. Knowing that adjustments in weir board elevations can change the course of vegetation succession in the seasonal wetland will require validation monitoring with adequate replication and statistical power.

Generally, for the HWRP, management of the transitional and upland habitats uses common practices monitoring, management of the tidal wetlands uses implementation monitoring, and management of the seasonal wetlands uses validation monitoring. The AMWG may decide to change the type of monitoring for specific restoration elements in the future, based on monitoring results. For example, if surveys for the salt marsh harvest mouse find unacceptably low numbers of the mouse once suitable potential habitat has developed, a more targeted assessment (validation monitoring) may be conducted to better understand cause and effect (e.g., additional habitat considerations, predation, other regional factors) and develop appropriate management actions.

For the HWRP, the USGS-USFWS framework was modified to explicitly identify the linkages between objectives, uncertainty, and decision-making, per comments from reviewers. Appendix E provides additional information on the USGS-USFWS-based adaptive management framework.

Finally, another USGS-USFWS type of monitoring is needed to ensure that permit and reporting requirements are met in a timely fashion.

- *Compliance monitoring for meeting regulatory requirements.* This type of monitoring tracks the status of tasks required for project permits issued by agency stakeholders.

Compliance monitoring is carried out on behalf of agency-based stakeholders who serve on the Adaptive Management Working Group. However, the data collected and analyzed may or may not be directly linked to management actions that affect the developing habitat, nor will they necessarily be linked to overall achievement of performance criteria or determination of project success. Instead, compliance monitoring provides information to stakeholders who may, in turn, use it to suggest alterations in the project to meet the concerns of their agencies or constituents.

4.6 Restoration Performance Criteria

The performance criteria for the HWRP are formulated for each of the three target habitats; tidal wetlands, seasonal wetlands, and transitional and upland habitats (including the wildlife corridor). Table 2 connects the performance criteria with the monitoring metric. The performance criteria were formulated upon current conceptual models of ecosystem creation, development, and

operation (Section 4.3 and stated fully in Appendix B). The restoration effort for the target habitats will be considered successful when these criteria are met.

Because of limitations in available dredge material during construction, the site was not filled as high as specified in the Basis of Design Report (USACE et al., 2008). The evolutionary trajectories to achieve restoration targets, presented below, have been extended to reflect the additional time required for natural sedimentation to reach the mudflat elevations.

One of the first jobs of the AMWG will be review, revise, and approve the success criteria laid out in this monitoring plan. (The RWQCB must also approve the final performance criteria as required by Board Order No. R2-2005-0034.)

4.6.1 Tidal Wetland Restoration Performance Criteria

The tidal wetland restoration performance criteria for the HWRP and their rationale are defined below.

Tidal water levels: Within a period of three years post-breach, full tidal action will be achieved across the site, comparable to natural marshes in the San Pablo Bay. Without dredging a channel through the wide outboard mudflat, is it anticipated that a tidal channel may not naturally scour to fully drain the site. A cut channel through the outboard mudflat has been included in the final project design to facilitate site evolution and drainage.

Water/sediment quality: Applicable surface water quality standards as established by the RWQCB will be achieved every year in the site waters, and beneficial resources (e.g. fish) across the site will not be impacted. Water quality emissions from stormwater inflows to the HWRP (beyond project control) will also meet RWQCB standards on a yearly basis.

Fill elevations: The maximum dredged material surface elevation approximately one month after tidal action is restored will not exceed 5.3 feet NAVD88 (this elevation is one foot below MHHW). This fill elevation will allow natural sedimentation to occur across the site to build the surface to elevations suitable for marsh development and allow for natural channels to form.

Tidal wetland development: A network of branching 1st, 2nd and 3rd order channels will form across of the site within five years of tidal action being restored. Channel densities and cross sectional geometry will be on a trajectory to fall within the range of natural and restoring reference tidal wetlands within San Francisco Estuary.

Sediment accretion/erosion and compaction: Sedimentation (including accretion, erosion, and compaction) will raise the average elevation of the mudflat-marsh surface and build towards marsh plain elevations[2].

[2] Monitoring at the Sonoma Baylands Demonstration Project identified a period of reduced mudflat building during the early project years due to dredged material consolidation/

Intertidal berm elevations: All of the berms will have crest elevations below 6.1 feet NAVD88 within ten years of the restoration of tidal action. This places the berm elevations at approximately MHHW, so they can develop as marsh plain contiguous with the surrounding areas.

Levee breach and outboard tidal channel: The tidal channel between the bayfront levee breach and San Pablo Bay will erode toward meeting the tidal hydrology criterion within one year of excavation of the levee breach. This will encourage development of full tidal exchange between the bay and the site.

Fringing marsh scour: There will be no significant loss in outboard mudflat and marsh beyond projected changes. Some loss in outboard mudflat and marsh is expected, but with the restoration, there will be no net loss.

Vegetation succession: Desired native plant species will populate the restoration site. The complex of intertidal marsh, low tidal marsh, high tidal marsh, and wetland-upland ecotone will represent a diversity of native species. Within five years the marsh plain will develop a nearly continuous fringe of saltmarsh plants along the wetland margins (generally dominated by pickleweed, Pacific cordgrass, saltgrass (*Distichlis spicata*), and alkali seaheath), with intermittent patches of the same species scattered throughout the site. Immediately above this margin, gumplant will be colonizing the transitional ecotone. Total cover by this vegetation will have progressively increased during the same time period. Across the marsh, mudflats will be building to elevations that support the colonization of low and mid marsh vegetation. After ten - 20 years, colonization of the marsh plain by saltmarsh plants will observed with patches of dense and sparse cover and gumplant will be distributed across more than 5% of the ecotone. The goal of these restoration targets is to demonstrate a trend toward establishment of self-sustaining, native wetland vegetation, well advanced but not necessarily complete by year 15. These measures must, however, consider the dynamic nature of a tidal system, and that the distribution and percentages of marsh species across the site can vary over time.

Invasive plants: The acceptable cover of non-native cordgrass and perennial pepperweed will be 0% for each in the vegetated area within the marsh and transition zone. Identification of these plants will trigger immediate irradication. This management trigger should be actively tracked over the 15-year monitoring period. Major infestations (those covering more than 100 m^2) of other invasive plants will be immediately eliminated using appropriate control measures.

Bird use: The total population densities of shorebirds, waterfowl, and other water birds (measured as three separate groups) that use the restored tidal area will not be significantly less than the corresponding densities for reference areas on the nearby mudflats and tidal marsh. As the site evolves the assemblage of birds using the site will also evolve from those which utilize mudflats to those that utilize vegetated marshes.

For small migratory shorebirds, seasonal targets will be set for densities of foraging shorebirds in each restored/managed habitat type (e.g. seasonal wetlands and restored mudflats) using previously collected field data (USGS, PRBO, SFBBO), as well as model predictions. Targets would be based on densities by habitat type necessary to increase overall regional (San Pablo

Bay) populations. Limited surveys will be conducted in a sample of habitats/locations within the HWRP area to estimate foraging densities.

Existing data from Flyway Project surveys and data from initial few years of window surveys will be used to determine the percentage of small migratory shorebirds that occur in San Pablo Bay compared to the entire San Francisco Bay. Abundance in fall, winter, and spring via high-tide will be assessed with baywide "window" surveys (in which multiple observers' census a number of locations in a brief [e.g., 3-day] period) conducted across the region. South Bay Salt Pond Restoration Project would provide for the coordination of these surveys.

Fish use: Estuarine fish and their life stages will utilize tidal channels in the restored tidal area in total densities that are not significantly less than the corresponding densities for reference areas within the nearby mudflats and tidal marsh. As with birds, the assemblage of fish species using the site will change as the mix of habitat evolves from dominantly mudflat to dominantly vegetated marsh.

Special Status species use: In time, California Clapper Rail and Salt Marsh Harvest Mouse will access and utilize the site. Depending upon initial fill elevations, it is anticipated that within ten years into the restoration these California Clapper Rail will be observed foraging within the wetland and that within 20-30 years nesting on creek banks. Salt Marsh Harvest Mouse is present in adjacent outboard marshes and is expected to utilize connected pickleweed marsh as it establishes on high transitional areas. For California Clapper Rail populations a long term target is to restore an individual density of 0.25 birds per acre and for Salt Marsh Harvest Mouse, a target of 75% occupied area of the vegetated marsh with a capture efficiency level of 5.0 or better in five consecutive years.

4.6.2 Seasonal Wetland Performance Criteria

The seasonal wetland restoration performance criteria for the HWRP and their rationale are defined below.

Pond hydrology: After five and ten years post-breach the water elevations within the seasonal wetlands will be sufficient to inundate all ponds during wet winters. The hydroperiod of the standing waters will be sufficient to control (either inhibition or promotion) the growth of target plant species that had been outplanted in test polygons for purposes of adaptive management (see below, Appendix B and Appendix C for more detail on the use of test polygons).

Water and soil salinity: After five years, spring tides will be sufficient to deliver salt water across "tension zones" in the lower (southeastern) portions of the panhandle seasonal wetlands and into lower ponds 3, 4, 5, and 6. Tension zones are the mostly flat, open areas surrounding each pond basin that will fluctuate between wet and dry conditions depending on rainfall, tidal heights, evaporation and weir board adjustments (panhandle only). Tension zone soils in the lower portions will be tidally inundated and thus salinized, hopefully exceeding 10 ppt total salinity, sufficient to eliminate salt intolerant plant species and to slow (stress) the growth of salt tolerant plant species that had been outplanted in test polygons. The salinities of pond soils receiving

tidal waters will exceed 30 ppt during summer months, sufficient to completely inhibit salt tolerant plant species in test polygons. Tension zone soils in the upper (northwestern) portions of the Northern Seasonal Wetland will be less often inundated with tidal waters and continually leached by rainfall. Consequently, these will attain lower levels of total salinity (perhaps 5 ppt or less), but sufficient to stress or eliminate salt intolerant plant species in test polygons around ponds 1 and 2. After ten years the lower pond soils will attain and maintain a salinity of greater than 40 ppt and the upper tension zone soils will maintain concentrations around 5 ppt. See, Appendix C, Section C.2.2 for more discussion.

Vegetation succession: Due to differences in the physiological tolerance limits of plant species to inundation and soil salinity, establishment and growth will be either promoted or inhibited by the developing physical conditions of the seasonal wetlands (see Sections 7.2.2, Appendix B, and Appendix D for a full discussion). After five years the survival and growth of pickleweed and cattail (*Typha* sp.) will be inhibited in the lower and upper tension zones, respectively. After ten years the lower tension zone and ponds will remain unvegetated or sparsely vegetated by perennial plants (e.g. stressed pickleweed) and the upper tension zone will be vegetated with brackish marsh species (e.g. bulrush (*Bulboschoenus*), saltgrass).

Invasive plants: After five years the survival and growth of weeds will be inhibited across the site and major infestations (those covering more than 100 m^2) will be immediately eliminated. After ten years, weeds will be excluded from the ponds and both tension zones by inundation and high soil salinities.

Bird use: Shorebirds and Waders will utilize the seasonal pond (wet condition) and panne (dry condition) area, in abundance and density comparable with reference wetland site.

Vector control: There will be no significant mosquito nuisance (e.g. public health, nuisance to neighbors).

4.6.3 Transitional and Upland Performance Criteria

The transitional and upland restoration performance criteria for the HWRP and their rationale are defined below.

Vegetation: After five years, hydroseeded native grasses and forbs will be present, and at least 30% of the outplanted individuals of native shrubs and small trees of all species will have survived and shown signs of growth (i.e. elongated shoots, new branches and leaves). The species richness of native shrubs and trees will be greater than three. After ten years, native grasses, forbs, and shrubs will be reproducing in some areas and the species richness of native shrubs and trees will be greater than six. See Pavlik and McWhorter (2010) for details on the planting plan for the wildlife corridor.

Invasive plant species/weeds: After five years, all major infestations of woody, perennial weeds (those covering more than 100 m^2) will be eradicated on the levees and transitional areas (e.g.

wildlife corridor), and after ten years the eradication effort necessary to achieve this level of infestation will be significantly lower than in year five.

5 COMPLIANCE MONITORING AND ADAPTIVE MANAGEMENT REQUIREMENTS OF THE REGULATORY AGENCIES

Compliance monitoring focuses on proposed methods for hydrological, geomorphological, and biological monitoring of the tidal wetlands, seasonal wetlands and transitional wildlife corridor over the first 15 years after breaching, that satisfies the requirements of the U.S. Fish & Wildlife Service Biological Opinion (USFWS, 2005), the San Francisco Bay Conservation and Development Commission Consistency Determination (BCDC, 2005a, b), and the California Regional Water Quality Control Board San Francisco Bay Region Waste Discharge Requirements and Water Quality Certification (RWQCB, 2005). Overall it provides data for certifying the quality of the project between the AMWG and the regulatory agencies.

The specific purposes of the compliance monitoring plan are four-fold.

1. Determine whether the objectives of the project have been achieved by evaluating the restoration of wetland habitats in comparison to the physical and biological success criteria (Section 4.3).

2. Identify any problems impeding the establishment of healthy wetland habitats, determine if remedial or novel actions are necessary, and, if so, what type of actions might be appropriate.

3. Determine whether water quality conditions are detrimental to native fish, and whether modification of the restoration is required to avoid or reduce impacts on these species.

4. Document the development of the physical and biological characteristics of the restored wetland system to provide information for use in the design of future restoration projects.

Table 3 describes the monitoring parameters for the HWRP wetlands summarized from the requirements of three regulatory agencies (USFWS, BCDC, and RWQCB). Details of these requirements are discussed in Sections 5.1.1 to 5.1.3, and the USFWS, BCDC, and RWQCB documents are provided in Appendix F.

5.1.1 Requirements of the USFWS Biological Opinion

The U.S. Fish & Wildlife Service Biological Opinion (1-1-05-F-0068, dated July 2005) states that a monitoring and adaptive management plan shall be submitted by the USACE to the USFWS and a panel of independent wetland restoration experts, for review and approval. USFWS indicated that compliance monitoring should occur each year for the first five years and in years 10 and 15. According to the USFWS the key elements of the monitoring plan should be:

- Measuring the extent of tidal marsh habitat development to ensure that sufficient habitat is restored to replace the amount of tidal marsh habitat lost by the proposed action at a 2:1 ratio for lost habitat.

- Monitoring habitat parameters such as tidal range, tidal current, wind speed and direction, wave characteristics, suspended sediment concentrations, sediment rates and distribution, marsh elevations, mudflat elevations, extent and location of tidal marsh vegetation, composition and density of vegetation, characteristics of subtidal channel and marsh surface sediments, and San Pablo shoreline characteristics.

- Monitoring locations, including the interior and perimeter of the restored tidal wetlands, subtidal channels, and existing San Pablo marsh shoreline.

Monitoring reports should be submitted for each year in which compliance monitoring is conducted, and include the following information.

- Comparing predicted and measured restoration development and function.

- Analyzing monitoring data to identify possible reasons for differences between predicted and measured or observed conditions.

- Recommending remedial actions to be implemented if restoration does not proceed as designed.

The Biological Opinion also states that an adaptive management plan should be developed and implemented to address methyl mercury production and accumulation in the restoration areas. The plan should be developed in consultation with the USFWS and other regulatory agencies. Elements of the plan would include constituents to be monitored, monitoring protocols, duration and frequency of monitoring, and corrective actions to be undertaken to minimize any potential adverse effects of methyl mercury. Monitoring would be conducted for a minimum of ten years after the outboard levee is breached. This report is being developed by others and may be attached to this report as an appendix when complete.

The Biological Opinion also requires monitoring of restored wetland areas for infestation by non-native cordgrass, perennial pepperweed, and other invasive, non-native plant species. All infestations occurring within the wetlands would be controlled and removed to the extent feasible without substantially hindering or harming the establishment of native vegetation. A long-term monitoring plan would be developed and remain in effect until tidal marsh habitat is established. The plan would be subject to review and approval by the USFWS.

The Biological Opinion considered two species potentially occurring on site; California Clapper Rail and Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*). The USFWS found that the HWRP, as proposed, is not likely to jeopardize the continued existence of the two species considered. The determination was based on:

- The relatively limited amount of habitat for these species that would be permanently lost

- The relatively low number of California Clapper Rail that likely would be harassed, harmed, or killed

- The large amount of habitat that would be restored with successful implementation of the proposed action.

5.1.2 Requirements of the BCDC Consistency Determination

The San Francisco Bay Conservation and Development Commission (BCDC) Consistency Determination (CN 7-05, dated August 12, 2005) and Letter of Agreement for Consistency Determination (dated September 7, 2005) require that the USACE submit and receive approval of a marsh monitoring plan, encompassing a 15-year monitoring period. BCDC specify that at a minimum the compliance monitoring plan should include the following components:

- Erosion: a plan for monitoring the effects of the project on increasing erosion and scour within the existing fringe tidal salt marsh, mudflat and surrounding areas and for studying accretion and erosion within the restored area. In addition, the plan shall include provisions for monitoring erosion in areas within the site that have low level contaminants that will be managed in situ.

- Water quality: a water quality monitoring program shall incorporate the San Francisco Bay Regional Water Quality Control Board's Self Monitoring Plan and, at a minimum, monitor pH, salinity, dissolved oxygen, and temperature within the tidal marsh restoration area.

- Vegetation: provisions for monitoring vegetation establishment in the areas returned to tidal action. Vegetation monitoring shall include determining the amount of vegetation established at the restoration site using aerial photographs and ground truthing, identifying the plant species that have become established until it is determined that the site has achieved 5% cover of tidal marsh vegetation. These aerial photographs shall be included in the monitoring report. Once marsh vegetation has become established on 5% or more of the restored area, transects shall be conducted to provide more detailed information on vegetation cover, including species present, percentage of the site vegetated, approximate percentage representation of different plant species and a qualitative assessment of anticipated plant colonization in the near future (next five years).

- Bird surveys: provisions for monitoring the use of the site by bird species including bird surveys conducted four times a year, two at high tide and two at low tide for the first five years following the completion of restoration activities and then every other year for the remainder of the monitoring period.

- Fish surveys: provisions for monitoring the use of the site by fish species including fish surveys conducted annually in the spring time, at high tide, for the first five years following the completion of restoration activities and then every other year for the remainder of the monitoring period. The survey techniques shall be developed in consultation with NOAA Fisheries staff.

- Invasive plant species: Control of non-native cordgrass and perennial pepperweed shall be complete (essentially 0% absolute cover) in the vegetated area within the marsh and upland transition zones, consistent with current management practices for the regional Invasive Spartina Project. Other non-natives identified by the AMWG should be maintained in the acceptable range of 0-5% absolute cover in these same areas over the 15-year monitoring period. Major infestations (those covering more than 100 m^2) will be immediately eliminated using appropriate control measures.

- Reference area: the USACE shall identify a suitable reference area for both the tidal and the seasonal portions of the marsh, most likely China Camp and Rush Creek, respectively that shall be evaluated as part of the monitoring program and shall provide a reference for evaluating the progress of the restoration site. These reference areas bracket the project area to the south and north, respectively.

- Sedimentation: provisions for monitoring sedimentation in the restoration area using a sufficient number of sedimentation pins, and/or plates and staff gauges, as reviewed and approved by the Commission staff.

Monitoring reports describing the data collected pursuant to the approved restoration plan shall be submitted to BCDC biennially (every two years) beginning on December 1, two years following the breaching of the exterior levee. The USACE shall provide all relevant monitoring information and data from other studies conducted on the site including but not limited to those of the USACE (ERDC), the RWQCB, the California Department of Fish and Game (CDFG), NOAA Fisheries, and the USFWS.

Specific monitoring requirements with respect to methyl mercury, to be included in a methyl mercury monitoring plan approved by BCDC, are as follows:

- Provisions for formation of a Methyl Mercury Technical Advisory Committee (MTAC) that shall include representatives from BCDC, RWQCB, and methyl mercury experts such as U.S. Geological Survey (USGS) and the San Francisco Estuary Institute (SFEI).

- Provisions for implementing adaptive management techniques to remedy methyl mercury accumulation if and when such techniques have been developed. Approval or disapproval of the monitoring program shall be made by or on behalf of BCDC in consultation with the MTAC, in particular the RWQCB.

- Describe methods that will be employed to assess methyl mercury accumulation at the site, particularly in indicator species, the frequency and timing of sampling, and a schedule for reporting results of the monitoring annually.

- The USACE shall monitor methyl mercury accumulation in the tidal, panhandle and southern seasonal wetlands, immediately prior to breaching the levee, and annually on the site in accordance with an approved methyl mercury monitoring plan.

- The USACE shall submit results of methyl mercury monitoring on the site, to BCDC no less than sixty days before breaching the site. The results of the monitoring shall be reviewed by or on behalf of BCDC in consultation with the MTAC. If monitoring results indicate that methyl mercury accumulation in these ponds are at levels that could pose significant risks to bay wildlife and fish, then the exterior levee shall not be breached until such time that more information has been gathered and reasonable remediation measures have been formulated to remedy excessive methyl mercury concentrations in marshes.

- The USACE shall continue to make the project site available to researchers and scientists and continue to encourage methyl mercury research at the site. To this end, the USACE shall report to BCDC and the RWQCB annually, beginning December 31 of the year following breaching of the bayward levee, on the results of methyl mercury research at the site and any future research proposals or opportunities, and the status of funding for studies to help manage the methylation of mercury in the newly restored wetlands.

BCDC also specify that the USACE shall assemble a Technical Advisory Committee (TAC) composed of local and/or regional experts, and staff from BCDC, RWQCB, CDFG, and USFWS. In conjunction with the TAC, the USACE shall develop an adaptive management plan that addresses potential issues on site, such as, but not limited to, levee failure, intertidal berm elevations, tidal panne development, and the development of habitat on site. The TAC will share information regarding the status of the restoration and provide peer review of any adaptive management strategies that may be employed. The TAC shall be convened a minimum of once a year following the placement of dredged sediment on site, for the 15-year monitoring period. (For purposes of the HWRP, the TAC will be named the "Adaptive Management Working Group" or "AMWG". See Sections 3.1 for a full discussion of the AMWG.

BCDC also state that the USACE shall comply with the RWQCB's Order R2-2005-0034 (issued on July 20, 2005) and/or any future amendments to the Order, as well as the Self Monitoring Plan for the project, so that potential water quality impacts of the project are minimized (Section 5.1.3).

5.1.3 Requirements of the RWQCB Water Quality Certification

The California Regional Water Quality Control Board San Francisco Bay Region Waste Discharge Requirements and Water Quality Certification (Order No. R2-2005-0034, dated July 20, 2005) requires that the USACE submit a monitoring and adaptive management plan, acceptable to the Executive Officer, that provides a detailed description of procedures for monitoring and assessing, using specific performance criteria, the overall success of the wetland restoration at the HWRP site. The performance criteria should address the parameters listed below, including but not limited to, tidal marsh development, tidal channel formation, biological success (plant and animal colonization), use by special status species, and control of invasive species colonization.

- Marsh water/sediment quality

- Methyl mercury adaptive management plan: background and concerns posed by mercury and methyl mercury relative to restoration of the site, monitoring objectives and strategy, and specifics of monitoring plan
- Levee dimensions: visual walkover inspection twice annually (pre- and post-winter conditions), and annual field survey until design expectations are met
- Post construction fill elevation prior to breach
- Sediment deposition rates and patterns
- Channel geometry
- Tide elevations: determine tidal regime and prism
- Peninsula crest elevation
- Marsh development: physical parameters (hydrology, topography/bathymetry), and biological parameters (plant and animal life) annually for first five years, then every five years until design expectations are met. Locations include tidal wetland interior, tidal wetland perimeter, subtidal channels, and existing San Pablo Bay marsh shoreline
- Vegetation: annually for first five years, then every two years until established
- Bird use: periodic surveys
- Fish use: ongoing surveys
- Mammal use: periodic surveys
- Special status species use: periodic surveys
- Benthic macroinvertebrates: additional surveys later if site deficiencies arise
- Seasonal wetland/upland vegetation: field surveys
- Invasive species monitoring: non-native plant assessment by qualified botanist
- Exterior tidal channels: monitor geometry periodically
- Internal channel development: map from aerial photographs and transects.

Annual reports detailing the progress of the HWRP will be sent to the RWQCB and presented annually to agencies and interested parties in a forum such as the Wetland Monitoring Group under the San Francisco Wetland Restoration Program, or some other forum for input and feedback on the project's progress and adaptive management strategies.

5.2 Compliance not covered in this document

Some of the regulatory requirements will be met by processes outside this Monitoring and Adaptive Management Plant. The RWQCB permit and BCDC Consistency Determination require regular visual inspection of the levees and maintenance as needed. The USACE will prepare an Operations and Maintenance Manual for the HWRP which will include the required levee inspection and maintenance. Public access monitoring, required by BCDC, is being conducted separately. Also, the project will coordinate with the Coastal Conservancy's Invasive Spartina Project for monitoring and management of invasive *Spartina* and with a separate regional effort for mercury monitoring[3].

[3] As of 3/6/13 the scope of regional mercury monitoring is under development by USACE, BCDC, SCC and RWQB.

6 MONITORING PLAN FOR TIDAL WETLANDS

Monitoring of the tidal wetlands consists of:

- Hydrological: tidal regime and wind climates.
- Water and sediment quality.
- Geomorphological: sedimentation, site elevation, channel development, and the subsidence of berms.
- Biological: including vegetation, invasive plants, fish, birds, and special status species.

This section describes monitoring methods, locations, frequency and durations, also summarized in Table 4.
The monitoring program will be 15 years in length, recognizing that site evolution will continue beyond this time line. Note that some of the monitoring parameters (e.g., tidal currents and wave climate) will be conducted only if required to inform adaptive management. These parameters would be conducted if the AMWG needed additional information to select appropriate corrective management actions. These parameters are described here for completeness in tracking all compliance monitoring parameters.

6.1 Hydrological Monitoring

6.1.1 Tidal Water Levels

Measurements of tidal water levels within the HWRP will be made to assess if the site is receiving the full range of tidal action. If tides are unimpeded, then the tide stage and tide range will be nearly identical inside and outside the site. If tides are constricted, then the tide heights inside the site will provide a simple indicator of this problem. Measurement of the tidal regime is a condition of the USFWS and RWQCB monitoring plan recommendations (Table 3 and Section 5).

Recording tide gauges will be installed at three locations (Figure 9). Gauge 1 will be located at the existing station at the Petaluma Railroad Bridge. Since it is close to the HWRP, this location will essentially capture the tidal signal in San Pablo Bay. Gauge 2 will be located just inside the levee breach. This gauge will capture the tidal signal at the downstream end of the main tidal slough system in the restored tidal area. Gauge 3 will be located near the furthest point from the breach within the site. This gauge will capture the tidal signal reaching the areas of the tidal system that are most distant from the tidal source. The exact location of gauges will be determined in the field, with considerations given to access for downloading and protection from vandalism.

Measurements of tide elevations will be recorded over a complete two-week spring tide cycle using automated recorders with a sampling frequency of ten minutes. To achieve geodetic compatibility between all data sets, the water level sensors will be tied to a common local benchmark through an elevation survey. Tide data will be collected at six month intervals until it is certain that full tidal action has been restored.

6.1.2 Tidal Currents

Monitoring of tidal currents is not necessary to confirm restoration trajectories but may be implemented to test adaptive management questions. This monitoring can be deployed to provide data on tidal flow velocity and bed shear stress and at different parts of the site. The timing of the monitoring should typically be undertaken over both spring and neap tides, and possibly strategically to capture infrequent high energy events such as storms and surges.

The types of current meter to be used, number of current meters, and their exact locations will be determined by the AMWG in the context of information required to answer targeted scientific questions.

6.1.3 Wind Speed and Direction

Monitoring wind speed and direction are necessary to satisfy the requirements of the USFWS Biological Opinion (Table 3 and Section 5). Monitoring will rely on existing data that has been collected in San Pablo Bay. Marker 11 in San Pablo Bay has historical hourly wind speeds recorded since 1995, and would appear to be the most useful and relevant dataset to monitor winds at the HWRP.

6.1.4 Wave Characteristics

Monitoring of wave characteristics is not necessary to confirm that the tidal wetlands areas is evolving towards restoration targets but may deployed to test adaptive management questions. Failure of the site to accrete towards or maintain marsh plain elevations would be an indication that additional information is required to support adaptive management. Measurements of wave characteristics can provide information on the effectiveness of the berms in damping wave heights, and the relationship of wave energy to any erosion that may be taking place across the restoration site.

The types of recorder to be used and their exact locations will be determined after a post-breach visual observation of the wave climate inside and outside the site has been carried out. The recorders will then be placed in the most appropriate positions to best understand the effects of the berms.

Notes:

1. Low level DDT refers to concentrations 24 to 1000 ppb.
2. Horizontal control is in California State Plane coordinate system NAD 83, Zone 3, in feet.
3. Vertical control is in NAVD 88.

Legend:

- Photo Doc Point (multiple directions per point)
- TideGages
- SETlocations
- Transects
- Channel Thalweg Profile
- Residual DDT
- Low Level DDT (under min. 3 ft cover)

figure 9

Hamilton Wetland Restoration MAMP

Monitoring Locations

ESA PWA

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6.2 Water and Sediment Quality

6.2.1 Water/Sediment Quality

During the construction phase, decant discharge water from the site is being monitored continuously for total suspended sediment. Water and sediment samples are periodically analyzed for pH, salinity, dissolved oxygen, and temperature, trace elements (arsenic, and metals including cadmium, copper, mercury, nickel, and zinc), polycyclic aromatic hydrocarbons (PAHs), PCBs, DDT, pesticides, and hexachlorocyclohexane. Post-breach, a single set of confirmatory water samples will be collected and analyzed for pH, salinity, dissolved oxygen and temperature.

6.2.2 Methyl Mercury

Methyl mercury is a contaminant specifically targeted for monitoring in both the BCDC and RWQCB monitoring plan recommendations. The BCDC recommendation stipulates that the USACE submit pre-breach monitoring results of this contaminant no less than sixty days before breaching the site. If BCDC establish that methyl mercury accumulation is high enough to pose significant risks to bay wildlife and fish, then the outboard levee will not be breached until remediation measures have been implemented to lower concentrations to safe levels. Monitoring of methyl mercury is not detailed in this report and is the subject of consideration under programmatic bay wide activities (http://www.sfei.org/rmp/). See Appendix G for additional detail.

6.3 Geomorphological Monitoring

Geomorphological monitoring is designed to understand how the form of the tidal wetland and creek channels are evolving in response to the physical processes of sedimentation and erosion at the site.

6.3.1 Tidal Wetland Development – Planform

All three agency monitoring plan recommendations necessitate monitoring of the planform development of the site, with respect to sediment and habitat distribution (Table 3 and Section 5). Aerial photographs will be taken of the site at a scale that can distinguish the development of the channel networks, and the distribution of marsh and mudflat areas. During every other monitoring year for ten years after breach, and then at year 15, new aerial photographs will be taken and changes in wetland layout will be compared to the previous aerial photographs. Free satellite photos will also be used when possible. Newly-formed channels and significant changes to the channel layout will be noted in each monitoring year. Photographs will be taken in the late summer and during a tide no greater than +2.0 feet MLLW so that channels are clearly visible and marsh/mudflat areas can be viewed. Mapping will be performed at a minimum scale of 1:2400. The images will be obtained in a digital rectified format to allow use in a GIS system.

Aerial photographs taken to evaluate channel development and marsh/mudflat layout will also support the external tidal channel/fringing marsh erosion and scour monitoring tasks (Sections 6.3.8 and 6.3.9), and biological monitoring (Section 6.4).

At years 1, 5, 10 and 15, photogrammetry or LIDAR (of sufficient accuracy) will be used to establish contours the surface of the site and provide a spatial baseline for site development, habitat evolution and of settlement of site features.

6.3.2 Tidal Wetland Development – Cross-Sectional

All three agency monitoring plan recommendations require measurement of accretion and erosion across the site in order to assess development towards marsh plain elevations (Table 3 and Section 5). The cross-sectional geometry of the marsh, mudflat, and channel system will be monitored using ground-surveyed transects and augmented with less frequent photogrammetry (described above). Transects (up to twelve, Figure 9) will be at key locations across slough channels and marsh/mudflat areas. Longitudinal profiles will be collected along the thalweg of the main channel and along branches of this channel in to the interior of the site. All transects will be surveyed following construction to provide baseline data on the fill elevation prior to tidal inundation. Transect starting and ending points will be permanently marked in the field to facilitate reoccupation in subsequent monitoring years.

Marsh transects will provide information on changes in slough channel dimensions, marsh/mudflat elevations, elevations of levees, berm and transitional upland areas. Transect data will indicate whether or not marsh/mudflat areas are receiving sedimentation at the expected rates. Transects will be surveyed in conjunction with the vegetation monitoring (Section Vegetation Succession 6.4.2). Access within the site is expected to be difficult initially due to the soft ground surface and the need to minimize disturbance to the site. Transect elevations will be surveyed during high tides by boat using GPS until it is possible to accomplish the surveys on foot. Transects will be resurveyed annually for the first five years, and then once every two years until design expectations are met.

6.3.3 Sediment Accretion/Erosion and Compaction

Sediment elevation tables (SETs) (up to six, Figure 9) will be installed within the tidal site to assess surface sediment elevations. For comparison, sedimentation plates will be installed at the same locations as the SETs. The use of sediment pins was specified in the BCDC Consistency Determination, and sedimentation monitoring was also a condition of the USFWS and RWQCB documents (Table 3 and Section 5).

The use of SETs in combination with plates will allow for a determination of shallow compaction. If no compaction is occurring at the site, then accretion rates measured by the plates will equal changes in elevation measured by the SETs. When compaction occurs it will serve to reduce elevation, and compaction is calculated as sediment accretion minus the change in elevation. These monitoring data will be invaluable to assess the compaction history of the fill post-breach.

The locations of the SETs and plates will be selected to provide a distribution of sedimentation data across the site (Figure 9). Data will be collected from the SETs and plates every three months for the first five years after breach. Readings will be taken every other year for five more years or until there is no significant year to year change in sediment surface elevations and/or compaction.

6.3.4 Suspended Sediment Concentrations

Monitoring of suspended sediment is not necessary to confirm tidal connection of the site but may be implemented to test adaptive management questions. Suspended sediment concentrations may be measured using turbidity meters at stations on a transect across the main channel and the mudflat/marsh on either side (Figure 9). The spatial variability of suspended sediment may be analyzed in conjunction with pressure gages to quantify the role of waves in defining mudflat elevation change.

6.3.5 Surface Sediment Characteristics

The USFWS Biological Opinion recommends monitoring of surface sediment characteristics (Table 3 and Section 5). Sediment composition across the subtidal channel, mudflats, and marshes of the restoration site will be evaluated by a campaign of surface sampling followed by laboratory analysis. The monitoring will start with a qualitative assessment of the sediments at the surface to establish general patterns of particle size and sediment composition. Sample locations can then be selected based on these observations to reflect sediment variability across the site. Particle size and other textural parameters such as sorting, and organic content, will be measured and maps of the temporal and spatial variability constructed. Depending on the visual assessment of sediment distribution, it may be possible to combine the sediment quality and sediment characteristics monitoring.

6.3.6 Intertidal Berm Elevations

The RWQCB monitoring plan requires tracking of intertidal berm crest elevations to confirm settlement to 6.1 ft NAVD by year 10 of the project (Table 3 and Section 5). The berms will be graded to this elevation prior to breaching. A confirmatory survey will be provided by the construction contractor. A follow up survey will be provided in years 5 and 10 to track subsidence.

6.3.7 Levee Breach and Outboard Tidal Channel

Measurements of the geometry of the outboard tidal channel will be conducted following breach in order to determine if the channel is providing unrestricted tidal exchange with the site. Several cross sections will be monumented appropriately across the excavated channel immediately after construction. As the channel widens and extends across the mudflat, additional cross-section stations and a thalweg profile will be added (Figure 9). The surveys will continue until there is no significant increase in the channel dimensions and full tidal action has been attained. The ground

surveys will be supported by analysis of aerial photographs. Monitoring of the geometry of the exterior tidal channel is part of the RWQCB regulatory conditions (Table 3 and Section 5).

6.3.8 Fringing Marsh Scour in San Pablo Bay Adjacent to Site

All three agency monitoring plan recommendations require an assessment of the impact of the restoration on the adjacent San Pablo Bay shoreline (Table 3 and Section 5). Following introduction of tidal action to the HWRP, there may be an increase in tidal current velocities locally which could result in scour of the fringing marshes and mudflats adjacent to the site. The extent of any scour will be monitored using a combination of aerial photograph comparison, and a couple of shore-normal transects, as the AMWG requires. Areas covered will include the fringing marsh seaward of the site and to its immediate north and south. This monitoring will investigate the spatial changes in fringing marsh area and change in the position of the fringing marsh-mudflat boundary. Marsh loss (or gain) will be calculated using the relative acreage change in the marsh between aerial photograph years.

6.3.9 Photo-Documentation

Ten permanent photo-documentation stations will be established at the locations shown in Figure 9. Photographs taken during monitoring years at these locations will provide further evidence for the rate of evolution of the marsh and mudflat areas.

6.4 Biological Monitoring

6.4.1 Reference Area

For the bird use and fish use biological monitoring parameters, a suitable reference area is required as a basis for evaluating the progress of the HWRP tidal wetland. For avian tidal flats specialists, the San Pablo Bayshore results from the Pacific Flyway Shorebird Survey (archived in the California Avian Data Center <http://data.prbo.org/cadc2/>) will provide reference. For avian tidal marsh specialists, densities of species in adjacent habitat of the outboard marshes should be used for reference. For fish, monitoring of the marshes / mudflats at and around China Camp Marsh will be used to guide the vision for long term restoration of the HWRP tidal marshes.

6.4.2 Vegetation Succession

All three agency documents recommend monitoring of native vegetation establishment, composition, and cover (Table 3 and Section 5). Following the BCDC Consistency Determination, vegetation monitoring will be carried out in two phases. Phase 1 will monitor the extent of vegetation in the HWRP tidal wetlands, transitions, and upland using aerial photographs with limited ground truthing. The total area of developing vegetation cover will be determined starting the second summer after breach or after initial establishment of marsh vegetation

(determined by on-site visual inspection). A map of the colonizing and expanding patches will be produced from the analysis of the aerial images.

False color infra-red photography may be used to aid in the identification of plant species that have become established. Photographs will be taken in the late summer to show the maximum extent of vegetation and to allow inter-annual comparison. Photographs will be taken during a tide no greater than +2.0 feet MLLW so that vegetated patches are clearly visible. Mapping will be performed at a minimum scale of 1:2400. The images will be obtained in a digital rectified format to allow use in a GIS system. Phase 1 will continue until it is determined that the site has achieved 5% cover of tidal marsh vegetation across the restoration site.

Phase 2 will begin once marsh vegetation has become established on 5% or more of the restoration site. At this time, vegetation transects will be conducted to provide more detailed information on the following:

- distribution of vegetation cover
- percentage of the site vegetated (absolute cover)
- approximate percentage representation of different plant species (relative cover) in representative locations
- canopy height
- qualitative assessment of anticipated plant colonization in the near future (next five years).

Vegetation transects will be conducted once every year in late summer for the first five years (beginning after the 5% threshold has been reached), and then once every two years for the remainder of the monitoring period.

6.4.3 Invasive Plants

The BCDC and RWQCB monitoring plan recommendations require monitoring of invasive plant species (Table 3 and Section 5). Monitoring for non-native plant species over the 15 year monitoring period will form part of the vegetation surveys and interpretation of aerial photographs described in Section 6.4.2. Major infestations (more than 100 m^2) will be immediately eradicated once detected. The USACE will completely control non-native cordgrass and perennial pepperweed (essentially 0% absolute cover) in the vegetated areas within the tidal and seasonal wetlands, the transition, and upland zones. Other non-natives identified by the AMWG should be maintained in the acceptable range of 0-5% absolute cover in these same areas over the 15-year monitoring period. The USACE will coordinate with the *San Francisco Estuary Invasive Spartina Project* to monitor and control introduced and invasive cordgrass. Perennial pepperweed is an aggressive weed species and has a high potential to invade the site. This species will be closely monitored and continuous maintenance will be performed and anticipated so that it does not form a monoculture across the site.

The BCDC conditions also include provision of a Control Plan for invasive plants in order to reduce competition for natives allowing them to establish more successfully (Appendix H).

6.4.4 Bird Use

BCDC and RWQCB require monitoring of bird use of the tidal wetlands, and comparison with the recommended reference area at China Camp (Table 4 and Section 5). Relatively frequent bird surveys are needed because bird activity changes throughout the year due to seasonal migration and breeding patterns. Comparisons of bird use between the HWRP and a reference area should recognize differences in the age and development of these sites and emphasize achievement of the correct trajectory by the latter. It is therefore recommended that the site be compared against a network of regional reference monitoring sites.

Bird surveys will be conducted every year for the first five years following the completion of restoration activities (i.e. breach of the outer levee) and then every other year for the remainder of the monitoring period. Surveys will be performed during the following periods; March 1 to August 15 (8 surveys), August 16 to October 31 (4 surveys) and November 1 to February 28 (6 surveys). This schedule provides a fairly even distribution of surveys throughout the year, with a slight concentration during the fall migratory period and a slight decrease during the summer breeding season. Site visits for counting birds will be timed to coincide with peak use by avian species. An absolute count of birds using the site will be conducted over a 90 minute period during a rising tide when mudflats are available to foraging shorebirds. The species richness, population density, and activity (e.g. feeding, loafing), for shorebirds (e.g. avocets, stilts, and terns), waterfowl, and other migratory birds will be calculated for the HWRP site. These monitoring data will be compared to data from a regional dataset of reference sites.

6.4.5 Fish Use

BCDC and RWQCB require monitoring of fish species and abundance across the restoration site, and comparison with the recommended reference area at China Camp (Table 3 and Section 5). Following breach and establishment of full tidal action, fish species assemblages will be surveyed annually in the spring at high tide. Sampling will be carried out each year for the first five years of the restoration and then every other year for the remainder of the monitoring period.

Although the survey techniques will be developed in consultation with NOAA Fisheries staff, it is anticipated that multiple sampling will assess the distribution and relative abundance of juvenile and adult fish species in the restored marshes, mudflats, and associated unvegetated shallow water areas. 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. Replicate samples will be collected until no new species are captured. If necessary, single individuals of non-salmonids may be retained as voucher specimens for subsequent identification. No listed species will be collected.

6.4.6 Mammal Use

Additional monitoring of mammal use is recommended if a lack of bird use becomes a cause for concern to the AMWG. Numerous methods have been developed for monitoring wetland mammal communities, which generally rely on various types of traps. At two monitoring

locations in the HWRP site, up to 20 Sherman traps will be deployed for five weeks in square grids or along transects to capture mammals. Four rounds of sampling will be conducted each year in late spring, and early, mid-, and late summer. Traps will be set and checked every day. All animals captured will be identified to species, weighed, measured, sexed, aged, marked with a PIT (passive integrated transponder) tag, and then released at point of capture. Traps will be shaded, and/or filled with sufficient moist plant litter to minimize physiologic stress to animals.

6.4.7 Special Status Species Use

The RWQCB monitoring plan recommendations require monitoring of special status species use of the tidal wetland (Table 3 and Section 5). A baseline survey for special status species will be performed just prior to breaching the levee. Beginning five years after tidal action is initiated, suitable and potential habitat for California Clapper Rail and Salt Marsh Harvest Mouse will be delineated on vegetation cover maps every second year to determine the presence and distribution of these species. Live trapping surveys for salt marsh harvest mice and vocal surveys for clapper rails will be conducted as appropriate, based on habitat conditions at the time of each survey. The USACE will coordinate the initiation and protocols for the surveys with the USFWS. Both species populations will meet the recovery plan goals for their respective habitats.

Habitat considerations for Salt Marsh Harvest Mouse include:

- Dense and extensive cover by native plants, especially pickleweed
- Moderate to highly saline environments
- An abundance of pickleweed and saltgrass; will not use areas dominated by bulrush, rush (*Juncus* sp.) or cattails
- Minimal areas that are open and unvegetated, such as unvegetated dikes or roads, that inhibit movement
- Old, abandoned bird nests for use as their own nests

Habitat considerations for California Clapper Rail include:

- Salt and brackish marshes in both the upper and lower marsh zones
- An abundance of pickleweed, with saltgrass, alkali seaheath, and jaumea in the upper marsh zone, creating dense, continuous cover
- Stands of Pacific cordgrass in the lower marsh zone, but interspersed with low cover, open mudflats and an intricate network of tidal channels with overhanging banks

6.4.8 Benthic Macroinvertebrates

Monitoring of benthic macroinvertebrates is not necessary to confirm tidal connection of the site but may be implemented to test adaptive management questions if bird populations are lower than expected.

Benthic invertebrates are typically sampled at random stations across the wetland areas. Replicate cores to a depth of 20 cm may be collected at each station. The cores are sieved in the field and all obvious animals identified, counted and released. Less obvious species may be

preserved and then identified and counted in the laboratory. The number of individuals per unit area sampled can be calculated for comparison with past and subsequent results. Benthic invertebrates are commonly sampled twice a year, in March and September. Studies have shown that invertebrate populations evolve over time (5 years or more) depending upon species mechanism for dispersal (Atkinson and others, 2004).

7 MONITORING PLAN FOR SEASONAL WETLANDS

Monitoring of the seasonal wetlands consists of:

- Hydrological: pond hydrology, water and soil salinity.
- Biological: including vegetation and birds.

This section describes monitoring methods, locations, frequency, and durations for the seasonal wetlands, also summarized in Table 4. The monitoring program will be 15 years in length, recognizing that site evolution will continue beyond this time line.

7.1 Hydrological Monitoring

The monitoring plan for seasonal wetlands is designed to test a number of management actions that will influence the storage of water and salt within the restoration site. If management actions, such as lowering weir board elevations in the northern (panhandle) seasonal wetlands, allow more flooding by bay waters, then inundation and salinization of the ponds will increase. Prolonged inundation and high soil salinity will inhibit colonization and growth of perennial, salt-tolerant vascular plants (e.g. pickleweed) and keep ponds open and unvegetated. Such conditions will provide essential habitat elements with high value to target species, such as shorebirds. Conversely, if vegetated habitat is required, actions resulting in less water and salt storage will be taken. The monitoring is designed to test whether adjustments to the salinity and inundation regimes will produce the required habitat composition, structure, and function. Monitoring of the seasonal wetlands will integrate hydrology, with biology and avian data to guide their restoration and adaptive management actions.

The hydrological monitoring of the panhandle will comprise three replicate pond stations for measuring inundation (e.g. water depth, hydroperiod) and six replicate pond stations for measuring water and soil salinity (Figure 6).

7.1.1 Pond Hydrology

Water level gauges will be placed in Ponds 1 (relatively higher elevation), 2, and 6 (relatively lower elevation) of the panhandle (Figure 9) to record water level fluctuations on each of three elevation terraces under conditions of varying tidal inundation frequency. Data analysis will focus on water level elevations, flooding duration and depth, and rates of seepage into the soils. Gauges will be in operation over the seasonal duration of ponding.

7.1.2 Water and Soil Salinity

Salinity in pond water (when present) and soil waters will be measured using a hand-held salinity refractometer. At each location a small pit (6-12 inches in depth) will be excavated above pond water levels and allowed to fill with soil seepage water. Any accumulated water will be tested in the field for salinity. Sampling will occur at a minimum frequency of at least seasonal intervals.

7.2 Biological Monitoring

7.2.1 Reference Area

A suitable reference area is required for evaluating the development of the HWRP seasonal wetlands, especially when evaluating vegetation structure and bird use. This monitoring plan recommends using Rush Creek as a reference area for seasonal wetlands. Rush Creek is a managed seasonal wetland with muted tidal cycles. It possesses a pronounced gradient of desirable habitat elements, including inundated, ponded areas, exposed pannes, a broad, open transition zone of stressed pickleweed, and surrounding pickleweed vegetation. Data collected for this project, Jan – Dec 2006 (unpublished), describes physical and vegetation components, as well as a year-long study of bird use at Rush Creek.

7.2.2 Vegetation Succession

The vegetation monitoring of the panhandle seasonal wetlands will use 220 “test polygons” that will be outplanted with container-grown individuals of acceptable plant species (“test founders”). In this first phase of the program, test polygons will be located in areas of the wetland that require control over vegetation development (primary succession). Test founders will be used as management indicators for controlling succession in the developing seasonal wetlands of the panhandle. This experimental approach will test the hypothesis that species composition and growth can be controlled by adjustments to water and salt storage in the wetland (e.g. weir board adjustment). If reasonable control over succession in test polygons is established, hydrologic management will be subsequently applied to both the panhandle and the southern seasonal wetlands with implementation monitoring. During this second phase, “restoration polygons” will bring container-grown founders of acceptable plant species (“restoration founders”) into the wetlands in appropriate habitat zones to facilitate vegetation development. The same hydrologic management will also be used to control weeds in the seasonal wetland. Details of this validation monitoring program are presented in Appendix C.

Eventually, the total area of developing vegetation cover will be determined from aerial photography. A map of the colonizing and expanding patches will be produced from the analysis of aerial images. The measured parameters are directly related to suggested success criteria (Section 4.6.2) that allow the evaluation of management actions, the development trajectories of essential habitat elements and the final assessment of project objectives.

7.2.3 Photo-Documentation

Six permanent photo-documentation stations will be established at the locations shown in Figure 9. Photographs taken during monitoring years at these locations will provide further evidence for the rate of evolution of the vegetation succession.

7.2.4 Invasive Plants

As in the tidal wetlands (see Section 6.4.3), monitoring for non-native plant species will be conducted during the 15 year monitoring period for seasonal wetlands. Monitoring of invasives will be included in the vegetation surveys (Section 7.2.2) and in interpretation of the aerial photographs described in Section 6.4.2.

7.2.5 Bird Use

The monitoring strategy for bird use of seasonal wetlands is the same as that for the tidal wetlands (Section 6.4.4); the two monitoring programs will run simultaneously. Comparisons of bird use between Rush Creek and the HWRP should recognize differences in the age and development of these sites and emphasize achievement of the correct trajectory by the latter.

7.2.6 Vector Control

Monitoring of mosquito populations is not a stated requirement of the regulatory agency recommendations, but may be implemented if a mosquito nuisance develops. Approximately three mosquito traps will be set across the tidal wetlands once each week, beginning the first week of June until the end of September, to identify the presence or absence of mosquitoes. Two types of trap will be used (CDC gravid traps and CDC light traps baited with CO_2), and at each trap location they will be paired together (within several meters of each other). CDC gravid traps collect egg-bearing mosquito species of concern found near water with a high organic content (i.e. polluted water), and CDC light traps, which collect host-seeking adult female mosquitoes of all species.

Trap catches will be sorted by species, and the number of *Culex* spp. and other mosquito species will be counted. The data will be used to calculate the number of acres of breeding mosquitoes, and the number of larvae per sampling "dip" in potential breeding habitat.

8 MONITORING PLAN FOR TRANSITIONAL AND UPLAND HABITATS

Monitoring of the transitional and upland habitats consists of biological monitoring of vegetation. This section describes monitoring methods, locations, frequency, and durations, also summarized in Table 4. The monitoring program will be 15 years in length, recognizing that site evolution will continue beyond this time line.

8.1 Biological Monitoring

8.1.1 Vegetation Succession

As discussed for the tidal wetlands, aerial photography with limited groundtruthing will be used to monitor the extent of vegetation in the HWRP transitional and upland habitats. A map of the colonizing and expanding patches will be produced from the analysis of the aerial images. See Section 6.4.2 for more detail.

8.1.2 Photo-Documentation

The sixteen permanent photo-documentation stations established in the tidal and seasonal wetlands (Figure 9) will be used also to photograph the transitional and upland habitats. Photographs will provide further evidence for the rate of evolution of the vegetation succession.

8.1.3 Invasive Plants

As in the tidal and seasonal wetlands (see Section 6.4.3), monitoring for non-native plant species will be conducted. Monitoring of invasive plants will be completed during regular inspections by the Site Manager and included in the interpretation of the aerial photographs described in Section 6.4.2.

9 REGULAR ASSESSMENTS

The HWRP will complete regular assessments to evaluate project performance. The assessments will compare monitoring results with performance criteria and management triggers (management trigger are described in Section 10) to determine whether any adjustments to the project are needed. The TAG will be the primary group responsible for these assessments and will communicate the results of the assessments to the AMWG for decision making. This section defines the assessment process, the frequency and timing of assessments, and assessment documentation.

9.1 Assessment Process

The assessment process consists of comparing the results of monitoring and ongoing inspections by the Site Manager to management "triggers", described further in the next subsection, that indicate how well the project is progressing toward the restoration objectives and whether any adaptive management action(s) need to be taken. Table 5 summarizes the linkages between the project objectives (from Section 4.1), monitoring parameters (from Sections 6-8) used to assess change with respect to the objective, and management triggers. Though performance criteria are not shown in Table 5, each management trigger corresponds to a performance criterion (Section 4.6).

Each trigger would be assessed regularly by analyzing the monitoring data. Each management trigger has a corresponding list of potential actions the AMWG may take if a trigger is reached (discussed in Section 10). The TAG will identify methods for comparing the restoration performance criteria/ triggers with monitoring data. These methods will include appropriate statistical comparisons (e.g. hypothesis testing, ANOVA, multivariate methods), as needed for assessment. The results of these assessments will be documented and stored in the monitoring database.

9.2 Management Triggers

A management trigger is a threshold that, when reached, indicates that the HWRP may not be performing well. Each performance criterion has a corresponding management trigger for action. 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. Like the performance criteria, the triggers will be reviewed and updated regularly as additional information becomes available.

Table 5 identifies the management trigger for each monitoring parameter, organized by project objective. Where appropriate, some of the rows in Table 5 list multiple management triggers. For example, the monitoring for special status species has management triggers for tidal wetland habitat development, salt marsh harvest mouse occupied area and capture efficiencies, and clapper rail populations. Table 6 provides an indication of the potential percentage cover of plants across the site as the project matures. This table provides a guide when considering management triggers.

9.3 Frequency of Assessments

Table 4 provides a summary of the monitoring activities planned for the HWRP site, the timing of each monitoring activity, and the years each monitoring activity is expected to occur. The monitoring schedule in Table 4 is consistent with the frequencies specified by the regulatory agencies in the permits. The temporal scales of the system responses were one of the main considerations in determining frequency and timing of monitoring. For example, inspections for fringing marsh erosion should be conducted annually at first, then every other year after year 5. In this case the frequency of monitoring will be greatest at the beginning when the fringing marsh is most likely to be changing due to the construction of the project. It should also be noted that the monitoring schedule described is adaptable based upon review by the AMWG.

The TAG and the AMWG will meet every year to discuss monitoring and research findings, compare these finding with management triggers, and discuss implications for adaptive management. Assessments may be more frequent, depending on the relevant physical or ecological scale of each restoration target.

9.4 Documentation and Reporting

The USFWS and RWQCB recommendations for the monitoring plan require submittal of a monitoring report for each year in which monitoring is conducted. The BCDC Consistency Determination indicates a report should be submitted every two years. In order to satisfy all three agency requirements, two forms of reporting are recommended to communicate monitoring data over the course of the monitoring period; comprehensive monitoring report and brief monitoring memorandum.

The USACE will store relevant HWRP monitoring and adaptive management documentation, including monitoring reports, monitoring memoranda, and other documentation (decisions, agendas, any meeting minutes). The USACE will also store relevant monitoring information and data from other studies conducted on the site including, but not limited to, those of the USACE (ERDC), the RWQCB, the California Department of Fish and Wildlife, NOAA Fisheries, and the USFWS. The USACE will provide this information and data to stakeholder agencies and the public, as requested.

9.4.1 Comprehensive Monitoring Reports

A comprehensive monitoring report will provide details of the monitoring methods, report all monitoring data collected (including water-level data, survey transects, sedimentation data, biological data, and aerial photographs) and provide discussion of the implications of monitoring data for site evolution, and comparison to the success criteria. The reports will include summaries of biological monitoring including species diversity and cover estimates, observations, and data summaries regarding the health and vigor of vegetation and plant survival. The monitoring reports will also detail the eradication efforts conducted on the site for invasive plant species, such as non-native cordgrass and perennial pepperweed, as well as any efforts to control other invasive plant species on site. The results of the wildlife monitoring will also be summarized. The monitoring reports will also include an executive summary which summarizes all of the relevant data, discusses any problems meeting performance criteria, and summarizes any changes or recommendations for adaptive management of the site.

9.4.2 Brief Monitoring Memorandum

The second form of reporting will be a monitoring memorandum, where discussion of monitoring methods will be brief, and the general results of monitoring will be summarized. The monitoring data will not be reported in full. If necessary, remedial actions indicated by monitoring data will be highlighted and a schedule for action will be identified.

9.4.3 Monitoring Data

The USACE will store and archive the HWRP 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. Monitoring data sets will be available upon request.

9.4.4 Reporting Schedule

Comprehensive monitoring reports will be submitted to the relevant regulatory agencies every two years beginning on December 31st of the year following the breaching of the levee. To satisfy the RWQCB requirements these comprehensive reports will also be presented to the agencies and interested parties at a selected forum where input and feedback on the restoration's progress and adaptive management strategies can be aired.

Monitoring memorandums will be submitted to the relevant regulatory agencies every two years beginning on December 31st, two years following the breaching of the exterior levee. The memorandums will be provided on the years in between the comprehensive monitoring reports.

10 DECISION-MAKING AND ADAPTIVE MANAGEMENT ACTIONS

This section describes the decision-making process for implementing any management actions required to keep the project on track. The decision-making process goes into effect if the assessment process (described in Section 9) finds that a management trigger has been reached, indicating that the system is not performing well. If the AMWG decides that small management actions need to happen, they would implement those immediately. If a larger change to the project approach or a substantial action is necessary, the AMWG may conduct additional studies and would vet this change or action through the Executive Committee, outside scientists, or the public, as needed, depending on the scale and type of issue.

Figure 2 shows a flow diagram for adaptive management decision-making. If a management trigger is reached (top right of figure; see Section 9), this prompts AMWG review for possible management action. When the cause for tripping a management trigger and the appropriate corrective management actions are clear, then the AMWG would implement the management actions. When the cause for tripping a management trigger or the appropriate response is not readily apparent, then studies and/or monitoring would be conducted to better understand what caused the system to respond differently than predicted. These studies and/or monitoring are referred to here as applied studies. Once adaptive management actions are implemented, subsequent monitoring will be used to evaluate the effectiveness of these actions.

Table 5 presents the applied studies and potential management actions for the full set of HWRP performance criteria. The applied studies and potential management actions are identified by project objective for each monitoring parameter and management trigger. Also provided in the table is the expected time frame for decision making. This is the time period within which the monitored parameter is expected to indicate whether performance criteria are being achieved and the time period within which the management trigger should be addressed.

10.1 Applied Studies

As noted above, applied studies are used to support decision-making when the cause for tripping a management trigger or the appropriate response is not immediately apparent. Applied studies test cause and effect relationships. They may collect and analyze available data, or include collection of new field data. These assessments typically involve convening an assessment team of experts to advise the AMWG on how to proceed.

Applies studies may be conducted, for example, to determine the cause if rates of sediment accretion are slower than expected (row four of Table 5). In this example, the cause may be regional decrease in sediment supply, excessive wave energy limiting deposition, or unexpectedly rapid settlement of the underlying soils – each of which may point to a different management action. In this example, applied studies may also be used to assess the biological significance of slow sediment accretion. Slow deposition and tidal marsh development (with more mudflat) may or may not be a concern in the context of regional habitat availability and biological community use.

The applied studies listed in Table 5 are provided as examples only. The actual applied studies implemented will depend on monitoring results. It is likely that only a few of the applied studies listed will be needed, or possibly none. It is also possible that applied studies not list in the table may be warranted.

10.2 Potential Adaptive Management Actions

Potential management actions are taken when the project is not progressing towards performance criteria as planned and a management trigger has been reached. Table 5 presents potential management actions. For example, if sediment accretion/erosion and compaction monitoring in the tidal wetlands (row two in the table) showed that fill elevations exceeded 5.3 ft NAVD after construction, the AMWG would arrange to remove fill in the locations that were too high. The majority of the proposed actions have been implemented elsewhere in San Francisco Bay for similar marsh habitat restoration projects. The management actions listed in Table 5 are provided as examples only. The actual actions implemented will depend on what is needed. Often, 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. The results of any relevant applied studies would be used to select appropriate actions.

For the tidal wetlands, a limited number of management actions are available to influence sediment dynamics – such as enlarging the breach (if undersized) to increase tidal exchange of water and sediments, adding supplemental dredge or propagule materials, and adding wave breaks. The project may also support actions to increase regional sediment supply, such as through watershed sediment management and dredge material disposal practices. Microdredging (with hand tools or small machinery) could be implemented to help channel formation. Since micro-dredging is expensive, it would likely only be used to facilitate formation of second- and third-order channels that add sinuosity and complexity to the system (e.g. overhanging banks) of value to target species, such as California Clapper Rail.

For the seasonal wetlands, management actions focus on influencing regular inundation, flooding, and salt storage. If there is too much vegetation encroachment in the panhandle (Cell 1), for example, management actions such as lowering weir board elevations will be taken to increase flooding with bay waters and salinization of pannes. Prolonged inundation and high soil salinity are expected to inhibit colonization and growth of perennial vascular plants (e.g. Sarcocornia) and

keep pannes and tension zones open and unvegetated. Conversely, if more vegetated habitat is required, actions will be taken that result in less water and salt storage.

For the transitional and upland habitats, the standard weed control measures incorporated into the design and ongoing management are expected to be sufficient to meet the performance criteria. Though considered unlikely, an unexpected problem could arise that required actions (adaptive management actions) beyond what could be handled by simply adjusting ongoing management. A possible adaptive management action, for example, might be an extensive removal of invasive plant source populations offsite.

10.3 Project Close Out

Closeout of the project would occur when it is determined that the project has been successful or when the maximum monitoring period has been reached. The project would be determined a success if the performance criteria have been met to the satisfaction of the AMWG in consultation with the Executive Committee and others as appropriate.

Monitoring is assumed to continue for fifteen years following construction. Monitoring for some or all parameters may be extended beyond this 15-year period if the monitoring data are considered critical to project success and funding can be secured. Conversely, if the performance criteria are met before the end of the 15-year period, monitoring may be discontinued for some or all parameters.

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13 GLOSSARY

AMWG	Adaptive Management Working Group
BCDC	San Francisco Bay Conservation & Development Commission
CDFG	California Department of Fish & Game
HWRP	Hamilton Wetland Restoration Project
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
NAVD	North American Vertical Datum of 1988
NOAA	National Oceanic and Atmospheric Administration
RWQCB	Regional Water Quality Control Board
TAG	Technical Advisory Group
USACE	U.S. Corps of Engineers

Table 1. AMWG and Executive Committee Membership

	Adaptive Management Working Group	Executive Committee
Federal	U.S. Army Corp of Engineers	U.S. Army Corp of Engineers
	U.S. Environmental Protection Agency	
	U.S. Fish and Wildlife Service	U.S. Fish and Wildlife Service
	U.S. National Oceanic and Atmospheric Administration Fisheries	
State	California Department of Fish and Game	
	California State Coastal Conservancy	California State Coastal Conservancy
	California State Lands Commission	
Regional	San Francisco Bay Conservation and Development Commission	San Francisco Bay Conservation and Development Commission
	San Francisco Bay Regional Water Quality Control Board	
	San Francisco Estuary Institute	
Local	City of Novato	
	Local Homeowners Association	
	California Native Plant Society, Marin Chapter	
Scientists	California State University, San Jose	
	University of San Francisco	

Note: agencies on AMWG may hire consultants to conduct monitoring and request consultant participation on the AMWG.

Table 2. Restoration Performance Criteria and Monitoring Metrics

Category	Performance Criteria		Monitoring Metric and MAMP Section (As Needed Applied Studies)
	Habitat Type	Criteria (Section 3)	
Hydrology	Tidal wetlands	Tidal water levels	6.1.1 Tidal Water Levels
	Seasonal wetlands	Pond hydrology	7.1.1 Pond Hydrology
	Seasonal wetlands	Water and soil salinity	7.1.2 Water and Soil Salinity
Water/Sediment Quality	Tidal wetlands	Water/sediment quality	6.2.1 Water/Sediment Quality
			6.2.2 Methyl Mercury
			(6.4.5 Fish Use)
Geomorphology	Tidal wetlands	Tidal wetlands development	6.3.1 & 6.3.2 Tidal Wetland Development
			6.3.9 Photo-Documentation
	Tidal wetlands	Fill elevations	6.3.3 Sediment Accretion/Erosion and Compaction
	Tidal wetlands	Sedimentation	6.3.3 Sediment Accretion/Erosion and Compaction
			6.3.9 Photo-Documentation
			(6.1.2 Tidal Currents)
			(6.1.3 Wind Speed and Direction)
			(6.1.4 Wave Characteristics)
			(6.3.4 Suspended Sediment Concentrations)
			(6.3.5 Surface Sediment Characteristics)
	Tidal wetlands	Intertidal berm elevations	6.3.6 Intertidal Berm Elevations
	Fringing Marsh	Outboard tidal channel	6.3.7 Levee Breach and Outboard Tidal Channel
	Fringing Marsh	Fringing marsh scour	6.3.8 Fringing Marsh Scour in San Pablo Bay Adjacent to Site
Biology	Tidal wetlands	Vegetation succession	6.4.2 Vegetation Succession
			6.3.9 Photo-Documentation
	Seasonal wetlands	Vegetation succession	7.2.2 Vegetation Succession
			7.2.3 Photo-Documentation
	Transitional and Upland	Vegetation succession	8.1.1 Vegetation Succession
			8.1.2 Photo-Documentation
	Tidal wetlands Seasonal wetlands Transitional and Upland	Invasive plants	6.4.3 Invasive Plants
			7.2.4 Invasive Plants
			8.1.3 Invasive Plants
	Tidal wetlands	Bird use	6.4.4 Bird Use
			6.4.1 Reference Area
			(6.4.6 Mammal Use)
			(6.4.8 Benthic Macroinvertebrates)
	Seasonal wetlands	Bird use	7.2.5 Bird Use
			7.2.1 Reference Area

	Tidal wetlands	Fish use	6.4.5 Fish Use
			6.4.1 Reference Area
	Tidal wetlands	Special Status species use	6.4.7 Special Status Species Use
	Seasonal wetlands	Vector control	7.2.6 Vector Control

Table 3. Compliance Monitoring Parameters for the HWRP Set by Three Agencies

Category	USFWS	BCDC	RWQCB	MAMP Section
Hydrology	Tidal range		Tidal water levels	6.1.1 Tidal Water Levels
	Tidal currents*			6.1.2 Tidal Currents
	Wind speed and direction			6.1.3 Wind Speed and Direction
	Wave characteristics*			6.1.4 Wave Characteristics
Water/Sediment Quality		pH, salinity, dissolved oxygen, and temperature[1]	Marsh water/sediment quality	6.2.1 Water/Sediment Quality
		Methyl mercury[1]	Methyl mercury[1]	6.2.2 Methyl Mercury
Geomorphology	Characteristics of subtidal channels		Channel geometry and development	6.3.1 & 6.3.2 Tidal Wetland Development (Also, 6.3.9 Photo-Documentation)
	Sedimentation rates and distribution Marsh and mudflat elevations	Sedimentation Accretion and erosion	Sediment deposition rates + patterns Fill elevation prior to breach and marsh topography / bathymetry	6.3.3 Sediment Accretion/Erosion and Compaction (Also, 6.3.9 Photo-Documentation)
	Suspended sediment concentrations*			6.3.4 Suspended Sediment Concentrations
	Characteristics of marsh surface sediments			6.3.5 Surface Sediment Characteristics
			Peninsula crest elevations	6.3.6 Intertidal Berm Elevations
			Levee dimensions Exterior tidal channel geometry	6.3.7 Levee Breach and Outboard Tidal Channel
	San Pablo marsh shoreline characteristics	Erosion and scour of fringing tidal marsh and mudflats	Marsh development - existing San Pablo Bay marsh shoreline	6.3.8 Fringing Marsh Scour in San Pablo Bay Adjacent to Site
Biology	Extent and location of tidal marsh vegetation Composition and density of vegetation	Vegetation establishment and cover including % of the site vegetated Plant species established including percentage representation of different plant species	Vegetation, plant colonization	6.4.2 Vegetation Succession – Tidal Wetlands (Also, 6.3.9 Photo-Documentation) 7.2.2 Vegetation Succession – Seasonal Wetlands (Also, 7.2.3 Photo-Documentation) 8.1.1 Vegetation Succession – Transitional and Upland Habitats (Also, 8.1.2 Photo-Documentation)
		Invasive plant species	Invasive species	6.4.3 Invasive Plants – Tidal Wetlands 7.2.4 Invasive Plants – Seasonal Wetlands 8.1.3 Invasive Plants – Transitional and Upland Habitats
		Bird use	Bird use	6.4.4 Bird Use – Tidal wetlands (Also, 6.4.1 Reference Area) 7.2.5 Bird Use – Seasonal wetlands (Also, 7.2.1 Reference Area)
		Fish use	Fish use	6.4.5 Fish Use (Also, 6.4.1 Reference Area)
				6.4.6 Mammal Use**
			Special status species use	6.4.7 Special Status Species Use
			Benthic macroinvertebrates	6.4.8 Benthic Macroinvertebrates
				7.2.6 Vector Control**

Notes: *Data to be collected should an adaptive management question require

** no permit requirements for this monitoring

[1] Monitoring report in development by others.

Table 4. Summary of Monitoring Schedule for the HWRP

Category	MAMP Section	Location	Monitoring Parameter	Time of Year	Years Monitored
Hydrology	6.1.1 Tidal Water Levels	Tidal wetlands	Water level and tidal range	Summer and winter	0, 1-5 (6-15, if necessary)
	6.1.2 Tidal Currents	Tidal wetlands	Tidal currents	Summer	As required for adaptive management
	6.1.3 Wind Speed and Direction	Tidal wetlands	Wind speed and direction	All year	Time series (Marker 11)
	6.1.4 Wave Characteristics	Tidal wetlands	Wave characteristics	Summer and winter	As required for adaptive management
	7.1.1 Pond Hydrology	Seasonal wetlands	Pond hydrology	During seasonal ponding	0, 1-15
	7.1.2 Water and Soil Salinity	Seasonal wetlands	Water and soil salinity	Quarterly	0, 1-15
Water/Sediment Quality	6.2.1 Water/Sediment Quality	Tidal wetlands	Water and sediment quality	Late summer	0, to be reviewed by adaptive management review team
	6.2.2 Methyl Mercury	Tidal wetlands			
Geomorphology	6.3.1 Tidal Wetland Development - Planform	Tidal wetlands	Tidal wetland planform (aerial photograph)	Late summer	0, 1, 3 5, 7, 9, 11, 13 & 15
	6.3.2 Tidal Wetland Development – Cross-Sectional	Tidal wetlands	Tidal wetland cross-sections	Spring	0, 1, 3 5, 7, 9, 11, 13 & 15
	6.3.3 Sediment Accretion/Erosion and Compaction	Tidal wetlands	Sedimentation	Quarterly	0, 1, 3 5, 7, 9, 11, 13 & 15
	6.3.4 Suspended Sediment Concentrations	Tidal wetlands	Suspended sediment concentrations	Summer and winter	As required for adaptive management
	6.3.5 Surface Sediment Characteristics	Tidal wetlands	Surface sediment characteristics	Summer and winter	0, 1, 5, 10 & 15
	6.3.6 Intertidal Berm Elevations	Tidal wetlands	Berm elevation	Pre-breach	Pre-breach, 5, 10
	6.3.7 Levee Breach and Outboard Tidal Channel Geometry	Fringing marsh	Levee breach and outboard channel geometry	Spring	0, 1, 2 3, until no increase in channel dimensions
	6.3.8 Fringing Marsh Scour in San Pablo Bay Adjacent to Site	Fringing marsh	Fringing marsh scour (aerial photograph)	Late summer	0, 1-5, 7, 9, 11, 13, 15
	6.3.9 Photo-Documentation – Tidal Wetlands 7.2.3 Photo-Documentation – Seasonal Wetlands 8.1.2 Photo-Documentation – Transitional and Upland Habitat	Tidal & Seasonal wetlands, Transitional and Upland	Photo-documentation	Late summer	0, 1-15

Table 4. Summary of Monitoring and Reporting Schedule for the HWRP - Continued

Biology	6.4.2 Vegetation Succession – Tidal Wetlands 8.1.1 Vegetation Succession – Transitional (Phase 1 only)	Tidal wetlands, Transitional and Upland (Phase 1 only)	Vegetation succession phase 1 aerial photograph Vegetation succession phase 2 transects	Late summer Late summer	0, 1-5, 7, 9, 11, 13, 15 Monitoring begins with 5% vegetation cover, 2 year interval
	7.2.2 Vegetation Succession	Seasonal wetlands	Vegetation succession		0, 1-5, 7, 9, 11, 13, 15
	6.4.3 Invasive Plants – Tidal Wetlands 7.2.4 Invasive Plants – Seasonal Wetlands 8.1.3 Invasive Plants – Transitional and Upland Habitat	Tidal & Seasonal wetlands, Transitional and Upland	Invasive plants	Late summer	0, 1-5, 7, 9, 11, 13, 15
	6.4.4 Bird Use (Also, 6.4.1 Reference Area)	Tidal wetlands	Birds	Seasonal	0, 1-5, 7, 9, 11, 13, 15
	7.2.5 Bird Use (Also, 7.2.1 Reference Area)	Seasonal wetlands	Birds	Seasonal	0, 1-5, 7, 9, 11, 13, 15
	6.4.5 Fish Use (Also, 6.4.1 Reference Area)	Tidal wetlands	Fish	Spring at high tide	0, 1-5, 7, 9, 11, 13, 15
	6.4.6 Mammal Use	Tidal wetlands	Mammals	Late spring, early, mid, late summer	As required for adaptive management
	6.4.7 Special Status Species Use	Tidal wetlands	California Clapper Rail Salt Marsh Harvest Mouse	Spring and fall Spring and fall	0, 5, 7, 9, 11, 13, 15 0, 5, 7, 9, 11, 13, 15
	6.4.8 Benthic Macroinvertebrates	Tidal wetlands	Benthic macroinvertebrates		As required for adaptive management
	7.2.6 Vector Control	Tidal wetlands	Mosquitoes	Summer	As required for adaptive management

Note: Monitoring parameters that are labeled "As required for adaptive management" are potential Applied Studies (see Section 10).

Table 5. Adaptive Management Decision-Making for the HWRP

Restoration Objective	Monitoring Parameter	Management Trigger	Time Scale for Decision-Making	As Needed Applied Studies	Potential Management Action
1. Create a mix of tidal habitats on 80% of the land available for restoration. This mix will consist of subtidal open water, intertidal mudflat, low, middle and high intertidal marsh, channels, interior tidal ponds, and tidal pannes, with the relative amount of each type changing over time as the site evolves.	Tidal Water Levels (Section 6.1.1)	The site is not progressing toward full tidal action	The extent of reduced tide range (damping) will be detectable immediately follow construction. Any damping is anticipated to reduce significantly within the first 1-3 years.		Potential management actions may include additional channel excavation.
	Sediment accretion/erosion and compaction (Section 6.3.3)	Fill elevations exceed 5.3 ft NAVD	Immediately post-construction		Potential management actions may include removing fill in locations higher than 5.3 ft NAVD
	Tidal wetland development (Section 6.3.1 & 6.3.2)	Channel formation does not occur as predicted	5-10 years depending on initial site elevation	Study the causes of slow channel development. Study surface sediment characteristics as a potential cause of slow development (Section 6.3.5)	If it determined that the breach is undersized and is limiting tidal exchange, additional breach excavation may be performed. If channel formation is limited or fails to provide the ecological function observed in the reference area, then micro-dredging may be warranted.
	Sediment accretion/erosion and compaction (Section 6.3.3)	Rates of sedimentation are slower than predicted	5-10 years depending on initial site elevation	Will sediment accretion in restored tidal areas be adequate to create and to support emergent tidal marsh ecosystems within the 50-year projected time frame? Study biological effects of slower mudflat evolution. Assess whether projected habitat evolution provides acceptable form and functions (e.g. should loss of mudflat be ongoing in San Pablo Bay, do the wider ecological requirements for mudflat dictate an adjustment of success criteria for the HWRP?) Study tidal currents, wave characteristics, and suspended sediment concentrations as potential limits to accretion. (Sections 6.1.2 - 6.1.4, and Section 6.3.4) Analyze wind speed and direction data as a potential limits to accretion	Convene Adaptive Management Working Group to review findings and assess whether observed trajectories require intervention. If it determined that the breach is undersized and is limiting tidal exchange, additional breach excavation may be performed. Should sediment availability be low, adding further sediment to the site or the adjacent mudflat sources may be warranted. If wave power is limited accretion, then further wave breaks may be added.
	Intertidal berm elevations (Section 6.3.6)	Intertidal berms do not settle as predicted	Intertidal berms were planned to be graded to permit elevations prior to breaching. Confirm prior to breach.	Assess settlement trajectory	If updated settlement estimates indicate that settlement will not occur within a reasonable timeframe, potential management actions include lowering the intertidal berms.
	Levee breach and outboard tidal channel (Section 6.3.7)	The outboard channel is not eroding as predicted	0-5 years depending on tidal connectivity and observed erosion of channel.	Study surface sediment characteristics as a potential cause of slow development (Section 6.3.5)	Potential management actions may include additional channel excavation.
	Vegetation succession (Section 6.4.2)	Vegetation extent varies (30-50%) from predicted	Timing of establishment depends on initial mudflat elevation. Plant colonization is anticipated to be detectable within 5 years on appropriately elevated areas. Habitat development trajectory is anticipated to be detectable within 5 years of the onset of plant colonization	Study the causes of slow vegetation establishment. Study surface sediment characteristics as a potential cause of slow establishment (Section 6.3.5)	Potential management actions may include inoculation using founding propagules of acceptable plant species.
	Invasive plants (Section 6.4.3)	Cover by non-native invasive species exceeds 5%	Timing of establishment depends on initial mudflat elevation. Plant colonization is anticipated to be detectable within 5 years on appropriately elevated areas. Habitat development trajectory is anticipated to be detectable within 5 years of the onset of plant colonization	Study the causes of slow vegetation establishment. Study surface sediment characteristics as a potential cause of slow establishment (Section 6.3.5)	Potential management actions may include increasing non-native invasive species control (if they cannot be controlled, study the biotic response to non-native vegetation).

Restoration Objective	Monitoring Parameter	Management Trigger	Time Scale for Decision-Making	As Needed Applied Studies	Potential Management Action
2. Create a mix of non-tidal habitat on 20% of the land area available for restoration. This mix will consist of shallow seasonal ponds and wetlands, and a limited amount of grassland and upland. If this is not feasible, then at least the minimum acreage necessary to replace existing seasonal wetlands on the site at a 1:1 ratio, about 8%, will be created.	Pond hydrology (Section 7.1.1) Water and soil salinity (Section 7.1.2)	Water levels within ponds or water and soil salinity vary from predicted	By year 5 soil salinities should have risen to 30 ppt. By year 10 soil salinities should have risen to over 40 ppt	Is wetland hydrology performing as predicted? If not, then; is the connection to San Pablo Bay limiting tidal full tidal exchange, are inflowing water salinities lower than expected, are water infiltration rates into the soils higher than design requirements?	Adjust water levels to maximize shallow flooded habitat during shorebird migratory season. To increase open pond and stressed vegetation area, adjust water levels and exchange with tides to enhance salinities in tension zones around lower pannes.
	Vegetation succession (Sections 7.2.2 and 8.1.1)	Vegetation evolutionary trajectory varies from predicted	By year 5, soils in the ponds subject to tidal flooding should have sequestered sufficient salts to control salt-tolerant plant species	Assess ecological value of evolving habitat	Seed transitional areas with native annual plant species
	Invasive plants (Section 7.2.4 and 8.1.3)	Colonization of the higher ponds by non native or non wetland plants	By year 5, soils in the ponds subject to tidal flooding should have sequestered sufficient salts to control salt-tolerant plant species Leaching of salts will be progressing in pond sediments above the elevation of tidal flooding. As the salts leach, the higher ponds will become vulnerable to grass and forb invasion. The time scale for this process will vary depending on rate of salt loss	Study the causes of slow vegetation establishment. Study surface sediment characteristics as a potential cause of slow establishment (Section 6.3.5)	If weeds infiltrate the pond areas, then raise water levels to drown vegetation, increase salt inflow to ponds, flood ponds with high summer tides when the salinities are greatest in the Bay.
	Vector control (Section 7.2.6)	Detection of mosquito nuisance	Ongoing	Study mosquito populations (Section 7.2.6) Study the relationship between mosquito larvae abundance and hydrology	Potential management actions may include adjusting design to enhance drainage or tidal flushing.
3. Ensure no net loss of wetland habitat functions presently provided at the HWRP site	Fringing marsh scour in San Pablo Bay adjacent to site (Section 6.3.8) Levee breach and outboard tidal channel geometry (Section 6.3.7)	Significant long-term net loss of outboard mudflat and marsh beyond projections for background change.	Any changes in mudflat and fringing marsh areas are expected within 10 years	Refine regional sediment budget including updated demands for HWRP and other regional restorations, sediment supply to San Pablo Bay and relative sea level rise. Will sediment movement into the restored tidal areas reduce habitat area and/or ecological functioning in San Pablo Bay?	Convene Adaptive Management Working Group to assess if observed changes are due to restoration actions or system-wide changes in the sediment budget, and whether changes will reverse when HWRP sediment demand reduces. Potential management actions include reducing accommodation space in the restoration site by increasing fill amount, supply sediment to outboard mudflats.

Restoration Objective	Monitoring Parameter	Management Trigger	Time Scale for Decision-Making	As Needed Applied Studies	Potential Management Action
4. Create and maintain wetland habitats that sustain viable wildlife populations, particularly for Bay Area special status species	Water/sediment quality (Section 6.2)	Non-compliance with RWQCB standards.	Ongoing	Which habitat is the source of the water quality infringement? Can water flows be modified to improve water quality?	Compare water quality data with Bay-wide water quality monitoring and conditions at similar restoration sites. Potential management actions may include improved connectivity to Bay or modification to seasonal wetland hydrology.
	Bird use and reference sites (Sections 6.4.1, 6.4.4, 7.2.1, & 7.2.5)	Three consecutive years in which observed densities of foraging shorebirds for selected habitat types are below targets Three consecutive years in which the percentage of San Francisco Bay small migratory shorebirds that use San Pablo Bay is below the baseline. Statistically significant declines in waterfowl numbers from baseline conditions (taking inter-annual variability into account).	Immediate response is expected due to creation of wetland complex in the construction phase, with future ecological gains immediately post breach	Can water levels in panhandle seasonal wetland be modified to maximize vegetation structure and habitat value for shorebirds? Will creating roosting sites within the tidal wetlands area increase shorebird densities (e.g. increase separation between wave berm and site exterior levees)? Is water quality or sediment contamination limiting bird densities? To what extend is water fowl and aquatic bird use a factor of site evolution? Is predator or human disturbance limiting bird densities? Study nesting patterns. Study mammal use. (Section 6.4.6) Study benthic macroinvertebrates. (Section 6.4.8)	Analyze all available monitoring data for San Pablo Bay, the Bay Area, and entire Pacific Flyway to determine whether declines are specific to the HWRP, or the result of external factors. If the declines are specific to HWRP then; identify habitat that is limiting shorebird densities, if seasonal wetland management is limiting shorebird utilization initiate studies of linkages between habitat structure and bird densities, and impacts of water level management and bird densities. If water and salt management in seasonal wetlands is failing to create habitat of ecological value consider converting to a muted tidal system. Adjust template to increase roosting habitat (such as increasing the isolation of the wave berms or create islands within tidal or seasonal wetlands).
	Fish use and reference sites (Sections 6.4.1 & 6.4.5)	Significant deviation from expected trajectory of native fish use.	Fish are expected to immediately use the site post breach Species counts will change with time as habitat structure evolves	How has habitat structure influenced species densities? Is channel formation limiting fish use?	Use available information to determine whether reduced species counts are specific to the HWRP or regional. If the channel structure is limiting fish use, consider micro-dredging. If the fish populations decline, conduct diet studies on piscivorous birds, to determine whether increased bird predation is responsible.
	Special status species use (Section 6.4.7)	See triggers for Tidal Wetland Habitat Establishment above. Salt Marsh Harvest Mouse occupied area and capture efficiencies are 60% of performance criteria or lower. Clapper rail populations drop below 0.15 birds/acre in any given year or rate of increase deviate significantly from projection.	Likely decades for high-quality tidal marsh development (10-year targets)	How do salt marsh harvest mice and/or other key tidal marsh species respond to variations in tidal marsh habitat quality and what are the habitat factors contributing to that response? Applied studies of habitat parameters, contaminant levels, and predation pressure related to clapper rail densities and productivity. How do clapper rails respond to variations in tidal marsh habitat quality and what are the habitat factors contributing to that response? Applied studies of habitat parameters, contaminant levels, and predation pressure related to clapper rail densities and productivity.	See Restoration Objective #1.

Table 6. Target Cover Ranges (% Absolute Cover) for Elements of Mature Habitats of the HWRP

element	Wetlands			Uplands
	North Seasonal	South Seasonal	Tidal	
unvegetated panne & pond	40 to 60	10 to 20	5	
unvegetated channels, open water & mudflat	1 to 5	15-30	10 to 40	
Sarcocornia pacifica	20 to 40	40 to 60	20-60	
Distichlis spicata	1 to 5	1 to 5	1 to 5	
Frankenia salina	1 to 5	1 to 5	1 to 5	
Spartina foliosa		10 to 30	20-60	
Bolboscheoenus robustus	10 to 20	10 to 20	1 to 5	
Juncus effusus var. *pacificus*	1 to 5	1 to 5	1 to 5	
Typha latifolia	1 to 5	1 to 5	0	
Grindelia stricta var. *stricta*	1 to 5	1 to 5	1 to 5	1 to 5
Quercus agrifolia				1 to 5
Heteromeles arbutifolia				1 to 5
Baccharis pilularis				5 to 10
Aesculus californica				1 to 5
Rosa californica				1 to 5
Symphoricarpus albus				1 to 5
Artemesia douglasiana				1 to 5
Achillea millefolium				1 to 5
Spartina alterniflora/densiflora	0	0	0	
Lepidium latifolium	0	0	0	0
Cortaderia selloana	0	0	0	0
Carpobrotus edulis	0	0	0	0
Acacia spp.				0
Genista spp.				0

Notes: Range estimates are for the habitat as a whole. The bottom six elements are invasive plants that have been targeted for aggressive eradication. Other perennial invasive plants will be reduced to 5% or less when possible.

APPENDIX A

Opportunities for Public Education and Participation

APPENDIX A. Opportunities for Public Education and Participation

The Hamilton Wetlands Restoration Project is of national significance in that it is a landscape sized project that brings together beneficial reuse of dredged sediments from a variety of sources while providing a mosaic of habitats needed for the survival of Bay Area species. It represents a large collaborative effort involving many agencies, industry and environmental groups. It is also located in close proximity to a new mixed-use community, amid growing Marin County. Because of these and other attributes, there is a variety of opportunities for both education and community participation.

The most passive of educational opportunities provided by the site is use of the public access area. Community members and visitors will be able to observe the restoration in progress by strolling along the paths that will be provided along the western perimeter of the site. They will have opportunities to view native vegetation and wildlife, assisted by interpretive signage that includes both explanations of the restoration process and the natural environment. The public access portion of the site is designed to accommodate school groups using the site as a field trip, potentially as an adjunct to classroom programs about the project specifically or wetlands in general.

The site itself offers research opportunities in areas such as marsh development, migratory bird use, invertebrate colonization, public access effects on wildlife, and a myriad of other topics. There are also number of colleges in the Bay Area whose students may consider some aspect of the project for their own research projects. The site is adjacent to the San Francisco Bay National Estuarine Ecological Reserve, China Camp, which will afford other opportunities.

The most involved, or hands-on education opportunities presented by the project includes participation in the actual restoration itself. The project team anticipates developing an onsite plant nursery that will be used to teach students and participants about native wetland plants. They will be able to assist in the collection of seeds, cuttings, propagation and care of the plants that will eventually be planted on the site. See Pavlik and McWhorter (2010) for a public-friendly native plant nursery design.

The restoration includes tidal and seasonal wetlands, a tidal panne area and an upland transition zone. With the exception of the tidal panne and tidal wetland areas, the site will be physically planted with native vegetation. The planting effort will involve thousands of native plants of different varieties grown in the onsite nursery. The planting effort itself will take place over a four year period. During this time school groups and community members will have the opportunity to assist in the planting, monitoring and caring for the plants that will make up the habitat as they become established. Invasive species control will be another area in which folks can participate in the project. While much of this aspect of the project is hands on, informational programming will be combined with the work so that the participants have a satisfying and meaningful experience.

Broad public support for the creation and management of habitats at HWRP is necessary and desirable. Gaining that support requires a demonstration that ecological restoration, endangered species protection, recreational access, and local governance can cooperatively work to protect the public trust. Part of the demonstration will come through concrete implementation of these management regimes. Another part will come through a public access and education program that makes the resources, issues and solutions real; that allows citizens to see these uplands, tidal wetlands and seasonal wetlands function to provide habitat for a broad array of native species. Implementation of these management regimes, along with an

education and access program, could powerfully demonstrate that public agencies and resource advocates can find a way to make local governance work for the benefit of all.

APPENDIX B

Conceptual Model of Habitat Evolution

APPENDIX B: CONCEPTUAL MODEL OF HABITAT EVOLUTION

This appendix provides a description of our conceptual understanding of the three target habitats – tidal wetlands, seasonal wetlands, and uplands – including a narrative of expectations of how the habitats will develop and how they will ecologically operate. Following presentation of the conceptual model for each habitat type, potential adaptive management actions are described.

The conceptual model narratives and the restoration targets based on them should be regarded as hypothetical and subject to revision when rigorously tested. In effect, they are a record of the facts and reasoning that future regulators, engineers and scientists, including the Adaptive Management Working Group of the HWRP, can evaluate and correct for purposes of improving this and other restoration projects.

1.6 Tidal Wetlands

1.6.1 General Conceptual Model

When tidal action is restored to a subsided bayland site through a deliberate or accidental levee breach, physical processes are set in motion that dictate the rate and manner of wetlands development. With breaching of an outboard levee, flooded bayland is reconnected to the circulation of tidal waters and sediment. Floodtides carry suspended estuarine sediments that deposit in the wave-protected slack waters of the site. As sediment accumulates, large areas of intertidal mudflats form. As the developing marsh plain slowly rises in elevation, the period of inundation and rate of sedimentation decline across its surface.

A mudflat is shaped by waves and tides. Waves redistribute sediment that accumulates most rapidly in sheltered areas. Tides cut channels that feed sediment to the developing wetland. Over time, the mudflat and channel system co-evolve, each influencing the other as patterns of sedimentation and flow adjust to the changing topography.

Once tidal mudflats achieve a threshold elevation relative to the tidal frame, plant colonization and vegetation succession can occur. Initial establishment of pioneer species usually occurs by dispersal of seed or vegetative fragments (propagules) in tidal waters. Colonization by these founders becomes progressively more rapid through vegetative growth and continued deposition of propagules. It usually becomes most obvious along the margins of slough banks because of good drainage but also because of constant tidal deposition of propagules in these areas. At this point a gentle shift in wetlands development occurs, as roots assist in the stabilization of sediment. Stabilization tends to confine water flows to the tidal slough, which cuts further in to the young marsh plain surface (Steel and Pye 1997). As the marsh sediments and vegetation

build, the channel system evolves – the size of the channels is dictated by the tidal prism of the upstream area of the marsh 'watershed', thus controlling tidal channel geometry at any given point (Williams 1986).

In San Francisco Bay, Pacific cordgrass (*Spartina foliosa*) is typically the first perennial marsh species to colonize an accreting mudflat. Its tolerance of seawater salinity and prolonged inundation allows domination of the low, often submerged marsh plain (Ustin and Pearcy 1987). In brackish areas of the bay, bulrush (e.g. *Bulboschoenus robustus*) will be the pioneer that colonizes the lower tidal frame. Once colonization occurs, marsh plain vegetation spreads by lateral expansion of rhizomes of founders on the mudflat, within channels and along the site perimeter. The presence of vegetation further contributes to the slow build-up of the marsh plain through sediment trapping and organic accumulation (Eisma and Dijkema 1997). As the vegetated marsh plain rises within the tidal frame, the accretion of estuarine sediment slows exponentially until a marsh plain forms at an elevation within a few tens of centimeters below mean higher high water (Atwater *and others* 1979) As tidal inundation decreases, soil salinities increase due to evapotranspiration and pickleweed (*Sarcocornia pacifica*) outcompetes *Spartina* to form the characteristic mid- to high salt marsh of San Francisco Bay.

The rate at which the mudflat and marsh plain build up is dependent on the amount of sediment, or suspended sediment concentration, carried into the site by the flood tide; the rate of relative sea level rise; the tidal range, and the amount of wind-wave action that erodes deposited sediments.

The higher the suspended sediment concentration in the flood tide, the faster the receiving marsh plain will develop. Annual suspended sediment concentrations (long-term average) at any point in the San Pablo Bay vary depending on position relative to the hydrodynamics of the estuary. Proximity to extensive intertidal mudflats is especially important because these areas act as sources of sediment resuspended by wave action. Suspended concentrations are ultimately determined by the sediment budget of the estuary, which dictates how much material is available over the long-term, as well as estuarine hydrodynamics that determine movement and deposition.

Relative sea level rise is the product of global eustatic sea level rise and local long term subsidence. Due to climate change, eustatic sea level rise is predicted to accelerate. For average modeling parameters, IPCC sea level projections for the next 50 years (from 2000 to 2050) for different greenhouse gas emissions scenarios range from approximately 2 to 4mm/yr, roughly twice the 20th century rate. The higher the rate of sea level rise the longer it takes for the marsh to evolve in a restoring site (Orr et al 2003). The projections for future sea level rise have been updated for the 2007 IPCC report.

Where wetland restoration sites are fully tidal, periods of inundation are unrestricted and similar to those in mature, natural marshes. At sites where tides are muted or restricted by narrow channels, periods of inundation are altered and vegetation establishment can be delayed. Over time, scouring action tends to enlarge constricted tidal channels, eventually establishing full tidal exchange. Until this occurs, the volume of sediment entering the site on the flood tide will be reduced proportionally to the reduction in tidal prism, extending the time of wetland development.

Even where bayfront levees remain intact at a restoration site, locally generated wind-waves can inhibit deposition of suspended sediment from the water column and resuspend deposited mud. In South San Francisco Bay, Schoellhamer (1996) found that suspended sediment concentrations were well correlated with seasonal variations in wind shear stress. Wind-wave action can reduce the net accretion rate, slowing the development of the marsh plain and limiting the final, stable elevation of the site. A low final elevation inhibits plant colonization and produces a permanent mudflat without subsequent succession and the development of emergent marsh vegetation

1.6.2 Conceptual Model for the HWRP

At the time the outer levee is breached, the tidal wetlands of the HWRP are expected to progressively develop as outlined above, producing a mosaic of subtidal, intertidal, channel and marsh plain habitat elements. The ecological trajectory of these tidal wetlands will depend upon construction of a full tidal connection, the final elevation of the placed dredged material, the amount and rate of autocompaction of the dredged material with time, the supply and sediment from San Pablo Bay and the effectiveness of constructed berms to dampen wind-wave energy. Development from mudflat through to marsh plain will be fastest if average suspended sediment concentrations from the bay are high, if amounts of dredged material autocompaction and low and if wind-wave energies are moderate.

To create a tidal wetland that develops with minimal post-breach management, the design template includes; 1) placement of dredge fill to elevations no higher than 1 to 1.5 ft below MHHW; 2) construction of internal berms to reduce wind-wave energy, resuspension of sediment and erosion of perimeter features; 3) removal of relict infrastructure that would interfere with natural channel development; and 4) wide breach of outboard levee to allow full tidal exchange. An important parameter in the design is that the fill material will be placed no higher than 1 to 1.5 ft below natural marsh plain elevations, as this is critical to allow for natural channel development. Plant propagules and invertebrates are anticipated to disperse from adjacent wetland areas and will not, for the most part, require inoculation (e.g., seeding, outplanting, stocking with rhizomes).

The network of channels will co-evolve with the intertidal mudflat and marsh plain. The exact morphology of this channel system cannot be clearly predicted. However, an unimpeded channel system with channel form comparable to that of natural tidal wetlands is expected to develop. Once dredge material has been placed and opened to the tide, the layout of the channel network will be influenced by the locations of high and lows in the surface. Feedback processes will define the network and with time, particularly after the establishment of marsh vegetation, this network will stabilize.

Stormwater discharge, passing via the drainage channels through the panhandle and southern seasonal wetlands, will act to sustain the two largest channels in the tidal wetlands. It is from these large channels that smaller channels will develop across the site. As the marsh plain builds, the stormwater inflows will mimic the action of freshwater inflows from upland watersheds into natural tidal marshes around the bay

To a great extent we expect the vegetation and other habitat elements of the created tidal wetlands to reflect biological responses to two major physical factors: sedimentation on the marsh plain and sediment removal within the channel system. High rates of sedimentation will lead to development of *Sarcocornia*-dominated mid- to high marsh over a majority of the site. Low rates of sedimentation (or high rates of erosion) will allow development of a *Spartina*-dominated low marsh adjacent to channels. Removal of sediments from a developing channel system will create topographic and ecological complexity, allowing open water, channel bottom and overhanging banks to form. On higher berms, elevated channel edges, and along the ecotone between marsh and upland habitats, a gumplant (*Grindelia stricta*) or alkali seaheath (*Frankenia salina*) - dominated high marsh will become established.

Dense, extensive stands of *Sarcocornia* with *Spartina* and *Grindelia* fringes are desired future habitat elements. Such habitat elements will promote colonization and use by the Salt Marsh Harvest Mouse for feeding, reproduction and refuge, thus achieving a primary project goal. An extensive, complex channel system with open water, overhanging banks and a *Spartina* fringe are also desired future habitat elements. Such habitat elements will promote colonization and use by California Clapper Rail for feeding, reproduction and refuge, thus achieving another primary project goal.

1.6.3 Potential Adaptive Management Actions

Management of tidal wetland habitat after construction and breach will focus on actions that influence sediment storage (= accumulation, deposition) and sediment removal (= loss, erosion). Storage of sediments brought in by flood tides will build the marsh plain across most of the site (>75% as a guestimate). Removal of sediments by ebbing tides and runoff will cut a channel system into remaining portions (<30%).

A limited number of management actions are available to influence the storage and removal "controls" that affect sediment dynamics – such as modification of the breach, the addition of supplemental dredge or propagule materials, and the installation of stabilizing fences.

If management actions maximize storage, then high rates of sedimentation will rapidly build a marsh plain for colonization by *Spartina* and *Sarcocornia*. Rapid colonization and growth of these species on the marsh plain will eventually provide essential habitat elements with high value to target species, such as Salt Marsh Harvest Mouse. Conversely, if more open, deep water area is required to support fish populations, actions will be taken to favor in high rates of sediment loss (e.g. removal of intertidal berms).

Microdredging (with hand tools or small machinery) is the only known post-construction management action that could be applied to channel formation. Such an expensive, labor-intensive technology would only be used to facilitate formation of second- and third-order channels that add sinuosity and complexity to the system. Only a complex channel system, with twists and turns and overhanging banks would provide essential habitat elements with high value to target species, such as California Clapper Rail.

1.7 Seasonal Wetlands

1.7.1 General Conceptual Model

Although there is a wealth of scientific data and practical experience pertaining to natural and created wetlands in California (Josselyn 1982, Josselyn and Buchholz 1984, Zedler and Langis 1990, Perrow and Davy 2002, Pavlik 2003, PWA, 2004; Breaux and others 2005), very little of it pertains to seasonal or ephemeral wetlands. Yet, these wetlands were prominent, natural features across 19th century marsh landscape (Collins and Grossinger, 2004) and are now thought to provide productive habitat for a wide variety of associated species. Seasonal wetlands whose hydrology is affected only by precipitation and evaporation are called vernal pools, while those also affected by tidal inundation are called marsh plain pools. After evaporation of the standing water (the pool), the dry, clay-dominated, unvegetated basin is referred to as a panne. Of existing natural systems, by far the best studied in the Bay Area are freshwater vernal pools. Elsewhere, salt-influenced pannes have been mainly studied in continental desert regions and along non-Californian arid, semi-arid and tropical shoreline (see review in PWA and others 2006).

Vernal pools are seasonally wet depressions associated with mesic or semiarid grasslands in Mediterranean climates (Vollmar and others 2002). Shallow basins of various sizes (200 to 2,800 m^2) usually form on alluvial surfaces (Central Valley), uplifted dune terraces (coast) or volcanic ash flows (northern California) over long periods of time (thousands to millions of years) (Keeley and Zedler 1998), and usually where a subterranean hardpan prevents water percolation and prolongs inundation after rainfall events or flooding (Vollmar and others 2002). Inundation during the winter and spring, followed by desiccation in summer, affects seed germination, root zone oxygen levels, leaf submergence, and severe drought stress that restrict both plant and animal colonization, growth and reproduction. Such extreme conditions result in the evolution of endemic species, many of which have been studied in detail (Keeley and Zedler 1998). Nevertheless, much about vernal pool origin and development remains a mystery (e.g. mina mound topography, interactions of water chemistry, inundation period, and climatic variation)(Vollmar and others 2002). Vernal pools are not associated with the HWRP, but remnants do occur in western Marin County.

More relevant to the creation of seasonal wetlands for the HWRP are natural, saline pannes and artificial muted tidal wetlands associated with San Francisco Bay. Some natural pannes, such as the salt ponds of the remaining, undisturbed tidal marshes along the Petaluma River, might be quite old, as determined by maps dating back to the 1850's that show pan features still recognizable within the landscape. They were historically referred to as *salinas* (Spanish and Portuguese for salt-making), and commonly harvested for salt. Coastal *playa* (Spanish for beach) habitats are similar to the salinas habitat, but occurring where soil salinities are low to moderate and vegetation development is largely controlled by wave and wind disturbance.

The development of natural pannes is dependent upon local topography, soil drainage and the nature of any inflowing water (precipitation patterns and amounts, tidal inflows, salt content). At high intertidal elevations, saline pannes that develop on the mature marsh plain are often flooded by spring tides and tend to hold ponds throughout much of the year. Precipitation is second to

tides in terms of water input. At higher elevations or in areas where tidal exchange is restricted by topography, saline pannes may support more ephemeral ponds that are flooded only by rare tides and surges. They are also influenced by precipitation amounts and patterns in a given weather year. Such ponds flood less frequently (two or three times per year), develop extreme soil salinities by evaporation (> 40 to 50 ppt) and are dry for a greater length of time (four to eight months depending on rainfall). Longer-lasting, less saline ponds may develop along the margins of upland areas with groundwater recharge or overland flow into localized pannes.

Thus, the development and maintenance of pannes as distinct features in the wetland landscape largely depends upon water and salt balance (PWA et al, 2006). Unlike the sedimentation processes that dominate formation and vegetation succession in tidal wetlands, the storage processes for water and salt dominate formation and succession in seasonal wetlands. Plant species that colonize and persist along the margins of these pannes must not only tolerate prolonged inundation, but also high levels of soil salinity that accumulate with each flood and concentrate with evaporation. Much about the plant species composition and community structure of the transition between dense tidal marsh and open seasonal panne is thus determined by the interaction of inundation and salinity in an ecological "tension zone" (PWA 2005). Germination and growth of annual plants, such as brass buttons (*Cotula coronopifolia*), occurs in response to saturating winter rains on shallow panne surfaces, but such plants are often excluded from basin bottoms with prolonged flooding. Perennial plants that dominate salt and brackish marshes (e.g. *Sarcocornia, Bulboschoenus*) will produce a dense canopy (absolute cover exceeding 100%) on these same shallow surfaces, with multiple layers near the pond margin. But such species become stressed and sparse on deeper panne surfaces that remain inundated for 6 to 8 months and where soil salinity exceeds 30 to 50 ppt. Such conditions lead to sparse, stressed plant growth around open tidal pannes that appear as gaps in the marsh vegetation. Thus, natural succession and the development or inhibition of vegetation in seasonal wetlands is a process that is probably controlled by inundation and salinity in the habitat.

At extremely high soil salinities, vegetation and many other forms of eukaryotic life may be excluded entirely. For example, in the present day landscape, anthropogenic salt ponds created by dikes and gates concentrate seawater until salts precipitate. These extreme salinities (100-400 ppt) completely retard the growth of vascular plants, leading to open waters and barren bottom sediments. Depending upon climate and hydrology, accumulations foster precipitation of gypsum, carbonate and even halite. Thus, artificial salt ponds are an extreme analog for natural, high intertidal pannes.

Muted tidal wetlands, with flow restricted be a confined inlet, are managed systems that possess characteristics similar to seasonal wetlands. In the Bay Area these wetlands have been built for a number of reasons, ranging from flood management to habitat creation. Muted tidal wetlands are hydrologically managed to dampen fluctuations in water level, usually with dikes and gates. Control of flow at a confined sill or through a pipe restricts the ingress and egress of tidal waters. Consequently, the low water levels are higher and the high water levels lower, than would otherwise occur in the absence of the control structures. Inundation is prolonged and asynchronous with respect to tidal patterns. Base water levels in the site, around which the muted tides oscillate, are rapidly adjustable either to provide a basin for water storage or to support

biological goals (such as lowering water levels to provide areas for nesting or raising water levels to eradicate invasive vegetation). As a consequence of the hydrologic management, soil salinity can be high in marginal areas exposed by evaporation (analogous to the edges of natural pannes). The vegetation that develops around muted tidal systems reflect prolonged inundation and elevated soil salinity, with a gradient between salt marsh, stressed salt marsh and exposed, unvegetated sediments that resembles the gradient observed in natural pannes (PWA 2005). Moreover, because the muted tidal system does not dry out during summer, the soft sediment provide optimal habitat for invertebrates, a food source for shorebirds and fish. Muted tidal systems can be found in Marin County at Rush Creek and Shore Bird Marsh and are described in the Hamilton Seasonal wetlands Design Report (PWA 2005; Appendix E and F) and in the Seasonal Wetlands Monitoring Report (PWA and others 2006).

The scientific literature is 'patchy' in its investigation of processes that sustain natural seasonal (or ephemeral) wetlands in California; and almost non-existent on created seasonal wetlands. Because of this significant gap and because seasonal wetlands will be created at the HWRP site by using dredged material, PWA and BMP (2008) undertook an investigation of a number of created wetlands that exhibit good and poor characteristics of seasonal wetland habitat. That investigation became a foundation for expected operations, design and post-construction management of the seasonal wetlands of the HWRP.

1.7.2 Conceptual Model for the HWRP

Seasonal wetlands to be created for the HWRP are expected to operate according to the yearly amounts and patterns of precipitation, evaporation, tidal influx, and percolation through the placed dredge material. Periods of heavy winter rainfall will cause water to accumulate in closed basins that have been constructed within the northern seasonal wetlands and southern seasonal wetland sites. Panne sill elevations will dictate the degree to which tidal waters contribute to water and salt storage in specific basins. Consequently, these created seasonal wetlands will have some of the same characteristics of other natural and hydrologically managed wetlands (e.g. pannes, muted tidal): prolonged inundation in shallow basins and high soil salinity. For a description of anticipated hydrology and operation of the constructed seasonal wetlands see the Restoration Design Report (PWA 2008), which includes model simulation of pond flooding depths, durations and salinity under varying conditions rainfall, tidal inflow and soil percolation.

One unknown that could affect duration of ponding in created basins at the HWRP site will be the water holding capacity of the placed fill, especially as surface sediments around the periphery begin to dry. As clays dry and shrink, surface cracks form in the exposed basins in the form of polygons. Water will drain into these shrink-swell cracks and percolate a foot or more below the level of the basin. The extent of clay cracking and impact on pond water retention will not be apparent until material has been placed and worked, though in the panhandle area the designed surface elevations are such that tidal waters can be drawn in to the site to compensate for losses to percolation.

Another unknown that will affect the operation of these seasonal wetlands will be subsidence. The weight of saturated sediments within the cells will cause compression of the underlying bay

mud and slowly change elevations of basin surfaces. This would then affect tidal influx and water levels, but these could be compensated by adaptively adjusting sill elevations or weir boards that control tidal drainage (see below).

Overland flow between saturated basins in a cell will be rare, occurring mostly as sheet floods during the highest high tides of a wet winter. In effect, these coincident, accumulating waters will also submerge peribasin soils and uplands that surrounded the otherwise isolated basins. But such waters also recede rapidly, leaving behind salts, some water-dispersed eggs and seeds, and brim-filled basins. These inundated, salt-affected areas around the basins will lie within an ecological tension zone between basins and vegetated marsh and will thus exhibit intermediate but fluctuating ecotonal conditions essential to the seasonal wetland habitat.

Long-term flooding in isolated ponds, necessary for wetland character, requires the rate of downward percolation to be less than the rate of precipitation and tidal influx once soils are saturated. Hydraulic head, combined with increased hydraulic conductivity (as filling expands the interstices), accelerate percolation rates. The downward front of water carries with it slurry of very fine particles and dissolved minerals gathered along the way. These come to rest a depth that reflects local precipitation regime, pond size, and soil structure, perhaps forming a hardpan over many decades or centuries. The hardpan is an impermeable layer that restricts percolation and leads to flooding regimes that can last for months during the rainy season (similar to that known from vernal pools). Hardpans can also form when very fine ash layers are deposited across a landscape by volcanic eruption, with subsequent soil formation and slow burial over millennia. Such processes are a major uncertainty in the creation of seasonal wetlands for the HWRP.

The duration of flooding in the seasonal wetlands of the HWRP will also depend on how rapidly evapotranspiration dissipates surface waters. During the wet, cool winters of a Mediterranean climate, evaporation rates are relative low, except during dry, windy periods. But as storms become infrequent and air temperatures begin to rise in early spring, the rate of evaporation accelerates and the water level in the pond rapidly recedes. Development of a leafy canopy in late spring also accentuates the drop in water level. Ultimately, the hydroperiod of any seasonal wetland is truncated by the onset and pattern of spring conditions and high rates of leaf transpiration, but especially by the stochastic effects of extreme events (e.g. late storms, early heat spells, drought, very high tides).

High soil salinity will be promoted as evapotranspiration takes place in the created ponds of the HWRP. Salts will accumulate on the basin surfaces as well as at sediment depths reached by percolating waters and root systems.

To a great extent we expect the vegetation and other habitat elements of the created seasonal wetlands to reflect biological responses to two major physical factors: water storage and salt storage in and around constructed pannes. Operation of the weir boards and other post-construction adjustments to Cells 1 and 2 will be used to actively control the composition and structure of the developing vegetation (the succession) with these two factors. Controlling succession in the seasonal wetlands at the HWRP site is a major objective for adaptive

management. Many previous constructed seasaonal wetlands have not persisted because of vegetation encroachment. Open, unvegetated waters surrounded by exposed, barren pannes and an open tension zone of stressed *Sarcocornia* are the desired future habitat elements that should form over a majority of the area of created seasonal wetlands (Figure 5 and Figure 6). Such habitat elements will promote colonization by invertebrates and provide protected areas for shorebird feeding and resting, thus achieving a primary project goal.

We expect that within created seasonal wetlands of the HWRP, invertebrates will respond favorable to the accumulation of winter rains and tidal influxes, emerging from encysted eggs or sealed pupae buried beneath the upper soil (dredge) layers. They will swim in abundance in the ponded waters, feeding on bacteria, phytoplankton, rotifers, and other microbial forms that cling to emergent plants or that grow on algal mats on the soil surface ("aufwuchs"). Some stay buried in the bottom sediments, filter-feeding in open waters or muddy flats. Others disperse into the ponds from other habitats, developing into a food fauna that supports shorebirds and other vertebrates.

Shorebirds, as well as waterfowl, require areas of shallow, open water separated by unvegetated pannes and tension zones that foster populations of food species (small fish and invertebrates) (Boyd 1982). Plentiful edge and protracted transition zones are necessary to create complex hydrological and salinity gradients that meet the habitat requirements of surface algae, bacteria, rotifers, copepods and other basal members of the food web. Emergent vegetation in these open zones should be confined to upper elevations where it can provide refuge habitat for hiding, roosting and escape. The emergent vegetation will necessarily be a mixture of native freshwater, brackish and tidal plants (but mostly *Sarcocornia*) that become zoned and continuous in areas of simple gradients but patchy or discontinuous where water and salinity factors become physiologically unfavorable. Continuous cover usually results in dense, essentially monocultural stands where a single species becomes dominant. Discontinuous cover would allow open, polycultural stands with a mix of species interrupted by bare, well-lit, often wet ground necessary to support aufwuchs (Zedler and others 1982). The challenge in creating such open, unvegetated and polycultural wetlands is to control (or at least influence) the process of wetland succession by 1) designing and building the landscape so that water and salinity conditions can be adjusted to favor acceptable species (natives or naturalized) yet retard invasion by unacceptable weeds (non-native), and 2) providing suitable plant material (rhizomes, seeds) of acceptable species for establishing founding populations and overcoming dispersal limitations. Although we can infer how to create and manage wetlands in general from a multitude of scientific and empirical sources, this program of adaptive management will be required to learn the site-specific and project-specific adjustments needed to achieve the stated goal of shorebird habitat.

1.7.3 Potential Adaptive Management Actions

Management of seasonal wetland habitat after construction and breach will focus on actions that influence water storage (= inundation, flooding) and salt storage (= high salinity). Storage of water from precipitation or occasional spring tides will increase pond area, depth and hydroperiod within constructed basins. Storage of salt from spring tides and evaporation of pond waters will increase soil salinity of pannes and tension zones surrounding the basins.

The proposed management and monitoring program for seasonal wetlands are designed to test a number of novel management actions that could influence the storage of water and salt in the panhandle (Cell 1). If management actions, such as lowering weir board elevations, allow more flooding with bay waters, then inundation and salinization of pannes will increase. Prolonged inundation and high soil salinity will inhibit colonization and growth of perennial vascular plants (e.g. *Sarcocornia*) and keep pannes and tension zones open and unvegetated. Such conditions will provide essential habitat elements with high value to target species, such as shorebirds. Conversely, if more vegetated, productive habitat is required, actions will be taken that result in less water and salt storage.

1.8 Uplands

1.8.1 Conceptual Model of Habitat Evolution

Dry uplands are expected to develop on constructed levees and berms and in the wildlife corridor on a highly disturbed substrate. Under local climatic conditions, there will likely be rapid colonization by ruderal plants and animals, some of which are acceptable with respect to project goals (e.g. most non-native grasses and forbs, native rodents, mustelids, procyonids, coyote), some of which are not (e.g. perennial non-native vines and shrubs, red fox). The wildlife corridor will link the inland and bay edge of the HWRP to accommodate the movement of acceptable vertebrates. Islands extending above 7.5 feet NAVD surrounded by tidal and seasonal wetlands will provide escape terrain to reduce the success of unacceptable predators. Attempts will be made to enrich the upland, corridor and islands with native grasses and forbs (hydroseeding) and with container-grown native shrubs and small trees (nursery propagation and outplanting during the first five years of the restoration project (probably 2013-2017)). Details of the planting plan for the wildlife corridor are found in Pavlik and McWhorter (2010). These efforts will result in a vegetation analogous to the local mosaic of oak woodlands, north coastal scrub and coastal prairie: a two- or three-layered canopy with an intermittent, mostly native, woody overstory and a mixed native/non-native understory of grasses and herbs. Long-term weed control, focused on the exclusion of invasive woody trees (e.g. *Acacia*), perennial shrubs (e.g. *Cytisus, Carpobrotus*) perennial grasses (*Cortaderia, Arundo*), vines (*Rubus*) and annuals (*Centaurea*), will be a substantial part of the ongoing management program.

There will be fairly extensive areas of transitional upland habitat (i.e. ecotone) between the upland on the landward side of a floodplain and the surrounding landscape. Lower elevation portions of the wildlife corridor will also grade into wetland edge. As a result, this broad ecotone will absorb storm runoff from uplands and be occasionally exposed to extreme high tides, producing a range of soil moisture and salinity conditions. The transitional uplands will be colonized by a mix of obligate (e.g. *Grindelia, Cotula*) and facultative (e.g. *Lolium*) wetland plants, as well as ruderal upland species in low rainfall years.

These transitional uplands will be created for the HWRP by placing dredged sediment, primarily Merritt Sand, from the crest of the perimeter levees on the southern, western and northern edge of the site, and an existing adjacent upland in the southwestern corner of the site, sloping gently

downward at approximately 1:125 foot slope. The toe of the transitional uplands will blend into the tidal marsh or seasonal wetlands. Lenses of bay mud will be incorporated into broad, elevated mounds with greater substrate depth and water holding capacity. The entire area will be sculpted to create a natural topography and undulating edges to add diversity in both topography and vegetation. Its considerable width will also buffer more sensitive wildlife species from the public access required along the edge of the site.

Once the sediment is in place and the topography created, the substrate will be hydroseeded with native grasses and forbs that would naturally occur in this habitat. The hydroseeding will happen quickly after completion of the sculpting to minimize colonization by ruderal, non-native species from adjacent areas. Once the hydroseeding is complete, container-grown native shrubs, such as coyote bush (*Baccharis*), toyon (*Heteromeles*) and wild rose (*Rosa*) will be outplanted to augment vegetation development and plant diversity. Lenses of bay mud will be planted with small numbers of coast live oak (*Quercus agrifolia*) and California buckeye (*Aesculus californica*), local trees whose growth will be constrained by the low freshwater holding capacity of the substrate. Care will be given to outplant founders in a natural gradient from higher transition, upland plants to obligate wetland species, such as alkali seaheath (*Frankenia*). As with the uplands, outplanting transitional uplands will take place during the first five years of the project and long-term weed control will be required.

1.8.2 Potential Management Actions

Hydroseeding will assist in deterring some unacceptable species, but not all. The full palette of available methods for weed control should be used to reduce or eliminate unacceptable perennial plants. It is unrealistic, however, to assume all infestations will be completely removed, given the proximity to large source populations in adjacent residential areas and disturbed habitats. Unacceptable species that will be present and eradicated to lowest possible levels include fennel (*Foeniculum*), star thistle (*Centaurea*) and perennial pepperweed (*Lepidium*). It will also be important to begin outplanting additional, container-grown plants shortly after hydroseeding to promote development of vegetation complexity and to reduce open habitat for weed infestations.

During the development of upland and transitional upland vegetation, there will be use by native birds and small mammals. As vegetation complexity develops, there will be more cover and food sources to support an increasing number of animal species.

APPENDIX C

Design of a Validation Monitoring Program for the Creation of Seasonal Wetlands

APPENDIX C: Design of a Validation Monitoring Program for the Creation of Seasonal Wetlands

C.1 USING "TEST FOUNDERS" AS MANAGEMENT INDICATORS FOR CONTROLLING SUCCESSION IN SEASONAL WETLAND HABITAT

Adaptive management of seasonal wetlands for the HWRP will require controlling vegetation development to favor characteristics preferred by shorebirds. Vegetation development in these created wetlands could be characterized as a primary succession on a new surface of bay sediments (placed dredge material). The path of any primary succession is greatly influenced by; 1) the sequence and rate of arrival of plant propagules (dispersal) and 2) a host of stochastic environmental events (patterns of rainfall, temperature, tidal inundation, and microbial activity) that determine the germination and growth of those propagules by affecting resource availability or tolerance limits. Low initial plant cover and lack of previous biological modification relegate species interactions such as competition, so important in secondary succession, to a much lower status during initial stages of the primary succession. Therefore, this adaptive management plan emphasizes limitations imposed by dispersal, resource availability and stress tolerance during the colonization and growth processes. It attempts to use an empirical understanding of those limitations to control the direction and rate of primary succession.

By its very nature, succession in wetlands leads to maximum plant cover, often with a dense, closed canopy. In contrast, the creation of shorebird habitat in a seasonal wetland requires large areas of shallow open water, unvegetated pannes and tension zones with sparse or no cover by acceptable (native) perennial plants. If designed, built, and operated properly, the seasonal wetlands of the HWRP will use tidal inundation and soil salinity to exceed tolerances of these perennials (Appendix E), inhibiting their growth in the lowest elevations (3.0 to 5.5 feet NAVD) to keep pannes and tension zones as open and unvegetated as possible. Models of inundation and salinity conditions have been developed (PWA 2005, USACE et al., 2008, Appendix E) so that site-specific target conditions can be known. It will be necessary to ensure that the target conditions can be maintained by operational adjustments (management actions) to the wetlands. Adjustments to tidal control structures (e.g. weir boards) can be used to increase water storage (tidal inundation) and salt storage to provide further inhibition or promotion of plant growth if necessary (Figure D1). These adjustments will not only control the succession of acceptable perennial plants, but also the exclusion of unacceptable (non-native) plants that will certainly invade from beyond the project's borders. However, we will only know if such control over succession and unacceptable plants will be possible by empirically removing dispersal and resource limitations early in the life of the project. Allowing natural dispersal and soil modifications to take place adds years, if not decades, of uncertainty to the question of control. Therefore, this adaptive management plan for seasonal wetlands of the HWRP has objectives arranged in two phases:

Phase I: Testing phase – determining how to control succession in the seasonal wetlands by controlling the growth of acceptable and non-acceptable plant species in the panhandle (Cell 1) of the HWRP with inundation and salinity (AMhyt framework with validation monitoring).

Phase II: Restoration phase – using the site-specific knowledge gained in Phase I to install and manage target vegetation types throughout the seasonal wetlands (AMbat framework with implementation monitoring).

C.2 OBJECTIVES OF PHASE I: TESTING WETLANDS OPERATION FOR PURPOSES OF ADAPTIVE MANAGEMENT (AMhyt)

Dispersal of propagules (seeds, rhizomes) into the seasonal wetlands will depend on their identity, distance, and direction. Species that produce large amounts of lightweight, wind-dispersed seeds (early seral characteristics) that are upwind and nearby will arrive first. Some of these are native, wetland species that may be acceptable with respect to creating wetlands (*e.g. Typha*) while others are non-native weeds that are unacceptable (e.g. *Cortaderia*). Other acceptable species have water-dispersed seeds that depend on the extent of flow from source populations (e.g. *Sarcocornia*) and across the new substrate surface. Yet another group of species tend to propagate vegetatively by rhizome growth (e.g. *Bulboschoenus*), which could take decades to reach interior portions of the project area. Given the amount of edge of the HWRP seasonal wetlands, the proximity to large source populations of unacceptable species (weeds), and the limited influence of tidal flow and rhizome growth in the interior (unlike the tidal wetlands), there is a substantial risk that natural, unmanaged dispersal would favor the early arrival and establishment of unacceptable species. To favor the arrival of acceptable species, founding propagules (i.e. container-grown plants) will be deliberately brought to target locations and outplanted in the substrate. Therefore, this adaptive management plan has the following objective: =

C.2.1. Objective 1: Favor and accelerate the arrival of acceptable plant species by propagating and outplanting "test founders" in the seasonal wetland.

Creating the desired vegetation characteristics for seasonal wetlands of the HWRP (open, unvegetated pannes, stressed *Sarcocornia* in tension zones, low, polycultural stands of acceptable tidal or brackish marsh species and a wetland-upland ecotone) will require the maintenance of soil submergence and soil salinity conditions that control plant growth during primary succession. These target conditions have been developed from studies of wetland plant tolerance limits in Suisun Marsh (Mall 1966) and studies of created seasonal wetlands along the western margin of San Francisco Bay (PWA 2005, Appendix E). However, it will be necessary to test whether the final design, construction and management of the HWRP seasonal wetlands will allow those target conditions to be realized and whether they will act effectively to control the succession of early seral founders (i.e. prevent dominant species and weeds from "taking over"). To determine if the succession can be controlled in the seasonal wetlands, it will be necessary to test the effects of inundation and salinity regimes (target conditions) on the test founders. Therefore, this adaptive management plan has the following objective:

C.2.2 Objective 2: Test for control over early seral succession by monitoring the effects of target conditions of inundation and soil salinity on survivorship, growth, and reproduction of acceptable plant species outplanted in specific zones throughout the seasonal wetland.

Objective 2 is the essential driver of the adaptive management program with hypothesis testing for the HWRP seasonal wetlands. A wide range of acceptable plant species will be used as indicators of the effectiveness of the target conditions (as determined by wetland design, construction and operation) in

controlling the succession and allowing desirable vegetation conditions (shorebird habitat) to develop. If certain species begin to dominate and accumulate large amounts of tall, dense phytomass (to the detriment of shorebird habitat), then adjustments in weir boards would be made to allow more tidal intrusion, prolonged inundation and salinity. The advantage of putting test founders of a range of acceptable species in the project area is that this test of control would take place within the first few years after breach of the outer levee (expected in 2011 or 2012), allowing an immediate evaluation and response by the AMWG. If only a few plant species were installed, or if there was reliance upon natural dispersal, the question of control and adjustment might not be answered for many years, even decades, after the breach

It will not be necessary to plant test founders across the entire area of seasonal wetlands. Extensive areas of low elevation basins (e.g. 3.0 to 5.5 feet NAVD) will have long hydroperiods and hypersaline soil conditions that will effectively retard the establishment of all plant species, native and non-native. In other words, there is less uncertainty about control of succession at the lowest elevations in basins (and adjustments to weir boards can easily ensure these conditions). The result will be open water and exposed sediment habitats that appeal to shorebirds. However, at some elevation, arbitrarily chosen now as 5.5 feet NAVD, there will be a zone of ecological uncertainty, a tension zone, surrounding every basin in Cell 1. In the tension zone, control over inundation and salinity will be very sensitive to precipitation, tidal cycles and management actions. It is the tension zone that will be susceptible to invasion and growth (e.g. succession) by obligate wetland plants, and, therefore, the primary area for testing management actions to control vegetation development.

There will be two types of tension zones; a lower elevation tension zone (roughly 5.5 to 6.0 feet NAVD surrounding ponds 3, 4, 5, and 6 towards the southeast end of the panhandle and a higher elevation tension zone (6.0 to 6.5 feet NAVD) surrounding ponds 1 and 2 towards the northwest end. The lower tension zone (LTZ) will be tidally influenced (though one or both weirs of Cell 1) and, therefore, subject to relatively high potential for water and salt storage. Target conditions for this zone will be long inundation (e.g. flooded with stored tidal water) and high salinity (storage of tidal salts in the soil, exceeding 10 ppt). These stressful conditions should only favor establishment of *Sarcocornia*, but growth and reproduction will be severely constrained. The resultant vegetation, called "stressed *Sarcocornia*", should eventually surround and extend for a short distance down into ponds 3, 4, 5, and 6. The upper tension zone (UTZ) will not be tidally influenced (except during the rarest HHW events), so inundation and salt storage will be much less pronounced than in the LTZ. Target conditions for this zone will be moderate inundation (e.g. flooded with stored rainfall) and moderate to low salinity (perhaps 5 ppt or less). These intermediate conditions will favor establishment and growth of a variety of obligate wetland species (*Sarcocornia, Bulboschoenus, Distichlis, Typha*). The resultant vegetation will be relative dense brackish marsh, with dominance determined by management actions that adjust water and salt storage in the cell.

In addition to the tension zones, there will also be an ecotone zone between the upland habitat on berms and levees and the seasonal wetlands. It is the ecotone zone that will be susceptible to invasion and growth (e.g. succession) by facultative wetland plants, many of which will be non-native, making it a secondary area for testing management actions to control vegetation development.

The availability of resources critical for propagule growth, especially water and nitrogen, could determine initial establishment of founders and their potential for maintaining themselves during later seral stages.

Drought in upper layers of the new, clay-rich substrate, can cause high mortality that will undermine the testing effort. Similarly, new substrates that lack organic matter and nitrogen-fixing microbes will be low in nitrogen, the soil-borne mineral nutrient needed in greatest supply by plants. The growth of roots and shoots of the founders will be severely limited, making them more susceptible to drought and displacement by ruderal species that require less nitrogen (e.g. many weeds). In addition, any control over succession exhibited during early seral, resource-limited conditions, may not be maintained over time (decades) when late seral, resource available conditions develop in the soil. To promote the establishment of acceptable species, and to see if the submergence and salinity conditions of the seasonal wetlands controls the succession under late seral conditions, propagules may be treated with soil supplements of a water-holding material (e.g. mulch, PEG beads) and/or a nitrogen source (e.g. osmocoat, N fertilizer). Therefore, this adaptive plan has the following objective:

C.2.3. Objective 3: Test for late seral control over succession, favoring the establishment of acceptable plant species by testing and applying supplements of water and/or nitrogen.

Preparations for Phase I in the seasonal wetlands should begin prior to deposition of the bay mud sediments. Establishment of a native plant nursery and production of a large number of founding plants (for objective 1) will require at least two years before work on objective 2 and 3 begins (see Pavlik and McWhorter (2010)). Phase I outplanting should begin immediately after the final wetland surface is drained and exposed to exogenous seed sources. Validation monitoring of the Phase I test (AMhyt) will take at least five years after breaching, during which time Phase II preparations are made. Finally, once it has been established that succession can be controlled by management actions, even when dispersal and essential resources are not limiting, then the vegetation plan moves from the Phase I testing mode (objectives 1, 2, and 3) to the Phase II restoration mode (objectives 4 and 5).

C.3 OBJECTIVES OF PHASE II: INSTALLATION OF THE VEGETATION (AMbat)

The results of the testing phase will be applied to creating appropriate target vegetation types throughout the seasonal wetlands as rapidly and efficiently as possible. Rapid installation of "restoration founders" of acceptable species, along with any treatment (control, water-holding materials added, nitrogen and water-holding materials added) that promotes establishment and growth in the correct zone to create the appropriate vegetation, will accelerate the development of shorebird habitat and lower the probability of unacceptable species gaining a significant foothold. Therefore, this phase of the plan has two objectives:

C.3.1. Objective 4: Install large numbers of restoration founders appropriate to target vegetation types in appropriate zones throughout the seasonal wetland along with treatments that optimize growth and establishment.

C.3.2. Objective 5: Conduct weed control within the seasonal wetlands by adjusting tidal control structures, using approved herbicides and performing hand removal throughout and beyond the project area.

Propagation of the large number of plants for installing the vegetation during Phase II would be ongoing during Phase I. Once Phase I test founders were outplanted and preliminary monitoring data suggest that the wetland is operating correctly, then Phase II outplanting could possibly begin (objective 4) with

implementation monitoring of survivorship and cover development. Weed control efforts within the wetland, on uplands, and beyond the immediate project borders should begin early and be sustained until the target vegetation has been extensively established.

C.4 METHODS

C.4.1 Founding populations of acceptable species (Objective 1)

Plant materials for founding populations of acceptable plant species will be collected locally and propagated on-site. This will require establishing a nursery, with simple, open facilities for cleaning, dividing, and planting rhizomes or cuttings (perhaps some seeds) into a large number of plastic containers (see Pavlik and McWhorter (2010) for details on collection, propagation and nursery construction). Each container will contain a growing individual of one species ("founder"). Founders from many as ten species, roughly eight wetland and two upland, will be grown until large enough for outplanting. Approximately 10,560 test founders will be needed during Phase I (for "test polygons", Tables C1 and C2) and 31,440 restoration founders will be needed during Phase II ("restoration polygons", Table 7). Due to mortality during propagation, about 30% more will need to be raised for each phase.

A separate effort to create upland vegetation on levees and other upland areas will employ hydroseeding mixes of native grasses and forbs. Local genetic sources should be used to the extent feasible, and pilot tests conducted. To this will be added propagated perennial trees and shrubs, such as *Quercus* and *Baccharis* (dry areas) and *Grindelia* (wet margins) as part of the upland target vegetation type described below. To prevent widespread establishment of unacceptable species in upland areas that will be constructed early in the project, this hydroseeding effort, along with weed control measures, will be implemented immediately after construction. See Pavlik and McWhorter (2010) for a full discussion of the planting plan for the wildlife corridor.

C.4.2 Testing for control over early seral succession (Objective 2)

Five types of target vegetation types, corresponding to five elevation ranges in the panhandle seasonal wetlands, will be used to test for control over early seral succession and as models for the final habitat attributes at the end of the project (Table C3). Details of these types have been developed from studies of other seasonal wetlands in the San Francisco Bay Area (USACE et al., 2008). Each target vegetation has been placed in an elevation range along a gradient of inundation and soil salinity, from lowest elevation (5.0-5.5 ft NAVD, with the greatest frequency and duration of tidal intrusion) to highest elevation (> 7.0 ft, with little or no tidal intrusion). The lowest elevation range is designed to be a seasonally wet, saline basin with open pannes and very little vegetation cover. As elevation increases, the influence of rainfall grows while that of high tides diminishes, producing less inundation and lower levels of soil salinity during the year. Consequently, a progression of vegetation types should develop, with inundation and salt-intolerant species gradually replacing the more stress-tolerant halophytic species at higher elevations.

To determine in these relationships between elevations, target conditions (of inundation and soil salinity), and tolerance limits of perennial plants are as hypothesized, founders will be outplanted in test polygons (Figure C2) with different species compositions (Tables C1 and C2). Species composition within any one polygon type (A,B, or C) reflects species that are acceptable for a particular target vegetation type

(promoted members) and species that are unacceptable but need to be tested for control (inhibited members). For example, test polygon type B will contain test founders that should become members of the final target stand (*Sarcocornia, Distichlis*and *Frankenia*) and test founders of a species that should be excluded from the stand (*Bulboschoenus*) if inundation and salinity conditions effectively inhibit establishment (Table 6). By bringing propagules of *Bulboschoenus* into the early seral founders (i.e. removing the dispersal limitation, objective 1), the test of control (inhibition by exceeding tolerance limits) will take place during the first tear or two of the adaptive management program, rather than many years later (because enough propagules were slow to arrive by natural dispersal). Monitoring the test polygons will provide the essential data for adjusting wetland operation (weir boards) and controlling subsequent development of the target vegetation.

C.4.3 Testing late seral control and promoting founder establishment (Objective 3)

Testing for control of succession under late seral conditions (enriched substrate that contains nitrogen and holds water) requires another level of empiricism. In addition to the variable of species composition contained in the test polygons (Figure C2), variables related to nitrogen availability and water holding capacity are included in the design. Each polygon will consist of four circular treatment cells; control (no supplements), + N, + water retaining "mulch", and + N + water-retaining mulch. Monitoring species X treatment interactions in the test polygons will determine which treatments best promote establishment of stand members (those acceptable for a given target vegetation type) and whether control over inhibited members is maintained. If supplements overcome the inhibitions, then inundation and salinity targets will have to be modified to produce the requisite levels of stress. Data from the test polygons will allow operational adjustments (weir boards) that anticipate late seral conditions in the developing vegetation.

C.4.4 Installing the target vegetation (Objective 4)

Numerous restoration polygons will be established for each target vegetation within the aforementioned elevational ranges (Table 7). The number of restoration polygons for each type was arbitrarily chosen to cover 10% of the total area of that particular vegetation (each polygon is 676 square feet). Species composition of these restoration polygons will include only acceptable species for the vegetation type, probably limited to mixtures of 2 species (Figure C3). No restoration polygons will be installed in the low, open panne areas (5.0 to 5.5 ft NAVD) or in the uplands (above 7.0 feet – see Sections 2.1 and 3.1.1). Placement of plants within the polygon will be random, but the positions of the polygons across the built landscape will cross complex gradients of inundation and salinity created by hydrological management. Monitoring of hydrological factors, founder establishment, and vegetation development will be centered on these polygons.

Outplanting of test and restoration polygons will be conducted by volunteers and contract crews. Training and supervision will be required to insure proper placement and outplanting. It is conceivable that volunteers could also conduct data collection for the monitoring effort if clear directions, simple measurements, and standardized datasheets were used. These datasheets would be checked for quality, catalogued and used for data entry into a spreadsheet for analysis. The analyses would then feedback to the Adaptive Management Working Group (AMWG) for evaluation and decision-making.

C.4.5 Controlling weeds (Objective 5)

Rapid development and control of the target vegetation will work to minimize weed populations throughout the project area. However, a comprehensive weed management program will also be necessary, given the size and exposure of the new, unvegetated surface to be created, and its proximity to local source populations of unacceptable species. All practical and legal methods of weed control should be available for use. See Appendix H for details on weed control methods.

C.5 Identifying target conditions for management

The desired vegetation characteristics for seasonal wetlands of the HWRP should be mapped in detail as part of the habitat design process. Founding propagules can then be used to inoculate the ponds in specific locations to provide access barriers (e.g. dogs, humans) and the mapped refuge habitat (see below). At this point in the wetland creation process it is difficult to know what species, with which structural or physiological features, will become established and produce the proper architecture for the stated goal. But in general, cover by rhizomatous perennial plants (e.g. *Typha, Sarcocornia*) should be confined to upper elevations adjacent to uplands or on islands surrounded by open water or muddy flats. Weed invasions around in and around the wetlands will have to be stopped immediately to prevent dominance. Excluding plants from lower elevations to maintain open habitat for shorebirds (and their food species) will thus require two types of vegetation management regimes: 1) hydrological management of soil submergence and salinity, and 2) population management of undesirable plant species (weeds).

C.5.1 Hydrological management

Wetland restoration projects usually attempt to create marsh vegetation that reflects zonation patterns with respect to tidal inundation and develops a closed canopy of dominant native species that is resistant to weed invasion (Pavlik 2003). The creation of seasonal wetlands at HWRP requires just the opposite: vegetation that is not zoned, lacks dominance, and remains open, ephemeral or intermittent so that open water and flats are maintained indefinitely. Therefore, it is important to identify hydrological management "targets" that prevent natives from becoming dominant during community succession and the development of vegetation zonation patterns. Such targets can be identified from the tolerance limits of each acceptable plants species for soil submergence and salinity. Once identified, they can be implemented and tested when the wetland landscape has been appropriately designed and built.

Specifically, manipulation of flooding with tidal waters can be used to sustain suboptimal, even detrimental, conditions for native species (especially rhizomatous perennials). Such conditions can be defined by graphically representing optimal or suboptimal submergence and salinity (that promote dominance or subdominance, respectively). Using the previously data obtained by Mall (1969), optimal and suboptimal regimes can be graphically represented (Figure C4). Optimal conditions for each species are indicated in red and suboptimal in yellow. Beyond the yellow are regions of submergence and salinity that exceed the tolerance limits of these plants. Therefore, two sets of "target conditions" become apparent (circles). One is a short inundation – hypersaline condition that could be applied in years of drought. The other is a long inundation – mesosaline condition that could be applied in years of high precipitation. Both would allow some minimal cover by *Sarcocornia*, but other wetland perennials should be largely excluded. This analysis and the identified target conditions should serve as testable hypotheses during the implementation phase of an adaptive management process.

C.5.2 Weed management

Although target conditions for the management of community succession can be identified, their effects on weeds are unknown. There are no comprehensive studies of unacceptable wetland plants that would define tolerance limits to inundation and salinity. Therefore, target conditions for hydrological management of unacceptable plants cannot be identified. Anecdotally, some wetland weeds appear to be quite tolerant of inundation (e.g. *Lepidium latifolium, Lolium multiflorum, Mentha pulegium*) while others may be intolerant (e.g. *Cortaderia* sp., *Foeniculum vulgare*). Most appear to be intolerant of high soil salinity (except *Salsola* sp.). Whether the target conditions will retard weed invasions will be a "key management question" to be addressed by adaptive management.

However, weed populations will have to be intensively managed before, during and after construction of uplands. A broad palette of tools, from hand removal to herbicides, should be available to retard the most aggressive or unacceptable species before they become abundant and widespread. Weed removal will be a part of CPM (Section 7 and Appendix H) so that infestations are extirpated on sight, without consultation with the AMWG. Simple monitoring will record the location (with GPS), identity and size of the infestation (number of individuals removed), along with a note on how and when the action was taken. Areas with recurrent infestations should be closely examined, possibly identifying off-site sources of weed propagules for eradication.

Table C1. Placement and composition of test polygons for validation monitoring of seasonal wetland in the Panhandle of the HWRP. Elevations and areas based on USACE et al, 2008. Total Panhandle area = 5,410,000 ft2.

elevation range (ft NAVD 88)	area (x 1000 ft2)	area (%)	habitat	target vegetation	# species in test polygon	test polygon type	# of test polygons	total # test founders
≤ 5.0	197	4.0	pond bottom	open panne	2	A	30	1,440
5.1-5.5	788	14.0	pond edge	open panne/stressed *Sarcocornia*	4	B	60	2,880
5.6-6.0	2,494	46.0	panne	stressed *Sarcocornia* /*Sarcocornia*	4	B	60	2,880
6.1-6.5	574	11.0	high panne	brackish mix	4	C	20	960
6.6-7.0	828	15.0	terrace	fresh mix	4	D	20	1,440
>7.0	530	10.0	upland	transitional upland	2	E	20	960
	Σ = 5,411	Σ = 100					Σ = 220	Σ = 10,560

Table C2. Characteristics and of target vegetation and desired responses of acceptable species in seasonal wetlands of the HWRP. Absolute cover and desired responses of species in test polygons to inundation and salinity conditions are indicated. inhibit = inhibition of founders, neutral = neutral effect on founders, promo = promotion of founder establishment. * = no target composition or cover to be specified.

target vegetation	acceptable species	target cover range (absol. cov %)	test polygon type	test polygon founder species	desired species response to conditions
open panne/stressed *Sarcocornia*	unvegetated	> 80	A		
(<5.5 feet NAVD)	stressed *Sarcocornia*	<10		*Sarcocornia*	inhibit
	Distichlis	<10		*Distichlis*	inhibit
	*Cotula**				
stressed *Sarcocornia* / *Sarcocornia*	*Sarcocornia*	50 to 100	B	*Sarcocornia*	neutral/promo
(5.5 to 6.0 feet NAVD)	*Distichlis*	5 to 10		*Distichlis*	neutral/promo
	Frankenia	5 to 10		*Frankenia*	neutral/promo
	*Cotula**			*Bulboschoenus*	inhibit
Sarcocornia -brackish mix	*Sarcocornia*	10 to 50	C	*Sarcocornia*	inhibit/neutral
(6.0 to 6.5 feet NAVD)	*Distichlis*	5 to 10		*Distichlis*	neutral/promo
	Frankenia	5 to 10		*Bulboschoenus*	neutral/promo
	Bulboschoenus	10 to 50		*Typha*	inhibit
freshwater mix	*Bulboschoenus*	10 to 50	D	*Bulboschoenus*	inhibit/neutral
(6.5 to 7.0 feet NAVD)	*Typha*	10 to 50		*Typha*	neutral/promo
	Grindelia	5 to 10		*Grindelia*	neutral/promo
	Juncus	5 to 10		*Juncus*	neutral/promo
transitional upland	*Grindelia*	5 to 10	E	*Grindelia*	promo
(>7.0 feet NAVD)	*Baccharis*	5 to 10		*Baccharis*	promo
	native grasses & forbs*				

Table C3. Placement and composition of installation polygons for establishing target vegetation of seasonal wetlands (panhandle + southern) for the HWR Elevations and areas based on PWA and BMP (2008). # of installation polygons is based upon a 10% overlay of polygon areas on total area each type of target vegetation. Each polygon = 676 ft2 (26 x 26 ft, Figure 14).

elevation range (ft NAVD 88)	area (x 1000 ft2)	area (%)	target vegetation	# species in installation polygon	# of installation polygons	total # installation founders
≤ 5.0	197	4.0	open panne	0	0	0
5.1-5.5	788	14.0	open panne/stressed *Sarcocornia*	0	0	0
5.6-6.0	2,494	46.0	stressed *Sarcocornia*/*Sarcocornia*	2	370	17,760
6.1-6.5	574	11.0	brackish mix	2	85	4,080
6.6-7.0	828	15.0	fresh mix	2	122	5,856
>7.0	530	10.0	transitional upland	2	78	3,744
	Σ = 5,411	Σ = 100			Σ = 655	Σ = 31,440

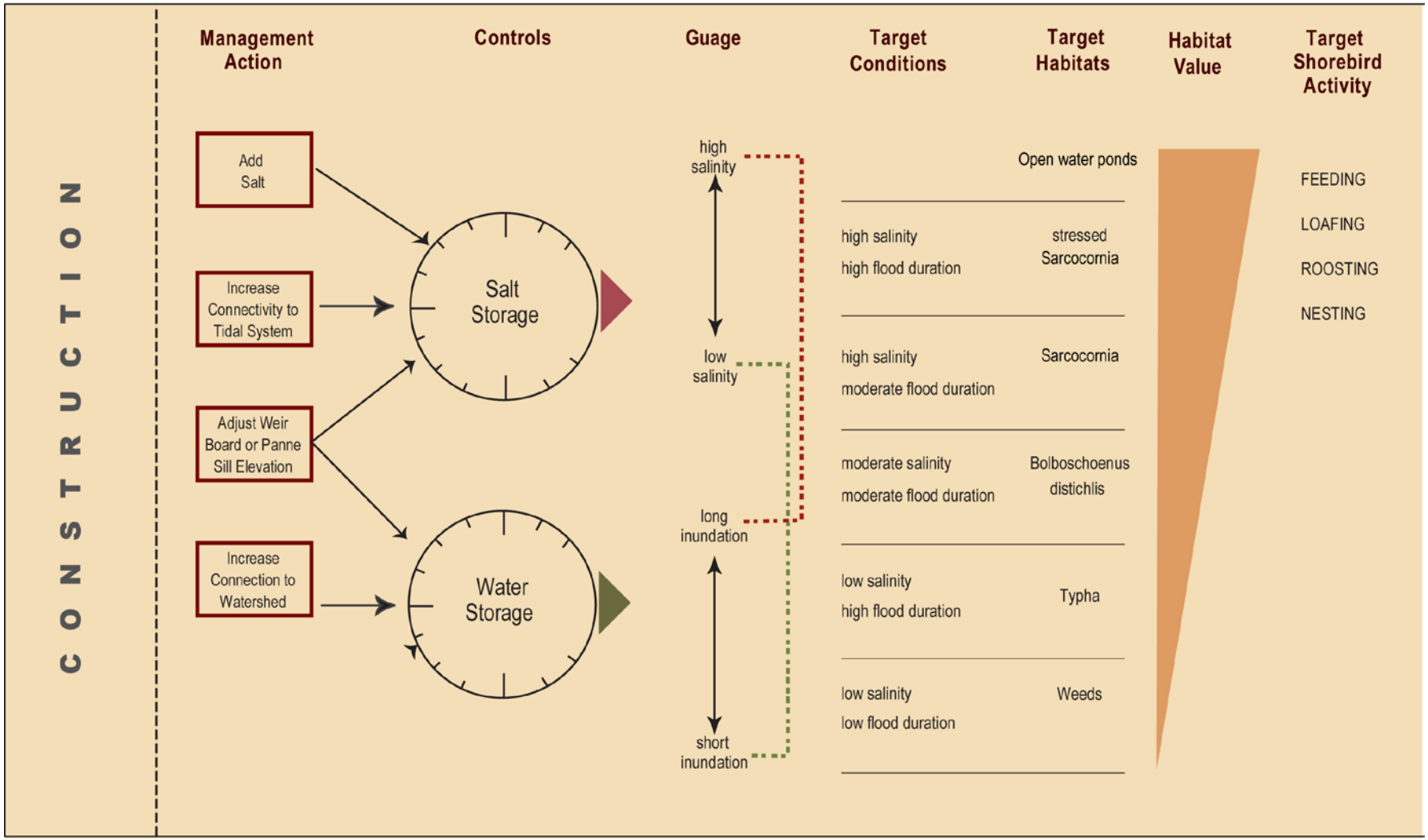


Figure C1
Conceptual model: Key Physical Drivers Influencing Ecological Outcomes of Seasonal Wetland Restoration

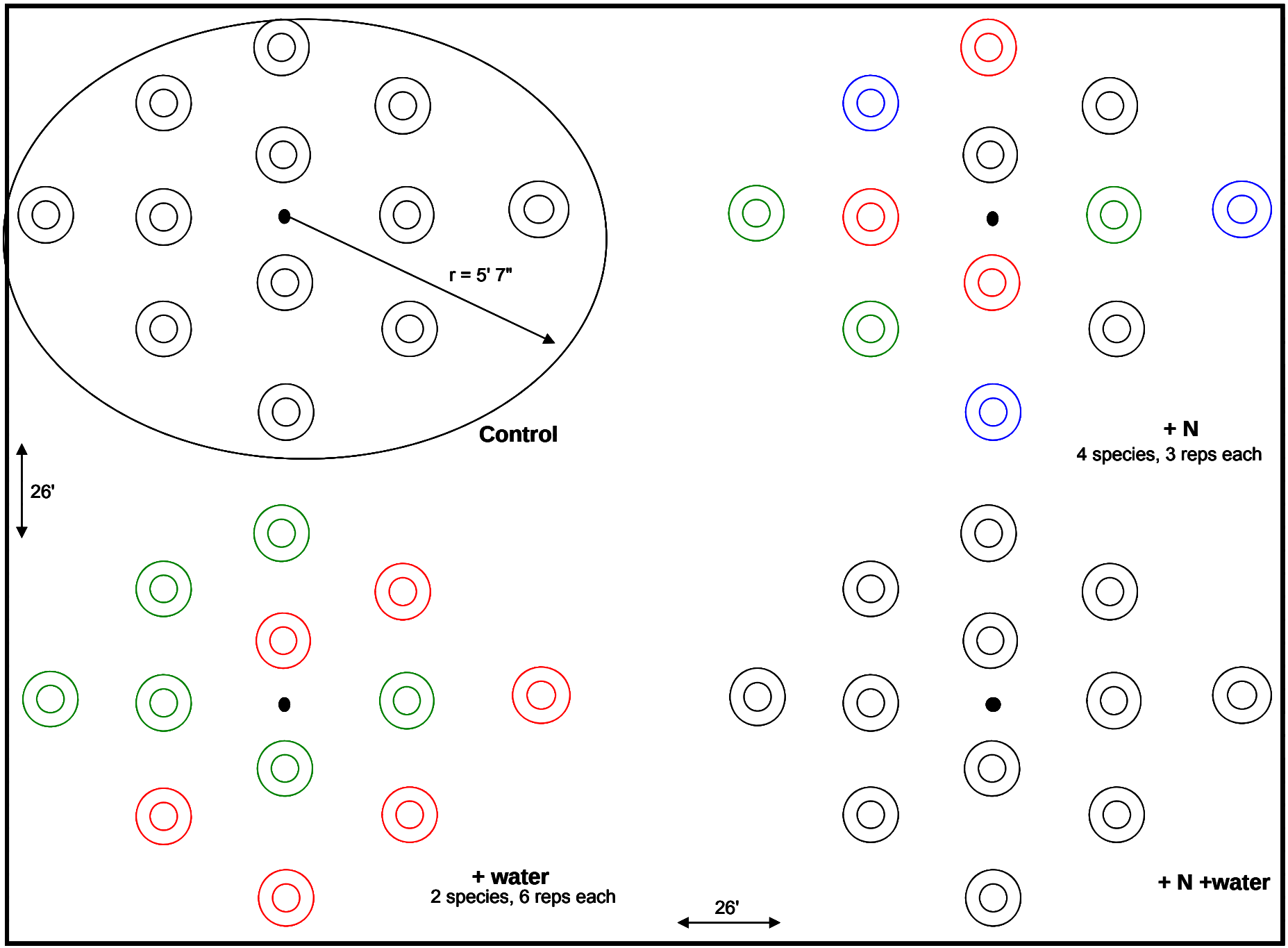


Figure C2. Test polygon showing four treatment plots each containing 12 founders. Total number of plants per polygon = 48, composed of 2 or 4 species.

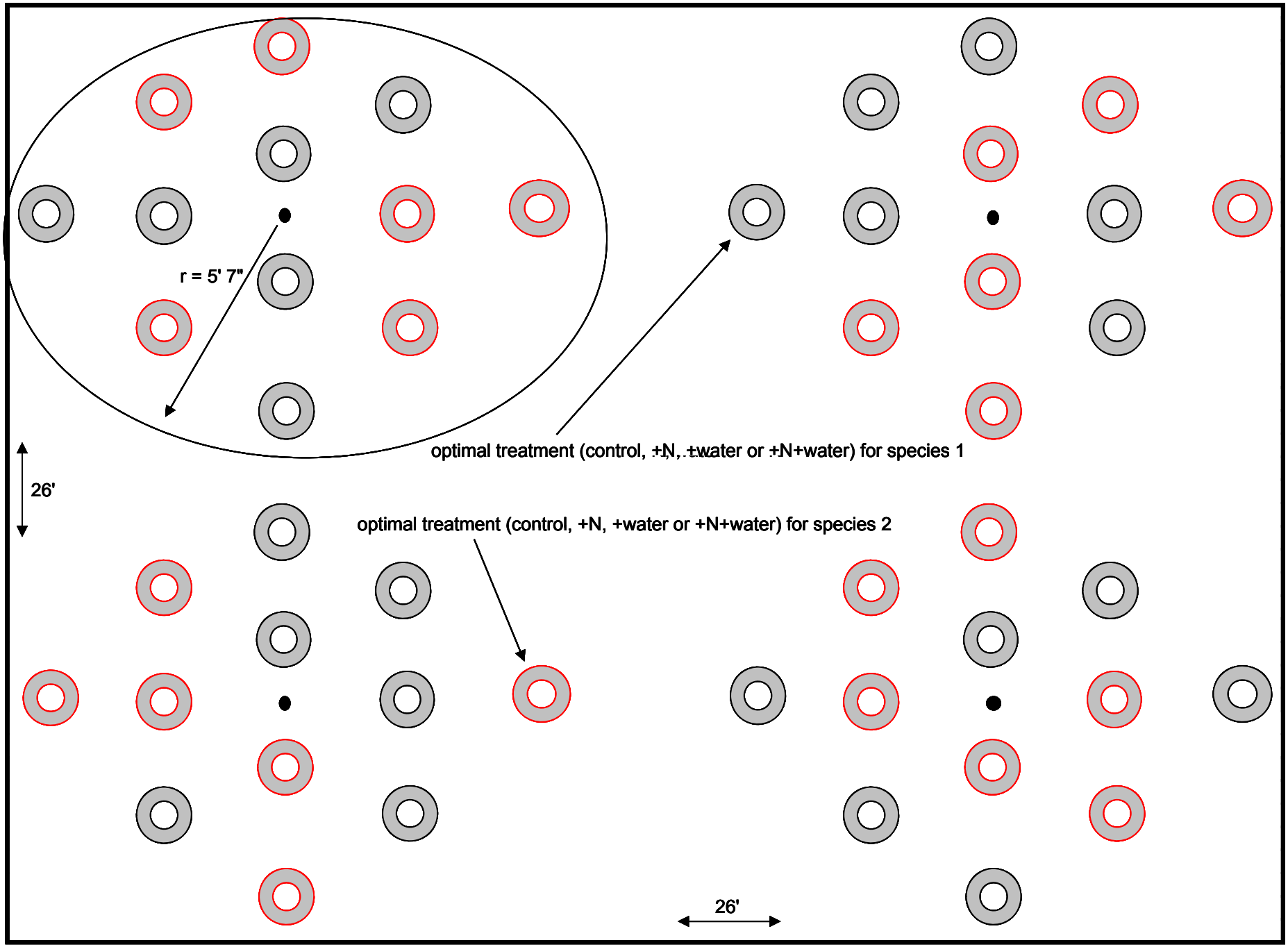


Figure C3 Installation polygon showing four plots each containing 12 founders Total number of plants per polygon = 48 composed of 2 appropriate species.

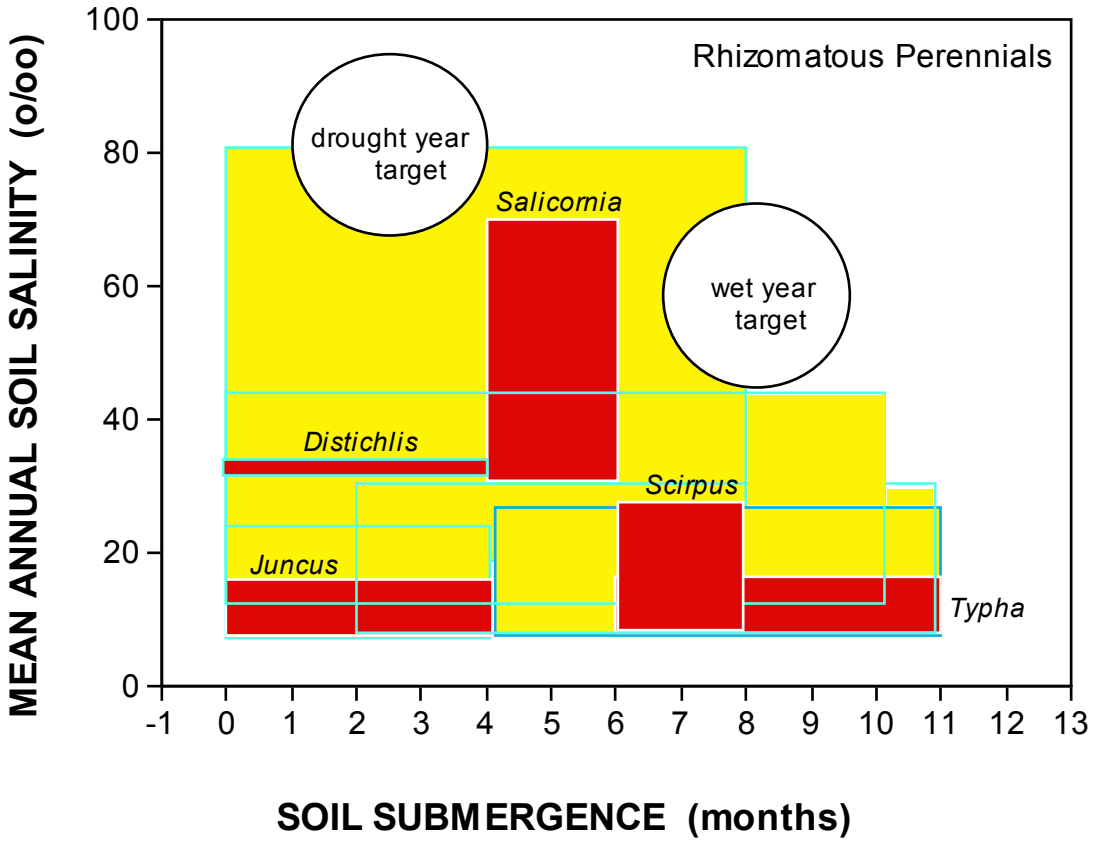


Figure C4. Optimal (red, dark) and subopimal (yellow, light) conditions of soil submergence and salinity of five wetland genera of rhizomatous perennial plants. Circles indicate suboptimal or determental target conditions that could be used to control succession in seasonal wetlands at Hamilton Army Airfield, Marin County, CA. Data from Mall (1969).

APPENDIX D

Tolerance Limits of Wetland Plants in Relation to Adaptive Management

APPENDIX D. Tolerance Limits of Wetland Plants in Relation to Adaptive Management

The physiological tolerance limits of acceptable wetland plants in northern California have been extensively investigated with respect to submergence and salinity in the Suisun Marsh (Mall 1969). Those limits will be used as thresholds for the control of succession in created wetland habitats (Appendix H). Below is a summary of those limits for native and naturalized plants that are likely to form the emergent wetland vegetation of the HWRP. The order is from freshwater to tidal species.

Juncus balticus (baltic rush)

Baltic rush becomes dominant when there is 0 to 4 months of flooding during the winter (e.g. November to February) (Mall 1969). Within this range, growth and competitive ability are not apparently affected, so the species is usually found along the upper, dry edge of wetlands in contact with upland species. Mean annual soil salinities (from 1:5 soil /water extracts) in the root zone of baltic rush stands ranges from 16 to 24 o/oo (–1.5 MPa) in the Suisun Marsh. Competitive ability increases as mean annual soil salinities drop below 16 o/oo (-1.0 MPa), making it the least salt tolerant of all native wetland species considered here. Therefore, controlling succession to dominance by baltic rush can be achieved with either seasonal submergence of 5 months or more or mean annual root zone salinities exceeding 24 o/oo or both. High salinities during the early growth period in winter (e.g. January to February) are particularly inhibitory.

Typha latifolia. T. angustifolia and hybrids (cattails)

Cattails require long periods of flooding, between 6 and 11 months of continuous submergence to form closed stands (Mall 1969). Under this regime only Olney bulrush (*Bulboschoenus olneyi*) is able to maintain itself within the cattails. Periods of flooding less than 5 months (during the winter, roughly November to March) allow other wetland species to relegate cattails to subdominant status. Depth of submergence is not an important factor for cattails, other than in its correlation with flooding period. Mean annual soil salinities (from 1:5 soil /water extracts) in the root zone of cattail-dominated stands ranges from 8 to 25 o/oo (–1.6 MPa) in the Suisun Marsh. Competitive ability rapidly declines when mean annual soil salinities exceed 27o/oo (-1.8 MPa). Therefore, preventing succession to dominance by cattail can be achieved with either seasonal submergence of five months or less or mean annual root zone salinities exceeding 27o/oo or both. During the summer a lack of inundation should also correspond with high root zone salinities to effectively exclude cattail.

Bulboschoenus acutus, B. robustus (bulrush)

Bulrushes become dominant on soils submerged between 3 and 11 months, with 7 to 8 months optimal for producing closed stands (Mall 1969). Areas submerged more than 8 months support diminished stands that allow invasion by cattail. Competitive ability is diminished below 6 months and areas submerged for 2 months or less do not contain bulrush. Depth of submergence is not an important factor for bulrush, other than in its correlation with flooding period. Mean annual soil salinities (from 1:5 soil /water extracts) in the root zone of bulrush-dominated stands ranges from 7 to 32 o/oo (–2.1 MPa) in the Suisun Marsh. The optimal level of mean annual salinity is 22 o/oo (-1.4 MPa), diminishing below 9 o/oo and above 28 o/oo.. Therefore, preventing succession to dominance by bulrushes can be achieved with either seasonal submergence of 6 months or less and/or mean annual root zone salinities above 32 o/oo.

Cotula coronopifolia (brass buttons)

Brass buttons is a common, naturalized species that occupies middle to lower elevations in Bay Area wetlands. It becomes dominant on soils submerged between 2 and 4 months during the winter (November to February) (Mall 1969). Areas submerged more than 4 months (after February) have delayed germination and progressively support fewer plants. Depth of submergence is not an important factor for brass buttons, other than in its correlation with flooding period. Mean annual soil salinities (from 1:5 soil /water extracts) in the root zone of brass button stands ranges from 9 to 31 o/oo (–2.0 MPa) in the Suisun Marsh. At levels above 22 o/oo (-1.4 MPa) brass buttons becomes subdominant. Therefore, controlling succession to dominance by brass buttons can be achieved by submergence of 4 months or more extending into spring and/or mean annual root zone salinities above 22 o/oo.

Distichlis spicata (saltgrass)

Saltgrass is encountered over a wide range of wetland elevations. Consequently, it appears to have broad tolerance limits for inundation. Dominance can be achieved if stands are continuously submerged for between 0 and 10 months (Mall 1969). No inundation provides optimal conditions for stand development, but increasing inundation results in progressive but slow decline. Depth of submergence is not an important factor for saltgrass, other than in its correlation with flooding period. Mean annual soil salinities (from 1:5 soil /water extracts) in the root zone of saltgrass-dominated stands ranges from 12 to 44 o/oo (–2.9 MPa) in the Suisun Marsh. Competitive ability declines when mean annual soil salinities are below 32 o/oo (-2.1 MPa) and above 34 o/oo (-2.3 MPa), indicating a narrow tolerance range for salinity. When mean salinity rises above 35 o/oo in mid-July, saltgrass stands turn yellow and stop growing. Therefore, controlling succession to dominance by saltgrass can be achieved with prolonged flooding (e.g. 6 months or more) or mean annual root zone salinities above 34 o/oo. Some combination of prolonged winter flooding and high summer salinity may be required.

Sarcocornia virginica (pickleweed)

Pickleweed is encountered over a wide range of wetland elevations. Consequently, it appears to have broad tolerance limits for inundation. Dominance can be achieved if stands are continuously submerged for between 0 and 8 months (Mall 1969). The optimal range for stand development is, on average, between 4 and 6 months, significantly diminishing (but not completely) when flooding exceeds 8 months. Areas submerged more than 10 months allow very little growth probably because the stems lack oxygen transport tissues (aerenchyma) that support respiring roots. Depth of submergence is not an important factor for pickleweed, other than in its correlation with flooding period. Mean annual soil salinities (from 1:5 soil /water extracts) in the root zone of cattail-dominated stands ranges from 18 to 81 o/oo (–5.7 MPa) in the Suisun Marsh. Competitive ability declines when mean annual soil salinities are below 31 o/oo (-2.0 MPa) and above 70 o/oo (-5.3 MPa). Therefore, controlling succession to dominance by pickleweed can be achieved with either seasonal submergence of 8 months or more or mean annual root zone salinities fall below 31 o/oo or exceed 70 o/oo. Some combination of prolonged winter flooding and high summer salinity may be required.

APPENDIX E

USGS-USFWS Monitoring Framework

Appendix E: USGS-USFWS Monitoring Framework

1.1 Linking Restoration to Management and Monitoring

The relationship between restoration, management and monitoring for the HWRP is based upon the following principles:

1. Our ability to successfully create or restore habitats is related to our current understanding of their ecological structure and function.

2. Adaptive management is a framework for improving our understanding, but it is also a decision-making process. Consequently, it may incorporate hypothesis testing ("science") or it may apply best available technologies, depending on the relative uncertainty associated with expected outcomes.

3. Monitoring programs must first supply information for decision-making, focused on measuring those attributes that are amenable to management actions. Consequently, data that do not drive decision-making should not be collected when time and money are limited.

4. The role of science is to fill data or knowledge gaps that elevate uncertainty in the outcome of ecological restoration and management. Science is focused on achieving restoration success (the vision of goals and objectives) by answering "key management questions."

5. Common practices management, unlike adaptive management, allows a site manager to take actions with minimal oversight and monitoring requirements because the uncertainty of a favorable restoration outcome is low or negligible.

These principles require strong linkages between how we expect a created habitat to develop and operate, what tools we have to manage or "adjust" the outcome, the different forms of management intervention and what measures we will take to evaluate the restoration trajectory and the available management tools. These linkages are examined in detail in Sections 14.2 and 14.3 of this plan. Below is an overview of how we expect the created tidal, seasonal and upland habitats of the HWRP will be managed and monitored.

1.2 Forms of Management

The HWRP will create three types of habitat; uplands, tidal wetlands, and seasonal wetlands. Each type has its own biological purposes, ecological characteristics, and uncertainties associated

with construction, operations and long-term maintenance. Consequently, each habitat type requires its own form of management and its own array of appropriate monitoring measures. It is important to link monitoring to specific forms of management so that decisions with the highest levels of uncertainty are informed by the most rigorous, focused monitoring data.

Three general forms of management will be required for the HWRP: Common Practices Management (CPM) for the upland habitat, Adaptive Management with best available technology (AMbat) for the tidal wetlands habitat, and Adaptive Management with hypothesis testing (AMhyt) for the seasonal wetlands. Each form of management corresponds to a different level of uncertainty in the outcome and in the reliability of tools and techniques used to achieve restoration objectives. CPM will be used in the upland habitat because there is no doubt an upland will be created (100% certainty, no uncertainty) and because existing tools for improving its quality are well-developed and readily implemented (hydroseeding, weed control, outplanting with natives). There is also high certainty that tidal wetland habitat will be created as planned. But AMbat will be used in the tidal wetlands at the HWRP site because some features of the developing habitat may not arise without ongoing adjustments. Those adjustments are made based upon best available technology (e.g. models, empirical evidence, other projects) that has been previously established. Data from an "implementation-type" monitoring program are used to confirm that adjustments are producing the desired trajectory for the developing habitat. Finally, AMhyt will be used in the seasonal wetlands because previous attempts to create this habitat tend to produce undesirable outcomes with respect to vegetation composition and structure (failure about 75% of the time). Furthermore, the adjustments required to improve outcomes have not been previously tested for creating seasonal wetlands (e.g. changing weir board elevation to affect inundation, timing of weir board adjustments to affect salinity). Such tests require a science-driven approach that tests management-oriented hypotheses (Pavlik 1996) in a "validation-type" monitoring program (see below). This program generates monitoring data to evaluate adjustments experimentally so that proper and effective management actions can be applied to the wetland. These forms of management are discussed below with respect to the creation of habitat for the HWRP.

1.2.1 Common Practices Management

Common practices management (CPM) is used to manipulate the quality of a biological resource when uncertainty of the management outcome is very low or negligible. Consequently, when a manager or a working group (that oversees the manager) prescribes a proven treatment or use of a standard tool for achieving a resource objective, it is implemented without a scientific framework and with the expectation that the result is reasonably assured. Thus, the application of common practices needs no science, a simple (documentation-type) monitoring effort and minimal oversight by a management committee. An example is the outplanting of native plant species to achieve certain habitat qualities (e.g. roosting sites, predator escape) or aesthetic objectives). Such an activity involves a habitat design, selection of appropriate species, propagation, outplanting, and maintenance, but does not require models, control groups or replicate blocks to test an ecological hypothesis. Common landscaping practices, with simple monitoring (e.g. photoplots, flagging, other forms of documentation and record keeping) are sufficient to achieve habitat objectives.

For the HWRP, creation of upland vegetation on berms, behind levees and in the wildlife corridor will require a basic design template for habitat elements (e.g. scattered overstory of oak, coyotebush and buckwheat, with an understory mix of grasses and native forbs), standard propagation tools (container-grown plants, hydroseeding), simple maintenance (e.g. periodic watering, weed control), and simple monitoring with photoplots and basic record keeping. As such, the form of management for this developing upland habitat is CPM to ensure heterogeneous cover by mostly native, perennial species. Simple success criteria (Section 3.5.3) will allow the evaluation of management actions and the final assessment of objectives for this habitat.

1.2.2 Adaptive Management for Tidal and Seasonal Wetlands Habitats

Adaptive management is the regime that is required when significant data gaps and uncertainties are associated with the creation or enhancement of biological resources, whether the resources be populations, species, habitats or entire ecosystems. The gaps and uncertainties associated with the creation and operation of tidal and seasonal wetlands at the HWRP site have already been discussed elsewhere in this report, but to summarize: 1) Naturally-occurring tidal wetlands (usually dominated by *Sarcocornia pacifica*), are common and well-studied in the San Francisco Bay region. Projects that have attempted to create tidal wetlands in the region have generally been successful (e.g. PWA and others 2005), although the formation of some features (e.g. channels, ecotones) remains uncertain. Therefore, a decision-making process that oversees tidal wetlands creation for the HWRP is required, but the level of uncertainty is sufficiently low to warrant use of the best available technologies developed by other projects, elsewhere. 2) Naturally-occurring seasonal wetlands are rare and poorly understood in the San Francisco Bay region. Projects that have attempted to create seasonal wetlands have produced poor- to moderate-quality habitat, and the salinity/water inundation conditions required to produce high quality habitat appear to be narrow and difficult to achieve. Therefore, a decision-making process that oversees seasonal wetlands creation and subsequent management actions for the HWRP is required, but the level of uncertainty is sufficiently high to warrant use of a scientific framework for testing management-oriented hypotheses (e.g. potential management actions/adjustments). Those decisions and actions must be informed and evaluated by robust scientific information, generated by a validation-type monitoring program, as well as by directed (i.e. management-oriented) research when necessary. The best way to combine the decision-making process with best available technology or hypothesis testing is through an adaptive management framework.

Adaptive management is iterative: it evaluates decisions or actions through carefully designed monitoring and proposes subsequent adjustments (Mulder and others 2000, Pavlik and Espeland 2005). The adjustments are in turn tested with an appropriate, perhaps redesigned, monitoring protocol. Adaptive management is logical, can deal with uncertainty and data gaps, and can incorporate the scientific process of hypothesis testing. It is also a learning process, imbedded within a regulatory and bureaucratic environment that presents logistical, political and economic constraints. Each stakeholder can voice a unique perspective (as well as their disagreements), but all are ultimately focused on enhancing the biological resource by cooperating in an open, non-adversarial process.

The process of adaptive management is often represented as a cycle of strategy, design, implementation, monitoring, and evaluation (Figure 9). The first and most important task for installation of the process is to develop a strategy that includes goals and objectives for a target resource, an inventory of known tools or actions for advancing the objectives (e.g. propagation of plants, weed control, hydrological manipulation), and the development of Key Management Questions (KMQs) that structure all subsequent monitoring and research activities. It is absolutely essential that stakeholders serving on the Adaptive Management Working Group (AWMG) cooperatively develop these elements of the strategy. Such cooperation will ensure that 1) stakeholder efforts (and the data they generate) will be focused, 2) successful actions (those demonstrated to be beneficial) will be promptly and correctly applied, and that rejected actions (those found to be detrimental) will be curtailed, and 3) emphasis will be placed on decision-making for improvement of target resources, not the generation of copious, unfocused data in a "everything but the kitchen sink" monitoring program.

Objectives and success criteria are needed to provide a vision for the long-term status of the resource – how it is structured and how it functions (thus, how it fulfills its purpose). That vision (e.g. whether it includes providing seasonal wetland habitat for special status species (i.e. listed as endangered, threatened or of conservation concern) as well as shorebirds) must be defined through consensus in order to have the broadest possible stakeholder support. Without that support, opposition or apathy can bring implementation to a standstill. The vision cannot be forced upon stakeholders by regulatory agencies; it can only be guided and facilitated.

Cooperative and committed management of the seasonal wetlands at the HWRP site will depend on the long-term efforts of motivated stakeholders. Those stakeholders (e.g. CCC, ACE, BCDC, USFWS, CDFG, CNPS, homeowner groups) will participate on the AMWG in order to resolve scientific, logistic and political issues that inevitably confront such a complex, expensive and time-consuming project. One of the first jobs of the AMWG will be the finalization and adoption of revised success criteria (= habitat-specific objectives) that speak to expected developmental trajectories and desired future states of the created habitats. The proposed restoration targets, presented in Section 2 of this plan, address the physical and biological components established by the Letter of Consistency (CN7-05) and other regulatory mandates (Section 4). However, it is likely that in the years immediately following breach there will be improved information and measurement technologies developed that lead to better restoration targets. It will be the job of the AMWG to incorporate those improvements into revised criteria.

Once success criteria have been finalized and adopted, other elements in the strategy can be developed. Especially important will be the Key Management Questions (KMQs) that focus science on specific management issues and data gaps to realize the vision set out in the goals and criteria. KMQs effectively constrict the tendency of purely academic investigations to "widen", that is, to generate new hypotheses of great interest to researchers but with little relevance to actually "doing" management. So, the broad base of scientific inquiry (e.g. geology, hydrology, genetics, ecology) is narrowed to a fine point by well-constructed KMQs. Similarly, the broad base of management vision (e.g. a seasonal wetland that provides resting, nesting and feeding habitat for shorebirds) is narrowed to another fine point by the same KMQs. Thus, KMQs bind the science and management vision together – no science is done unless it can be related to

directly achieving specific goals and objectives of the program. An operating example of the critical role of KMQs in adaptive management is presented in Pavlik and O'Leary (2002) as a component of the program detailed in Pavlik and others (2002) and Pavlik and Stanton (2005). These reports detail adaptive management for restoration of the rare, but federally unlisted plant (Tahoe Yellowcress, *Rorippa subumbellata*) that has been implemented on behalf of multiple state and federal agencies in the Lake Tahoe Basin.

1.3 Forms of Monitoring

1.3.1 Simple Monitoring for Common Practices Management

Simple monitoring requires minimal design, effort and data collection. It is used to confirm or document that management actions were conducted (e.g. founders were outplanted, weeds removed). Less emphasis is placed on quantifying the outcomes of those actions, although baseline records (number, identity and location of founders) will be kept. Photo-monitoring stations and a map (GPS) record of all CPM efforts, including weed control, will also be part of the simple monitoring program for upland habitats for the HWRP. For the most part, simple monitoring is non-quantitative, but it still requires meticulous data collection and storage techniques to be useful.

1.3.2 Monitoring for Adaptive Management

Monitoring informs management. It is designed and implemented with the expressed purpose of determining if actions are effective and if success criteria for a given habitat are being achieved. Unlike CPM with simple monitoring, higher levels of uncertainty in adaptive management projects require that the outcome of an action (e.g. an adjustment or a management experiment) be fully quantified and evaluated. Consequently, some basic elements of quantitative monitoring are universal; consistency (repeatable methods applied each year), constancy (applied at regular time intervals), and appropriateness (for the target resource). Such design elements are essential for evaluating actions and research efforts, as well as revealing the status of the focal resource (in this case, the development of tidal and seasonal wetland habitats).

There are two general types of quantitative monitoring that could be used in adaptive management programs, implementation and validation.

1.3.2.1 Implementation Monitoring for Adaptive Management with Best Available Technology (AMbat)

Implementation monitoring is designed to evaluate the efficacy of applied management actions (= adjustments to the operation of the project). It tells the AMWG if a given attempt at improving the quality of a resource (e.g. tidal wetland habitat) has been successful (i.e. meeting the criteria proposed in Section 3.3 and/or refined by the AMWG) using a reasonable, previously tested adjustment (presumably the best available technology). Although the action itself may not be replicated for statistical purposes, multiple samples or instrument stations are used to gauge the

effect across the project area (see Section 5). The data thus generated can be compared to a baseline condition or reference site to determine if the adjustment provided the predicted change in resource quality. In addition, the characteristics of the developing wetland habitat can be compared to established success criteria for the purpose of project evaluation. This type of monitoring and would be designed by science-trained members of the Technical Advisory Group, with input from the Site Manager and associated consultants who would ultimately perform the adjustment and data collection.

1.3.2.2 Validation Monitoring for Adaptive Management with Hypothesis Testing (AMhyt)

Validation monitoring is used to test an operational model of a population or habitat or to test a management-oriented hypothesis. It may utilize management treatments, but with a rigorous design (e.g. replicates, controls) it attempts to establish ecological cause and effect. With respect to the HWRP, it is also applied to the development of management tools (= new adjustments) for achieving specific outcomes by measuring the effects of relevant variables (e.g. changes in weir board height) on ecological processes (e.g. vegetation development, shorebird feeding). Validation monitoring is used to fill very specific data gaps that have been identified and prioritized by the AMWG. It is very specialized, time-consuming and relatively expensive. Consequently, this type of science-oriented monitoring and should be designed by the Technical Advisory Group in consultation with expert consultants who would ultimately conduct the investigation (a proposed design is presented in Appendix D). The data thus generated would be used by the AMWG to develop new management recommendations based upon an improved operational model (understanding) of the target resource.

The principles and techniques of implementation and validation monitoring are given in Taylor and Gerrodette (1993), Pavlik (1994), Willoughby and others (1997), Thompson and others (1998) and Feinsinger (2001).

1.4 Switching Between Forms of Management

Adaptive Management using best available technology (AMbat) allows manipulation of the quality of a biological resource (e.g. the tidal wetlands) when uncertainty of the management outcome is low to moderate. Like CPM, AMbat is also implemented without a scientific framework because the suggested adjustments are well established from models (e.g. simulations of sedimentation rates vs. tidal exchange), empirical studies (e.g. experiments from other systems) or experience gathered on similar projects. The adjustments are, in the best professional opinion of the manager or working group, appropriate alterations in post-construction design or operations to achieve a resource objective. But the outcome of those adjustments (e.g. increased sedimentation rate, accelerated spread of *Sarcocornia*) depends on multiple, linked variables and cannot be readily predicted. There may also be several iterations of adjustment required to affect a complex variable in a desired manner, thereby achieving an appropriate trajectory. Thus,

implementation monitoring is required to determine if the action taken (e.g. the reasonable adjustment) is producing the desired outcome in the resource (see below).

Creation of tidal wetland habitat for the HWRP will require AMbat. Experience at other sites around San Francisco Bay (e.g. Sonoma Baylands, outer Muzzi Marsh) has demonstrated that existing approaches to wetland design, construction and revegetation are likely to produce a basic *Sarcocornia*-dominated habitat within 6 to 12 years after breaching the outer levee (e.g. PWA and others 2005). However, significant uncertainties remain with regard to channel and panne formation, vegetation complexity, and utilization by native animals (e.g. fish, California Clapper Rail, Salt Marsh Harvest Mouse). It may be necessary, for example, to enhance sedimentation rates, microdredge channels, alter the width of the breach, or inoculate with some plant species (e.g. *Grindelia*) in order to achieve habitat quality objectives. Consequently, AMbat can provide a framework for making these adjustments, with evaluation from a program of implementation monitoring.

It is possible that a resource (e.g. a newly created tidal wetland habitat) does not respond as reason might suggest and careful adjustments would intend. Monitoring data that document an unpredicted response, especially a shift away from established objectives, would provide justification for shifting the resource from an AMbat regime to an adaptive management regime that uses science to better understand the resource (tidal habitat) and its responses. This switch to Adaptive Management with hypothesis testing (AMhyt) will require more planning, money and effort in order to develop new, alternative management actions. Conversely, a resource that is conforming to expectations and meeting success criteria may not require an AMhyt regime and could be switched to AMbat or possibly CPM. Such switching decisions would be made by the AMWG after analysis of available monitoring data.

1.5 Forms of Management by Habitat Type

Creation of upland habitat, along with its Common Practices Management program and simple monitoring, will begin when appropriate native plants have been propagated and outplanted into the Wildlife Corridor (Pavlik and McWhorter 2010). Creation of tidal and seasonal wetlands, along with their particular forms of adaptive management and monitoring, will commence with the breach of the outboard levee and subsequent intrusion of tidal waters. Each of these habitats requires a different management and monitoring approaches because each has a different level of uncertainty associated with its restoration success.

1.5.1 Adaptive Management of Tidal Wetlands

Naturally-occurring tidal wetlands are common and well-studied around San Francisco Bay. Tidal wetland restoration projects in the region have been broadly successful, achieving vegetated marsh and channel networks that support special status, endemic species. The formation of some habitat features, however, requires continuing improvement in quality (e.g. channel structure, vegetation ecotones). While guidelines for aiding tidal wetland restoration exist (PWA, 2004), novel lessons are always being learned from each attempted project. Perhaps the greatest

uncertainty with the restoration of tidal wetlands with a site as large as the HWRP is the impact of wind waves on sediment resuspension and, in turn, the rate of site evolution and the final mix of vegetated marsh and unvegetated mudflat. Channel establishment is another, less certain, part of the tidal wetland restoration.

During the early planning of the restoration project, in the 1990's, the rapid establishment of vegetated marsh was seen as a key requirement; nowadays the value of establishing a mix of habitat intertidal types has gained heightened recognition. Similarly there has been a growing shift in understanding that monitoring activities should track the evolution of a restoration site towards the desired outcome, but that the outcome will not necessarily be achieved within a few years. Given previous levels of success, low to moderate levels of uncertainty are associated with creating tidal wetlands at Hamilton and thus adaptive management with 'implementation' monitoring is warranted. This form of adaptive management utilizes proven approaches and actions developed by other projects, requiring little to no experimentation for creating tidal wetlands at the HWRP. The monitoring, therefore, is only needed to determine if those approaches and actions are producing the same results on the Hamilton site as they have at other sites.

This implementation monitoring is then designed to evaluate the effectiveness of adaptive management actions and to steer the restoration towards its ecological objectives. It provides data on whether a given management action to improve the quality of tidal wetland habitat has been successful using a reasonable, previously tested action (presumably the best available technology). The data generated can be compared to a baseline condition or reference area to determine if the management action provided the predicted change in resource quality. Data from the implementation monitoring would be used to confirm that restoration actions are producing the desired trajectory to meet the success criteria for the developing habitat. Details about implementation monitoring are presented in Sections 5 and 14.3.2.1 of this plan.

When uncertainties do arise concerning the formation or operation of tidal wetlands at Hamilton, the AMWG can perform specialized monitoring to answer specific questions. For example, there may be uncertainty concerning the developing structure of the channel network and whether portions are deep enough and with enough overhang to provide habitat for the California Clapper Rail (*Rallus longirostris obsoletus*). A field survey of channel cross sections (in addition to existing cross sections; Section 5.3.2) can then be designed and conducted for just that purpose. Other uncertainties with respect to HWRP tidal wetlands might include whether constructed berms are acting as corridors for unwanted predator activity, or what the effects of wave action are on sedimentation and erosion. But until those questions arise, such monitoring would not take place, allowing managers to focus on other aspects of the project.

1.5.2 Adaptive Management of Seasonal Wetlands

Naturally-occurring seasonal wetlands are rare and poorly understood in the San Francisco Bay region. Projects that have attempted to create seasonal wetlands have produced poor- to moderate-quality habitat, and the salinity/water inundation conditions required to produce sustainable, high quality habitat appear to be narrow and difficult to achieve (Appendix E).

Furthermore, the management actions required to improve outcomes have not been previously tested (e.g. changing weir board elevation to affect inundation, timing of weir board adjustments to affect salinity). Hence, high levels of uncertainty are associated with creating seasonal wetlands, requiring a science-driven approach to test management-oriented hypotheses in a 'validation' monitoring plan.

Validation monitoring will guide adjustment in site controls to achieve a preferred outcome, thus establishing ecological cause and effect. With respect to the HWRP, it will be applied to the development of management tools for achieving specific outcomes by measuring the effects of relevant variables (e.g. weir board adjustments) on ecological processes (e.g. pond depth, soil salinization, vegetation development, shorebird feeding). Science is thus built into the decision-making process so that a better understanding can be achieved from conducting management actions and implementing those that prove beneficial to the seasonal wetlands. Details about validation monitoring are presented in Sections 4, 1.3.2.2 and Appendix D) of this plan.

1.5.3 Common Practices Management of Upland Habitats

The low levels of uncertainty associated with creating upland habitats (transitional and dry) will require a program of common practices management (CPM). CPM will be used because there is little doubt upland habitats will be created and because existing tools for improving their quality are well-developed and readily implemented (hydroseeding, weed control, landscaping with native plants). Simple monitoring requires minimal design, effort, and data collection. It is used to document that management actions were conducted (e.g. founders of populations were outplanted, weeds removed). Less emphasis is placed on quantifying the outcomes of those actions, although baseline records (number, identity and location of founders) will be kept. Details about CPM are presented in Sections 7 and 14.3.1 of this plan

APPENDIX F

USFWS, BCDC and RWQCB Regulatory Documents

Making San Francisco Bay Better

February 13, 2009

Lt. Col. Laurence Farrell
Department of the Army
U.S. Army Corps of Engineers, San Francisco District
1455 Market Street
San Francisco, California 94103-1398

SUBJECT: Consistency Determination No. CN 7-05, Amendment No. Four

Ladies and Gentlemen:

Enclosed please find an Amended Letter of Agreement for Consistency Determination No. 7-05, incorporating the amendment requested in your letter of December 29, 2008. In the Amended Letter of Agreement, deleted language has been ~~struck through~~ and added language has been underlined.

I am issuing this amendment on behalf of the Commission and upon the following findings and declarations:

1. The amendment to the Letter of Agreement is issued pursuant to Regulation Section 10812 upon the same criteria provided for the issuance of administrative permits and consistency determinations in that the project authorized by this amendment involves the addition of the Navy ball field parcel into the southern seasonal wetlands portion of the Hamilton Wetland Restoration Project for which the Executive Director may issue a letter of agreement, pursuant to Government Code Section 66632(f) and Regulation Section 10622(a).
2. The amendment to the Letter of Agreement is consistent with the Commission's Amended Management Program, the San Francisco Bay Plan, and the McAteer-Petris Act because the proposed project will not adversely affect the San Francisco Bay Coastal Zone, the Bay nor public access to and enjoyment of the Bay consistent with the project.

Thank you for your cooperation. If you have any questions concerning the Amended Letter of Agreement, please contact Brenda Goeden at 415-352-3623 or via email at brendag@bcdc.ca.gov.

Very truly yours,

CAITLIN SWEENEY
Chief Deputy Director

Enc.
CS/BG/ec
cc: Irene Lee, U.S. Army Corps of Engineers
Eric Jolliffe, U.S. Army Corps of Engineers
Dave Smith, U.S. Environmental Protection Agency
Naomi Feger, S.F. Bay Regional Water Quality Control Board
Donn Oetzel, State Lands Commission
George Isaac, California Department of Fish and Game
David Woodbury, NOAA Fisheries
Ryan Olah, U.S. Fish and Wildlife Service
Eric Polson, Polson Engineering
Tom Gandesbery, California State Coastal Conservancy

Making San Francisco Bay Better

LETTER OF AGREEMENT FOR
CONSISTENCY DETERMINATION NO. CN 7-05
(Issued on August 18, 2005, As
Amended Through February 13, 2009)
AMENDMENT NO. FOUR

U.S. Army Corps of Engineers
San Francisco District
1455 Market Street
San Francisco, California 94103

ATTENTION: Lt. Colonel Laurence Farrell

Ladies and Gentlemen:

On August 18, 2005, the San Francisco Bay Conservation and Development Commission, by a vote of 19 affirmative, 0 negative, and 0 abstentions, adopted the original resolution pursuant to which this consistency determination was issued. Moreover on September 13, 2006, August 27, 2007, ~~and~~ December 11, 2008, and February 13, 2009, pursuant to Commission Regulation Section 10810, the Executive Director approved Amendment Nos. One, Two, ~~and~~ Three, and Four, pursuant to which this amended consistency determination is hereby issued:

I. Agreement

A. The San Francisco Bay Conservation and Development Commission agrees with the determination of the U.S. Army Corps of Engineers that the following project located at the former Hamilton Army Airfield in the City of Novato, Marin County, as conditioned, is consistent with the Commission's amended management program for San Francisco Bay.

Under the Amended Coastal Zone Management Act, and the Department of Commerce regulations, the federal agencies are required to carry out their activities and programs in a manner consistent with the Commission's federally-approved coastal management program, which includes the *San Francisco Bay Plan* (Bay Plan). The federal consistency requirement for this project is: "A federal activity that directly affects land or water uses within the coastal zone must be consistent to the maximum extent practicable with the coastal management program." Because the Hamilton Wetlands Restoration Project will affect the coastal zone, it must be consistent to the maximum extent possible with the Bay Plan (Amendment No. Three).

In the Bay:

1. Install, use, and maintain a temporary (for up to 8 years) structure for the offloading of dredged sediments from barges consisting of the following elements:
   a. an approximately 75-foot by 250-foot (a total of 18,750 square feet) diesel or electrically operated dredged material offloader to hydraulically offload dredged material from dredge scows;
   b. one 50-foot by 150-foot (a total of 7,500 square feet) attendant barge for tools and equipment;
   c. three flat-deck mooring barges, each 75 feet by 250 feet (a total of 56,250 square feet);
   d. 29 three-pile dolphins for mooring dredge scows and booster pump barges (273 square feet);
   e. two booster pump barges, each 50 feet by 150 feet (a total of 15,000 square feet);
   f. an approximately 27,000-foot-long by 30-inch-in-diameter, submerged dredged material transport pipeline resting on the Bay bottom (totaling 67,000 square feet);
   g. an approximately 500-foot by 30-inch-in-diameter floating pipeline (1,250 square feet);
   h. pipeline collars and anchors along approximately ten percent of the pipeline (totaling 6,700 square feet); and
   i. 32,000 feet of 8-inch-in-diameter electrical supply cable (totaling 21,333 square feet), connecting to the shoreline, if an electrically powered offloader is used. All of these elements combined total 194,056 square feet (4.5 acres) of new Bay; and
2. Dredge approximately 25,000 cubic yards (cy) from the existing salt marsh to create a tidal channel from the Bay to the project site using a small cutter-head hydraulic dredge or excavator, and place the dredged material either onsite if the material is determined to be cover quality, at the adjacent Bel Marin Keys V parcel, at the Montezuma wetlands disposal site, or at another location authorized by the Commission. The channel will be 165 feet wide by 800 feet long at the surface. The channel will be dredged to minus 6 feet Mean Low Low Water (MLLW), for a total of 132,000 square feet (3.0 acres) of tidal marsh impacted by the project.

Partially within the 100-foot shoreline band:

1. Construct, use and maintain a 5,700-foot-long section of levee along the northeastern boundary, a 4,050-foot-long section of levee along the northern boundary, a 2,025-foot-long section of levee along the southwestern boundary, and a 3,075-foot-long section of levee along the southern boundary of the site;
2. Maintain two existing pump-house facilities and one electrical substation, and remove both pump house facilities and electrical substation prior to breaching the Bay front levee of the site;
3. Place three 12-inch-in-diameter, 5,000-foot-long electrical conduits in or on the ground along the Bay front levee to provide power to the existing pump-houses, and potentially to the offloader facility;
4. Place, on a temporary basis, a 100-foot-long segment of 30-inch-in-diameter, dredged material transportation pipeline along the shoreline band;
5. Place an approximately 5,000 cy portion of the approximately 7.9 ~~7.1~~ million cy of cover quality dredged sediment to a maximum elevation of +4.7 NAVD '88 (Amendment No. Four);
6. At project completion, lower the existing Bay front levee and potentially excavate sediment up to three feet deep below the levee, and backfill with cover quality sediment to a maximum of +6.23 feet NAVD '88 (approximately MHHW); and
7. Breach a 15-foot-deep (to minus 6 feet MLLW), 280-foot-long by 200-foot-wide section of the Bay front levee to create a tidal connection between the site and San Pablo Bay in the northern portion of the levee.
8. Place up to 65 power poles and electrical lines within the transmission corridor (Exhibits B and C). A maximum of 20 poles (of the total 65) will be placed adjacent or on the western side of the outboard levee (Amendment No. Two).
9. Place one 800-square foot earthen pad, one 225 sq. ft. earthen pad, one booster pump on the earthen pad, one supporting substation on the second earth pad. The earthen pads, booster pump and substation will be located adjacent to the western side of the outboard levee as shown in Exhibit C (Amendment No. Two).
10. Install and operate two 24-inch pumps and two 24-inch pipes connecting the new pumps to the existing 35-inch outfall pipe to return dredged material decant water and storm water to the Bay (Exhibit D)(Amendment No. Two).

In the Commission's Wildlife Priority Use Area:

1. Construct, monitor and maintain 395 acres of tidal marsh; 13 acres of tidal pannes; 160 acres of seasonal wetlands; 35 acres of uplands (wildlife corridor); 3.9 acres of public access; and 41 acres of developed lands (levee system) using dredged sediment from San Francisco Bay (Amendment No. Three);
2. Construct and maintain 15,825 feet of perimeter levees as described on Figure 13 of the Corps submittal (Amendment No. Three);

3. In the tidal wetlands area, construct seven intertidal wave fetch berms to a maximum height of 6.1 feet NAVD '88 (approximately MHHW) and total length of 7,740 feet (Amendment No. Three);

4. Place dredged sediment in the tidal area to the maximum elevation of 4.5 feet NAVD 88 around the perimeter of the tidal wetlands and 2.6 feet NAVD 88 in the center of the tidal wetlands. Place sand up to an elevation of 3.0 feet NAVD 88, in the southern seasonal wetlands, sculpt and place mud to final fill elevations as determined by the marsh restoration plan and final design documents. The overall volume authorized for placement at the site is 7.9 ~~7.1~~ million cy of sediment (Amendment No Four ~~Three~~);

5. Add the approximately 18.4-acre Navy ball field parcel to the existing wetland restoration project (Exhibit E)(Amendment No Three);

6. Construct a berm to prevent dredged sediment from being placed on City of Novato property until such a time that the City of Novato provides an easement or other adequate property interest to the Corps for placement of sediment on City of Novato property (Amendment No Three);

7. Construct, maintain, and use a 2.66 mile paved segment of the Bay Trail, approximately 12 feet wide, with two–two-foot wide shoulders along the perimeter of trail (Amendment No Three)~~.~~; and

8. Add the approximately 314-acre State Lands Parcel PRC 8813.9 to the existing wetland restoration project (Exhibit F). Place up to 650,000 cy of dredged sediment in the existing borrow areas 1, 2,and 3 to minus 1 NAVD 88. Construct temporary berms not higer than +4 NAVD 8 around the perimeter of borrow areas. Pipe decant water through decant water pathway to settling basin one as shown on Exhibit F. No dredged sediment or berms will be placed in the Federally Used Defense Site (FUDS) (Amendment No Four).

B. This agreement is given based on the information submitted by or on behalf of the Corps in its consistency determination dated June 28, 2005, and your letters received on June 21, 2006, June 21, 2007, ~~and~~ November 17, 2008, and December 29, 2008, requesting Amendment Nos. One, Two ~~and~~ Three, and Four, respectively, including all accompanying and subsequent submitted correspondence and exhibits, particularly the *1998 Hamilton Wetland Restoration Project Environmental Impact Report and Environmental Impact Statement (EIS/EIR) and the 2003 Supplemental EIS/EIR*, entitled *"Bel Marin Keys Unit V Expansion of the Hamilton Wetland Restoration Project"* (April 2003).

C. The work authorized by this amended consistency determination must commence by June 30, 2006, and must be diligently pursued to completion and must be completed by December 31, 2013, unless the terms of this concurrence are changed by amendment of this consistency determination.

D. The project will result in the restoration of ~~648.4~~ 962.4 acres of tidal and seasonal wetlands, tidal pannes, and transitional upland. In addition, this project furthers the goals of the Long Term Management Strategy for the Placement of Dredged Material in the Bay Area (LTMS) effort to secure beneficial reuse sites for cover-quality dredged sediments. At project completion, approximately 378 acres of new tidal marsh will be

added to the Bay, and approximately 156 acres of seasonal wetlands will be restored. With the addition of the Navy ball field property and the State Lands Commission parcel, the seasonal wetland acreage will increase to approximately 174 acres, and the total project acreage to approximately ~~648~~ 962.4acres (Amendment No. Four~~Three~~).

An estimated 7.9~~7.1~~ million cubic yards of dredged materials will be placed on site to raise site elevations to those appropriate for marsh vegetation establishment. The project will also result in approximately 4.5 acres of temporary fill in San Pablo Bay for the offloader and transport pipeline while dredged sediment is being pumped onto the site.

The project will also provide approximately 2.66 miles of a 12-foot-wide paved segment of the Bay Trail, with five overlooks, viewing scopes and an appropriate number of benches, along the southern, western and northern edge of the site.

II. Special Conditions

If the Corps does not agree with the following conditions or fails to incorporate them into the project, the Corps shall notify the Commission immediately of its refusal to agree or to incorporate the conditions into the project and this conditional concurrence shall become converted to an objection. The Corps shall also immediately notify the Commission if the Corps determines to go forward with the project despite the Commission's objection.

A. Specific Project Plans and Plan Review

1. **Plan Review.** No work shall be commenced on any specific construction element pursuant to this consistency determination until final precise site, architectural, engineering, public access, marsh restoration and grading plans and any other relevant criteria, specifications, and plan information for that portion of the work have been submitted to, reviewed, and approved in writing by or on behalf of the Commission. The Commission staff will determine the specific drawings and information required. To save time, preliminary drawings shall be submitted and approved prior to final drawings.

   a. **Site Plans.** Site, architectural, engineering, marsh, public access, restoration, marsh monitoring, adaptive management, and grading plans and any other relevant criteria, specifications, and plan information shall include and have clearly labeled the five-foot contour line above Mean Sea Level (the Mean High Tide Line, or the inland edge of marsh vegetation up to five feet above Mean Sea Level in marshland), property lines, the boundaries of all areas currently reserved for public access purposes, grading, details showing the location, types, dimensions, and materials to be used, all water control structures, and dredged material placement cells, and other design/construction features.

   b. **Engineering Plans.** Engineering plans shall include a complete set of contract drawings and specifications and design criteria. The design criteria shall be appropriate to the nature of the project, the use of any structures, soil and foundation conditions at the site, and potential earthquake-induced forces. Final plans shall be stamped by the professional of record or be certified by the Corps as being complete as evidenced by a Corps Independent Technical Review (ITR) and a Bid-ability, Constructability, Operability and Environmental Review (BCOE).

(1) Evidence that the design complies with all applicable codes; and

(2) Evidence that a thorough and independent review of the design details, calculations, and construction drawings has been made.

Plans submitted shall be accompanied by a letter requesting plan approval, identifying the type of plans submitted, the portion of the project involved, and indicating whether the plans are final (95% plans are considered final) or preliminary. Approval or disapproval shall be based upon:

(1) completeness and accuracy of the plans in showing the features required above, particularly the Mean High Tide Line, or the inland edge of marsh vegetation up to a line five feet above Mean Sea Level in marshland, property lines and any other criteria required by this authorization;

(2) consistency of the plans with the terms and conditions of this consistency determination; and

(3) assurance that any fill in the Bay does not exceed this consistency determination, as established by or on behalf of the Commission.

Plan review shall be completed by or on behalf of the Commission within 45 days after receipt of the plans to be reviewed. The Commission staff will review preliminary plans (35% and 65%) in an effort to facilitate a more rapid review of the final plans. The Corps shall provide the 95% plans as early in the contract review process as possible to allow the Commission staff time to review and comment on plans, and so as to not disrupt the contracting process. The 45-day review and approval process shall commence on the submission of the 95% plans and specification submittal package.

2. **Conformity with Final Approved Plans.** All work, improvements, and uses shall conform to the final approved plans. No noticeable changes shall be made thereafter to any final plans without first obtaining written approval of the change(s) by or on behalf of the Commission.

3. **Discrepancies between Approved Plans and Special Conditions.** In the event of any discrepancy between final approved plans and Special Conditions of this permit, the Special Condition shall prevail. The Corps is responsible for assuring that all plans accurately and fully reflect the Special Conditions of this authorization.

B. **Dredged Material Offloader Facility**

1. **Total Fill.** The total Bay fill authorized for the dredged sediment offloader facility and pipeline may not exceed 2.3 acres of floating fill, and 2.2 acres of solid fill, unless an amendment to this consistency determination is approved. The 2.3 acres of floating fill include: (1) one dredged sediment offloader; (2) one attendant barge; (3) three flat-deck mooring barges; (4) two booster pump barges; and (5) one floating pipeline. The 2.2 acres of solid fill include: (1) the dredged material transportation pipeline; (2) the pipeline anchors; (3) thirty-one three-pile dolphins; and (4) electrical cable. The exact dimensions of these components will be provided by the Corps during plan

review, and require Commission staff approval prior to placement. In the event that the offloader does not require an electrical power supply, the fill authorized for the cable cannot be used for another purpose. No additional fill in the Bay is authorized unless further amendment of this consistency determination is approved by or on behalf of the Commission.

2. **Offloader Facility Location and Dimensions.** The Corps shall submit plans identifying the final placement of the dredged sediment offloader, pipeline, electrical cable and booster barges to the Commission staff for review and approval no less than 30 days before installation. The Commission staff will review preliminary plans (35% and 65%) in an effort to facilitate a more rapid review of the final plans. The Corps shall provide the 95% plans as early in the contract review process as possible to allow the Commission staff time to review and comment on plans, and so as to not disrupt the contracting process.

3. **Intake Pipe Screen.** Prior to operation of the offloader, the Corps shall outfit the intake pipe of the offloader with a fish screen constructed of 3/32-inch mesh. The intake pipe will be sized so as to maintain an approach velocity that does not exceed 0.33 feet per second. At no time shall the offloader be operated without this screen securely in place on the intake pipe.

4. **Pipeline Placement and Pile Driving.** The dredged sediment offloader facility and booster pump barges requires the use of up to twenty-nine, three-pile dolphins. The size of the piles shall not exceed twenty-four inches-in-diameter. In addition, all pipeline construction and pile driving activities shall be conducted from June 1st through November 30th of any year to minimize impacts to listed salmonids during the migration period.

   In the event that pile driving is necessary at other times of year, the Corps shall monitor, in consultation with NOAA Fisheries, the sound pressure created by the pile driving, and maintain peak underwater sound pressure levels below 180 decibel re 1 micropascal, whenever an impact hammer is used, or implement additional measures to reduce the sound pressure waves.

5. **Offloader Facility Removal.** Within three months of when the final placement of dredged sediment on site, the Corps shall fully remove the offloader facility, piles, pipeline, electrical cable, power poles, booster pumps, substations, pumps, and anchoring system and any other related equipment from San Pablo Bay and the shoreline (Amendment No. Two).

C. **Marsh Restoration**

1. **Restoration Plan.** Prior to December 31, 2006, the Corps shall submit a marsh restoration plan and program, to be approved by or on behalf of the Commission, for the restoration and enhancement of the Hamilton Army Airfield, a parcel consisting of not less than 630 acres located in the City of Novato, Marin County. The plan shall describe in detail the restoration of 378 acres of tidal marsh, 156 acres of seasonal marsh, 13 acres of tidal pannes, and 34 acres of transitional upland. The plan and program shall contain the following:

a. **Site Conditions and Modifications.** A topographic map of the site with 0.5-foot contour intervals for the marsh area, and one-foot intervals for the upland area, showing the proposed modifications. All elevations shall be relative to North American Vertical Datum (NAVD '88). The map shall include typical cross-sections showing the proposed elevations of the tidal marsh, the seasonal wetlands, including pond bottoms after fill placement and expected settlement, any areas of excavation (substrate or hardened structures), channel templates, and any high spots, such as intertidal berms. The map shall show: (1) figures for the ratios of typical horizontal to vertical slopes for proposed marsh surface, channels, and sloughs, particularly for areas where either grading, excavation, or fill will take place; (2) expected plant species along the cross-sections according to their expected zone of growth; (3) the elevation of adjacent surrounding levees; and (4) estimated Mean Higher High Water (MHHW), Mean High Water (MHW), Mean Lower Low Water (MLLW), Mean Sea Level (MSL), the maximum predicted tide, and the 100-year tide. To promote positive drainage, constructed elevations shall grade gently toward constructed channels and breaches. Both the constructed elevation and predicted elevation at time of breach and long term shall be specified.

b. **Earth Moving Schedule.** A schedule indicating when construction of levees, intertidal or containment berms, excavation, placement of dredged sediment, and/or grading will occur and the time to be allowed for settlement before the levee is breached.

c. **Intertidal Berms.** The elevation of the intertidal berms proposed as part of this project shall be no greater than 6.1 feet NAVD '88 (approximately MHHW) at the time the bayfront levee is breached. The Corps shall provide a report, which verifies this elevation no later than 30 days prior to breach for review by Commission staff. In the event that the elevation of the intertidal berms are determined to be greater than 6.1 feet NAVD '88 immediately prior to breach, the Corps shall lower the berms to this height before breaching the exterior levee.

d. **Temporary Berms.** Prior to open filling of the entire tidal wetland area, the Corps shall deconstruct all temporary connector berms and containment berms down to original grade except for the extension berm connecting Cell 3 intertidal berm to the N-2 Levee, which will be excavated down to elevation +4.5 ft NAVD 88. Similarly, all temporary berms on the State Lands Parcel shall be deconstructed to existing grade prior to filling the area for restoration (Amendment No. Four).

ed. **Final Survey.** The Corps shall provide a final site survey of the constructed site, including the existing fringe marsh, in 0.5-foot intervals in wetland areas, and one-foot intervals in the upland areas, and provide it to the Commission staff for review. In the event that the final survey does not meet design specifications, the Corps shall discuss with Commission staff potential remedies, and implement agreed upon remedies prior to breach.

2. **Marsh Monitoring Plan.** Prior to December 3, 2006, the Corps shall submit and receive approval by or on behalf of the Commission, pursuant to Special Condition II-A, of a marsh monitoring plan. The approved plan shall encompass a 15-year monitoring period and, at a minimum, shall include components listed below (a through j), unless, through discussions with the project Technical Advisory Committee, more appropriate and thorough monitoring parameters are developed and approved by or on behalf of the Commission (Amendment No One).

   a. **Erosion.** A plan for monitoring the effects of the project on increasing erosion and scour within the existing fringe tidal salt marsh, mudflat and surrounding areas and for studying accretion and erosion within the restored area. In addition, the plan shall include provisions for monitoring erosion in areas within the site that have low level contaminants that will be managed in situ.

   b. **Water Quality.** A water quality monitoring program that shall incorporate the San Francisco Bay Regional Water Quality Control Board's (Water Board) Self Monitoring Plan and, at a minimum, monitor pH, salinity, dissolved oxygen and temperature in the restoration area.

   c. **Vegetation.** Provisions for monitoring vegetation establishment in the areas returned to tidal action. Vegetation monitoring shall include determining the amount of vegetation established at the restoration site using aerial photographs and ground truthing, identifying the plant species that have become established until it is determined that the site has achieved 5% cover of tidal marsh vegetation. These aerial photos shall be included in the monitoring report. Once marsh vegetation has become established on 5% or more of the restored area, transects shall be conducted to provide more detailed information on vegetation cover, including species present, percentage of the site vegetated, approximate percentage representation of different plant species and a qualitative assessment of anticipated plant colonization in the near future (next five years).

   d. **Bird Surveys.** Provisions for monitoring the use of the site by bird species including bird surveys conducted four times a year, two at high tide and two at low tide for the first five years following the completion of restoration activities and then every other year for the remainder of the monitoring period.

   e. **Fish Surveys.** Provisions for monitoring the use of the site by fish species including fish surveys conducted annually in the spring time, at high tide, for the first five years following the completion of restoration activities and then every other year for the remainder of the monitoring period. The survey techniques shall be developed in consultation with NOAA Fisheries staff.

   f. **Invasive Plant Species.** The Corps shall develop and implement an invasive plant monitoring and control plan for undesirable plant species such as invasive *Spartina* species, ice plant, broom and star thistle over the 15 year monitoring period. The plan shall include provisions for complete eradication of all non-native *Spartina* species and ice plant.

Monitoring reports submitted to the Commission pursuant to the approved monitoring plan shall report on all eradication efforts conducted on the site for invasive plant species such as non-native *Spartina*, ice plant, broom and thistle as well as any efforts to control other invasive plant species on site. The Corps shall completely control nonnative *Spartina* species, and reasonably control (average of less than 5% cover of upland areas) other undesirable nonnative species during the 15-year monitoring period.

g. **Reference Site.** The Corps shall identify a suitable reference site for both the tidal and the seasonal portions of the marsh, most likely China Camp and Rush Creek, respectively, that shall be evaluated as part of the monitoring program and shall provide a reference site for comparison in evaluating the progress of the restoration site.

h. **Sedimentation.** Provisions for monitoring sedimentation in the restoration area using a sufficient number of sedimentation pins, and/or plates and staff gauges, as reviewed and approved by the Commission staff. The Adaptive Management Plan required below shall include the number and location of pins, plates, gauges, etc., as part of the submittal.

i. **Monitoring Reports.** Monitoring reports describing the data collected pursuant to the approved restoration plan shall be submitted to BCDC biennially (every two years) beginning on December 1st, two years following the breaching of the exterior levee.

j. **Relevant Monitoring Data.** The Corps shall provide all monitoring information and data from other studies conducted on the site including but not limited to any Corps (ERDC), the Water Board, the California Department of Fish and Game (CDFG), NOAA Fisheries, and the U.S. Fish and Wildlife Service (USFWS).

3. **Technical Advisory Committee.** The Corps shall assemble a Technical Advisory Committee (TAC) that shall include local and/or regional experts, and members of the Commission, Water Board, CDFG, and USFWS staffs, and to share information regarding the status of the restoration and to provide peer review of any adaptive management strategies that may be employed. The TAC shall be convened a minimum of once a year following the placement of dredged sediment on site, for the 15-year monitoring period.

D. **Marsh Protection**

1. **Best Management Practices.** All construction operations shall be performed to prevent construction materials from falling, washing, or blowing into the Bay. In the event that such material escapes or is placed in an area subject to tidal action of the Bay, the Corps shall immediately retrieve and remove such material at its own expense. The Corps shall also employ best management practices, such as placing drip pans below engines during fueling and storage, covering chemicals or potential contaminants during the rainy season, etc., to minimize the potential for introducing new contaminants into the restored marsh.

2. **Marsh and Upland Plant Protection During Construction.** The work authorized by this consistency determination shall be performed in a manner that will prevent, avoid, or minimize to the extent possible any significant adverse impact on the existing tidal marsh and existing native upland vegetation.

   It is understood that the marsh channel cut and breaching of the bayward levee to restore tidal action to the site, will likely result in some erosion of the side slopes and channel bottom as the Bay seeks equilibrium with the restored site. Reconnecting the project site to the Bay will also likely lead to the development of a channel across the existing fringing mudflat. If any unforeseen adverse impacts occur to the existing marsh or mudflat, such as excessive erosion, the Corps shall propose stabilizing measures to prevent further erosion of the existing areas, and submit the proposal to the Commission staff for review and approval prior to implementing proposed actions.

   The Corps shall employ mitigation measures to minimize impacts to wetland areas, such as minimizing all traffic in marsh/mudflat areas, and carefully removing, storing, and replacing wetland vegetation that has been removed or "peeled back" from construction areas as soon as possible following construction.

3. **Placement of Dredged Sediment.** The characteristics of any dredged sediment placed on site shall be first be reviewed and determined by the Dredged Material Management Office (DMMO) to be suitable for beneficial reuse at a wetland site and must be considered cover quality material. The DMMO shall use the requirements set forth in the Water Board's July 20, 2005 Order No. R2-2005-0034, when determining the suitability of the dredged sediment on the Hamilton site. This information will be contained in the Soil Management Plan provided to the Commission.

4. **Removal of Excavated Material From Bayward Levee Breach.** All excavated material must be characterized and results provided to the Water Board and the Commission to determine whether and how it can be utilized on site, or whether it shall be removed from the restoration site and disposed of in an appropriate manner offsite and outside of the Commission's jurisdiction.

5. **Removal of Dredged Sediment.** Prior to excavation or dredging of the tidal channel, a sampling and analysis plan and subsequent test results shall be submitted to the DMMO for review and a suitability determination. If the DMMO finds the material suitable for reuse on site, then the Corps can place the material dredged from the channel cut on site. If the DMMO determines that material is not suitable for placement on site, then the dredged material shall be disposed of at an approved site or upland location.

6. **Debris Removal.** All construction debris and any uncovered debris, such as concrete, asphalt, wood, plastics, etc., on the restoration site shall be removed from the project site for proper disposal outside of the Commission's jurisdiction. Excavated debris may be temporarily stored within the Commission's jurisdiction, provided measures are employed to assure that such material does not wash or erode into the surrounding marsh or Bay. In the event that any such material is placed in any area

within the Commission's jurisdiction for an extended period (i.e. more than 60 days), the Corps, its assigns, or successors in interest, or the owner of the improvements, shall remove such material, at its own expense, within ten days after it has been notified by the Executive Director of such placement.

E. **Protection of Special-Status Fish and Wildlife Species.** The Corps shall take all precautions to avoid adverse impacts to special-status species such as the Chinook salmon, Coho salmon. Steelhead trout, California clapper rail, salt marsh harvest mouse, burrowing owls, northern harriers, salt marsh song sparrow, and the San Pablo song sparrow. The Corps shall implement the measures described in the NOAA Fisheries consultation dated August 9, 2005 to ensure that impacts to special-status fish species are minimized. The U.S. Fish and Wildlife Service's (USFWS) Biological Opinion for the project was issued on July 21, 2005, and is currently being reviewed by the Corps. The Corps shall implement the final biological opinion (as revised), and at a minimum, shall include such measures as:

1. **Chinook, Coho salmon, and Steelhead Trout.** To minimize the effects on listed salmonids, the Corps shall perform any dredging activities, or pile driving between June 1st and November 30th of any year. In addition, the prescribed fish screens shall be in place prior to and during the pumping of any Bay water onto the site or into the offloader.

   In the event that pile driving is necessary at other times of year, the Corps shall monitor the sound pressure created by the pile driving, and maintain peak underwater sound pressure levels below 180 decibel re 1 micropascal;

2. **California Clapper Rail.** Except for the placement of dredged sediment, the Corps shall implement the following measures to avoid or minimize adverse impacts to clapper rails from direct construction impacts on existing tidal salt marsh habitat: (1) limit operation of equipment, and construction activities to September 1st to January 31st of any year; (2) if work in or adjacent to the existing marsh cannot be avoided during the breeding season, then the Corps shall survey, using a USFWS-approved survey protocol, the area to identify individuals and/or nest sites; (3) if no individuals/nests are identified within 250 of the construction site, then construction can proceed; (4) if surveys indicate that individuals/nests are present within 250 feet of the construction site, then the Corps shall consult the USFWS to determine what, if any, additional measures are required; and (5) no maintenance of the dredged sediment transport pipeline shall take place outside of the work window stated above.

3. **Salt Marsh Harvest Mouse and Salt Marsh Wandering Shrew.** The Corps shall implement the following measures to avoid or minimize adverse impacts to the salt marsh harvest mouse and salt marsh wandering shrew due to direct construction impacts on existing tidal or non-tidal salt marsh habitat: (1) construction impacts shall be limited to the smallest possible area of suitable salt marsh harvest mouse or salt marsh wandering shrew habitat; (2) prior to the start of construction activities in areas with salt marsh vegetation, using a USFWS approved survey protocol, a quali

fied wildlife biologist shall survey construction sites for salt marsh harvest mouse and salt marsh wandering shrew; (3) if the CDFG does not allow trapping, the vegetation within the construction area shall be hand removed; and (4) after the vegetation is removed, a barrier fence shall be placed twenty feet from the construction boundary.

Conversely, if the CDFG does allow trapping, then the following measures shall be taken: (1) a barrier fence, with three-foot-long stakes and the bottom of the fence buried in the ground, shall be placed twenty feet from the construction boundary and adjacent to salt marsh vegetation areas; (2) a qualified biologist approved by USFWS shall trap salt marsh harvest mice and salt marsh wandering shrew and release any captured individuals in suitable habitat outside of the fenced area; and (3) no construction shall take place until the qualified biologist believes all salt marsh harvest mice and salt marsh wandering shrews within the construction site have been removed.

4. **Protection of Burrowing Owls and Northern Harriers.** The Corps shall implement the following measures to avoid or minimize adverse impacts to Burrowing Owls and Northern Harriers in the project area:

   a. Survey the construction sites for burrowing owls year-round and Northern Harriers during nesting season (generally late March through August) prior to construction. Pre-construction surveys for burrowing owls and Northern Harriers shall be conducted in and adjacent to all construction areas, especially levees, within 30 days of all construction activities, or by following the CDFG survey protocols currently in effect at that time. If construction activities at a site are delayed or suspended for more than 30 days, the site shall be re-surveyed;

   b. During the breeding season (February 1st through August 31st for burrowing owls and March through August for Harriers), if burrowing owls are found on or adjacent to a construction site, a clearly-delineated construction buffer with temporary fence and signs shall be established around each occupied burrow at a minimum radius of 250 feet from the burrow;

   c. If an active Northern Harrier nest is found at or adjacent to a site where construction will shortly take place, construction activities shall be rescheduled until after the nesting season. If this is not feasible, construction buffers shall be established around each nest, at a minimum radius of 200 feet from the nest. The buffers shall be clearly marked with temporary fencing and signs. No construction activities shall occur within the buffer as long as the nest is active;

   d. If construction vehicles must pass through an established buffer for the burrowing owl or an active Harrier nest in order to access a construction site, a "no stopping" policy shall be implemented;

   e. During the non-breeding season for burrowing owls, if destruction of an occupied burrow is unavoidable, or if a construction site is located within 160 feet of an occupied burrow, passive relocation measures shall be implemented to encourage the owl(s) to move away from the burrow prior to construction. If no suitable alternate burrows are present within 500 feet of the destroyed burrow,

two artificial burrows shall be installed at appropriate locations, to be determined by a qualified ornithologist. Passive relocation methods for owls and artificial burrow locations shall be subject to CDFG approval. Passive relocation for owls shall not be conducted during the breeding season (February1st -August 31st); and

f. All protection measures shall remain in place for the duration of construction at the occupied sites to ensure that the protective measures are effective and to implement additional measures, if necessary. The protection measures shall remain in effect until the biological monitor determines that the burrow or the nesting cycle has been successfully completed or that the nest or burrow is no longer active.

5. **Protection of Common Yellowthroat and Song Sparrow.** The Corps shall implement the following measures to avoid or minimize adverse effects to the breeding activity of salt marsh common yellowthroat and San Pablo song sparrow: (1) construction associated with implementation of the project shall be located and timed to avoid impacts to potential nesting habitat of these species, to the extent feasible; (2) if avoidance of construction during the nesting season is not feasible, pre-construction surveys shall be completed, prior to the initiation of project construction, at construction sites that are located within, or adjacent to, suitable nesting habitat for these species; and (3) if active nests are present, construction buffers shall be established at a minimum radius of 50 feet from the nest. Active nest sites shall be monitored by a qualified biologist periodically during the nesting season to verify that the protection measures are effective and to implement additional measures, if necessary.

6. **Use of Raptor Perch Deterrents.** The Corps or its contractors shall use raptor perch deterrent devices on all poles placed within 1,500 feet of the outboard marsh, to protect special status species from additional predation. The devices used shall include, or be similar to the products described in the amendment request labeled "Kaddas Enterprises Inc., as Triangle Anti-Perch and Pole-Kap" (Amendment No. Two).

7. **Pole Removal.** The Corps or its contractor shall, no later than July 1, 2008, remove 33 existing power poles described in the amendment request and on Figure 4 (Exhibit C) (Amendment No. Two).

F. **Public Access**

1. **Bay Trail.** The 3.9 acres of Bay trail and scenic overlooks along approximately 2.66 miles of new Bay shoreline (once the site is restored) as generally shown on Exhibit A, along with an appropriate area on either side of the trail to be determined pursuant to Special Condition II-F-2, shall be made available exclusively to the public for unrestricted public access for walking, bicycling, sitting, viewing, picnicking and related purposes. If the Corps wishes to use the public access area for other than public access purposes, it must obtain prior written approval by or on behalf of the Commission.

2. **Public Access Area.** The Corps, its agent or assignee, shall provide a map that shows the area of public access to be dedicated pursuant to Special Condition II-F-1and II-F-3, no later that September 30, 2007, with a minimum width of twenty feet along the trail and twenty-five feet in the area of the overlooks, for review and approval by or on behalf of the Commission (Amendment No. One).

3. **Permanent Guarantee.** Upon completion of construction of the public access improvements authorized herein, or by December 31, 2012, whichever is earlier, the Corps, its agent or assignee, shall, by instrument or instruments acceptable to counsel for the Commission, dedicate to a public agency or otherwise permanently guarantee such rights for the public to the new 3.9-acre public access area. The instrument(s) shall create rights in favor of the public, which shall commence upon the transfer of the property from the Corps or its agent or assignee to another public agency or nonprofit organization for operation and maintenance. Such instrument shall be in a form that meets recordation requirements of Marin County and shall include a legal description of the property being restricted and a map that clearly shows the new shoreline (5 feet above Mean Sea Level), the property being restricted for public access, the legal description of the property and of the area being restricted for public access, and other appropriate landmarks and topographic features of the site, such as the location and elevation of the top of bank of any levees, any significant elevation changes, and the location of the nearest public street and adjacent public access areas. Approval or disapproval of the instrument shall occur within 30 days after submittal for approval and shall be based on the following:

   a. Sufficiency of the instrument to create legally enforceable rights and duties to provide the public access area required by this authorization;

   b. Inclusion of an exhibit to the instrument that clearly shows the area to be reserved with a legally sufficient description of the boundaries of such area; and

   c. Sufficiency of the instrument to create legal rights in favor of the public for public access that will run with the land and be binding on any subsequent purchasers, licensees and users.

4. **Recordation of the Instrument.** Within 30 days after approval of the instrument(s), the Corps, its agent or assignee, shall record the instrument(s) on all parcels affected by this instrument(s) and shall provide evidence of recording to the Commission. No changes shall be made to the instrument(s) after approval without the express written consent by or on behalf of the Commission.

5. **Improvements Within the Total Public Access Area.** According to the schedule set out in Special Condition II-F-10, the permittee shall install the following improvements, as generally shown on the Hamilton Wetland Restoration Project's public access plan (Exhibits R – Y of the BCDC application summary dated July 8, 2005) including:

   a. 2.66 miles of a paved, twelve-foot-wide, multi-use trail, with a two-foot-wide shoulder on either side.

   b. Five overlooks with seating, observation scopes and interpretative signage;

   c. An appropriate number and types of seating along the trail and overlooks; and

d. An appropriate number of public access signs, Bay Trail signs, and interpretive signage (history, marsh restoration, wildlife protection, and directional, etc.) along the trail, to be developed as part of a comprehensive sign program to be approved by or on behalf of the Commission pursuant to Special Condition II-A.

6. **Reasonable Rules and Restrictions.** The Corps, its agent or assignee, may impose reasonable rules and restrictions for the use of the public access facilities authorized herein to correct particular problems that may arise. Such limitations, rules, and restrictions shall have first been approved by or on behalf of the Commission upon a finding that the proposed rules will not significantly affect the public nature of the area, will not unduly interfere with reasonable public use of the public access areas and will tend to correct a specific problem that the Corps has both identified and substantiated. Rules may include restricting hours of use and delineating appropriate behavior.

7. **Maintenance.** The areas and improvements within the public access facilities authorized herein shall be permanently maintained by and at the expense of the Corps, its agent, or its assignees. Such maintenance shall include, but is not limited to, repairs to all paths, fencing, vegetated buffers and overlook facilities, repairs or replacement as needed of any public access amenities such as interpretive or directional signs, seating, viewing scopes, trash containers, periodic cleanup of litter and other materials deposited within the access areas, removal of any encroachments into the access areas, and assuring that the public access signs remain in place and visible. Within 30 days, after notification by staff, the Corps or its assignee shall correct any maintenance deficiency noted in a staff inspection of the site. In the event that the Corps cannot respond within 30 days, it shall show good faith effort, such as contracting for the work, as rapidly as possible, given the Corps contracting process.

8. **Protection for Wildlife.** In order to minimize effects to wildlife, fencing and vegetated buffers shall be installed and maintained. In addition, as recommended by the USFWS, a seven-hundred-foot-long gap shall be maintained between the end of Section E of the trail and the existing bayward levee. Once the bayward levee has been lowered, the public access trail shall end 700 feet from the southeastern corner of the project site.

9. **Segment E.** In the event that the property to the south of this project, known as the Las Gallinas spray fields, is restored to tidal wetlands, portions or all of Segment E of the trail may be removed by the Corps. At that time, a new connection to the Bay Trail to the south, as it moves westerly, shall be developed and installed prior to removing Section E. The proposal for this new connection shall be reviewed and approved by the Commission staff prior to implementation, and shall incorporate appropriate techniques for reducing any potential impact to wildlife from use of the public access trail. All or portions of Segment E may be left in place, if the USFWS, CDFG, the State Coastal Conservancy and the Commission staffs determine that it is and would not significantly affect wildlife at the restoration sites.

10. **Phasing of the Public Access.** Because the site is being constructed in sections, the public access may be opened and public improvements completed in phases. Sections A, B and C, from the plans entitled "Bay Trail Plan" and dated May 2005, shall be opened and completed as the fill in these or immediately adjacent areas is complete, but not later than December 31, 2010, whichever is earlier. Sections D and E will be opened and completed for use as soon as construction of the perimeter levees and placement of fill are complete in these areas, but not later than December 31, 2012, whichever is earlier. Once the trail is complete and open to the public, closures for construction or other purposes must be reviewed and approved by Commission staff.

11. **Public Access Easement.** Prior to placing fill against the City of Novato levee, or by August 30, 2007, the Corps or the California Coastal Conservancy, as its agent, shall accept a dedicated easement from the City of Novato to allow construction, use and maintenance of the public access trail along the aforementioned levee, consistent with the requirements of Special Condition II-F-1 and provide evidence of the dedication to Commission staff.

12. **Public Access Monitoring and Management Plan.** To ensure that the public access will not have unacceptable impacts on wildlife, and to better inform future decisions regarding management of public access at Hamilton, the Corps shall prepare a monitoring and management plan for the trail, and provide it to the Commission for its review and approval, no later than December 31, 2007. The plan shall include: (1) a monitoring program with the express purpose of observing potential impacts from trail/overlook use on wildlife; (2) an appropriate number of observation days in the field to observe effects during different seasons and tide heights; (3) observations at different locations on the trail when different management techniques have been employed (i.e., fencing, domestic animal controls, vegetated buffers, overlooks, etc.) to assess their relative effectiveness; (4) adaptive management measures to be undertaken in the event that impacts to wildlife are observed and significant; (5) a signage program providing information on public access use that is protective of wildlife; and (6) a management plan for maintaining the trail. Once the plan is approved by or on behalf of the Commission, it shall be implemented by the Corps, its agent or assignee.

13. **Assignment of Public Access Maintenance Responsibility.** Prior to assigning any portion of the obligations under this consistency determination, the Corps shall submit for approval by or on behalf of the Commission, a legal instrument that establishes responsibility for maintaining all public access areas, improvements, and landscaping. The Executive Director shall approve the instrument only if it demonstrates to the Executive Director's satisfaction that the responsible party(ies) can and will meet the responsibilities for maintaining all of the public access areas, improvements, and landscaping required herein.

G. **Mitigation Measures.** In addition to the measures required by Special Conditions II-E-1 through 5, to minimize potential adverse effects associated with the project, the Corps shall implement the mitigation measures described in the *"Hamilton Wetland Restoration Project EIS/EIR"* (1998) and *"Bel Marin Keys Unit V Expansion of the Hamilton Wetland Restoration Project"* (2003). Such measures shall include: ensuring that Best Management

Practices (BMPs) are implemented during construction activities, performing pre-construction surveys for special-status plant species in areas of suitable habitat, limiting dog use of public access trails, coordinating with the Marin County Mosquito Abatement district to minimize mosquito production, and educating construction crews regarding special-status fish and wildlife.

H. **Water Quality**

1. **RWQCB Order No. R2-2005-0034.** The Corps shall comply with the RWQCB's Order (issued on July 20, 2005) and/or any future amendments to the Order, as well as the Self Monitoring Plan for the project, to ensure that potential water quality impacts of the project are minimized.

2. **Methylmercury Concerns.** To aid in the understanding of mercury methylation at the site and to inform future adaptive management strategies that may be proposed to remedy excess methylmercury accumulation at the site, if it occurs, the Corps shall do the following:

   a. No later than June 30, 2006, the Corps shall submit and receive approval, by or on behalf of the Commission, of a methylmercury monitoring program for the project. The program shall at a minimum include the following: (1) methods that will be employed to assess methylmercury accumulation at the site, particularly in indicator species, the frequency and timing of sampling, and a schedule for reporting results of the monitoring annually; (2) provisions for the creation of a Methylmercury Technical Advisory Committee (MTAC) that shall include representatives from the Commission, Water Board, and methylmercury experts such as U.S. Geological Service (USGS) and the San Francisco Estuary Institute (SFEI); (3) provisions for implementing adaptive management techniques to remedy methylmercury accumulation if and when such techniques have been developed. Approval or disapproval of the monitoring program shall be made by or on behalf of the Commission in consultation with the MTAC, in particular the Water Board; and (4) implement the plan once it is approved by the Commission.

   b. The Corps shall monitor methylmercury accumulation in the tidal, northern and southern seasonal wetlands, immediately prior to breaching the levee, and annually on the site in accordance with the above described and approved methyl mercury monitoring plan. The Corps shall submit results of methylmercury monitoring on the site, to the Commission no less than sixty days before breaching the site. The results of the monitoring shall be reviewed by or on behalf of the Commission in consultation with the MTAC. If monitoring results indicate that methylmercury accumulation in these ponds are at levels that could pose significant risks to Bay wildlife and fish as determined by or on behalf of the Commission in consultation with the MTAC, then the exterior levee shall not be breached until such time that more information has been gathered and reasonable remediation measures have been formulated to remedy excessive methylmercury concentrations in marshes; and

   c. The Corps shall continue to make the project site available to researchers and scientists and continue to encourage methylmercury research at the site. To this end, the Corps shall report to the Commission and the Water Board annually,

beginning December 31st of the year following breaching of the bayward levee, on the results of methylmercury research at the site and any future research proposals or opportunities, and the status of funding for studies to help manage the methylation of mercury in the newly restored wetlands.

I. **Creosote Treated Wood.** No pilings or other wood structures that have been pressure treated with creosote shall be used in any area subject to tidal action in the Bay wetland within the Commission's jurisdiction as part of the project authorized herein.

J. **Debris Removal.** All construction debris shall be removed to an authorized location outside the jurisdiction of the Commission. In the event that any such material is placed in any area within the Commission's jurisdiction, the Corps, shall remove such material, at its expense, within ten days after notification by the BCDC's Executive Director of such placement.

K. **Responsibility for Flooding.** The Corps shall be solely and entirely responsible for any flooding that may occur inland of the marsh restoration site and the Corps shall assure that the restoration plan meets the requirements of the Public Works Director who has jurisdiction over the site and the surrounding area. The Corps shall provide a letter to the Commission indicating that the review has been done and that inland areas will not flood as a result of the work shown on the plan.

L. **In-Kind Repairs and Maintenance.** Any in-kind repairs and maintenance of the facilities authorized herein shall only use construction material that is approved for use in San Francisco Bay. Construction shall only occur during current approved months during the year to avoid potential impacts to fish and wildlife. BCDC staff shall be contacted to confirm current restrictions.

M. **Site Access.** The Corps grants permission to any member of the Commission's staff to conduct a site visit at the subject property during and after construction to verify that the project is being/has been constructed in compliance with the authorization and conditions contained herein. Site visits may occur during business hours without prior notice upon checking in with the site manager for safety reasons and after business hours with 24-hour notice.

N. **Notice to Contractor.** The Corps shall provide a copy of this document to any contractor or person working in concert with the Corps to carry out the activities authorized herein and shall point out the special conditions contained herein.

O. **Recording**. The Corps shall record this consistency determination or a notice specifically referring to this consistency determination on all parcels affected by this consistency determination with Marin County within 30 days after execution of the consistency determination issued pursuant to this agreement and shall, within 30 days after recordation, provide evidence of recordation to the Commission.

III. Findings and Declarations

This concurrence is given on the basis of the Commission's findings and declarations that the work reviewed herein is consistent with the McAteer-Petris Act, the *San Francisco Bay Plan*, the California Environmental Quality Act, and the Commission's amended coastal zone management program for San Francisco Bay for the following reasons:

A. **Fill.** Section 66605 of the McAteer-Petris Act states, in part, that: (1) fill in the Bay and certain waterways can be authorized only when the public benefits of the fill exceed the public detriment from the loss of water areas; (2) fill in the Bay and certain waterways should be limited to water-oriented uses (such as wildlife refuges), or minor fill for improving shoreline appearance or for public access; (3) fill can be authorized only when no alternative upland location exists for such purposes; (4) the water area authorized to be filled should be the minimum necessary to achieve the purpose of the fill; and (5) the nature, location and extent of any fill should be such that it will minimize harmful effects to the Bay Area, such as, the reduction or impairment of the volume surface area or circulation of water, water quality, fertility of marshes or fish or wildlife resources. Fill in the Commission's Bay jurisdiction may be authorized only if the Commission can find that the fill meets the tests of all of the subsections cited above.

Approximately 4.5 acres of floating fill for the offloader, pump and mooring platform, and solid fill for the conveyance pipeline placed on the Bay bottom will be placed in the Commission's Bay jurisdiction. The dredge material offloader and accompanying barges and pipelines will enable dredged sediment from Bay Area dredging projects to be offloaded from dredge scows and pumped to the Hamilton Wetland Restoration site approximately 5.3 miles away. Currently, there is no feasible way to transport dredged material to the site via a land route. In addition, beneficially reusing dredged material on site to raise the elevations to those suitable for marsh development will substantially reduce the amount of time necessary for tidal marsh to develop at the restoration site.

This project, along with other beneficial reuse projects, will greatly reduce the volume of dredged material that currently is disposed of in the Bay. As a result, this project will significantly reduce water quality impacts to the Bay. In addition, wetland restoration projects have significant benefits to the public such as increase wildlife viewing and recreational opportunities, reduced flooding impacts due to the ability to absorb storm water, and increased habitat for native, and threatened and endangered species.

- **Public Benefits v. Public Detriment.** Approximately 4.5 acres of solid and floating fill will be placed in San Pablo Bay for approximately eight years in order to offload and transport dredged sediment from dredge scows to the project site. The dredged sediment will then be used to restore the elevation of subsided, diked baylands to levels that will allow marsh habitat establishment. Over ninety percent of the wetlands in the Bay area have been lost to diking and filling of historic marshes. Placement of the offloader and associated barges, pilings and pipeline will facilitate the re-establishment of a portion of the lost habitat value of the Bay and enable beneficial reuse of dredged sediments, consistent with both the LTMS and Commission policies.

Because the project will result in both the restoration of significant wetland area to the Bay and the beneficial reuse of dredged sediments, the Commission finds that the public benefits associated with the fill for the dredged sediment offloader, barges and pipelines in San Pablo exceed the public detriment from its placement.

- **Water-Oriented Use.** Section 66605(a) of the McAteer-Petris Act states that, "...[f]urther filling of San Francisco Bay and certain waterways...should be...limited to water-oriented uses...such as wildlife refuges..."

The purpose of the fill associated with the dredged sediment offloader facility and pipeline is to safely moor dredged sediment scows and to pump the imported dredge sediment to the project site to restore tidal and seasonal wetlands to the site and create habitat for resident, migratory species including a number of threatened and endangered species. The site will eventually be transferred to an appropriate resource agency for management as a wildlife refuge.

The Commission finds that the fill associated with the dredged sediment offloader facility and pipeline for the purpose of restoring tidal and seasonal wetlands, is a water-oriented uses as defined by the McAteer-Petris Act.

- **Alternative Upland Location.** There is no alternative upland location for the dredged sediment offloader facility as the dredged sediment is from Bay Area federal navigation channels, port berths, and marinas that will be transported to the offloader by barge (possibly also by hopper dredge) and there is no facility for offloading dredged sediment in the Bay Area capable of handling 7.1 million cy of sediment. In addition, it is simply infeasible to bring the sediment to the site any other way, for the cost of drying dredged sediment, loading it on vehicles, and bringing it to the site would be cost prohibitive and would overwhelm the already congested highway system. Further, the consistency determination states that the dredged sediment must stay wet to prevent acidification and over consolidation of the dredged sediment.

The Commission finds that there is no alternative upland location for the dredged sediment offloader because of the water-oriented nature of dredging and the transportation of dredged sediment, the potential impacts on regional transportation if material was transported by land, and the prohibitive cost of bringing the sediment to the site any other way.

- **Minimum Necessary Fill.** The Corps states that the 4.5 acres of floating and solid fill that will be placed in San Pablo Bay is the minimum amount necessary to safely and efficiently offload dredged sediments in open water, and transport that material to the project site. The consistency determination originally included 6.6 acres of fill in the Bay, but after discussions with Commission staff and further research, the Corps was able to reduce the overall fill in the Bay to 4.5 acres. To ensure that the project minimizes fill in the Bay, Special Conditions II-B-1 limits Bay fill to: (1) one dredged sediment offloader; (2) one attendant barge; (3) three flat-deck mooring barges; (4) two booster pump barges; (5) floating pipeline; (6) the dredged material transportation pipeline; (7) the pipeline anchors; (8) thirty-one three-pile dolphins; and (9) electrical cable, for a total of 4.5 acres of floating and solid fill.

  The Corps states that the off-loader needs to be located in an area of the Bay that is deep enough for the vessels supplying dredged material to safely access the off-loader at any tide level and under typical storm conditions. A depth of minus 32 feet MLLW provides the draft needed for fully loaded scows, with appropriate under keel clearance in all weather conditions and stages of tide. The equipment, dolphins and mooring and booster pump barges have been sized for the existing tidal current and storm conditions typically encountered in this area of

San Pablo Bay. The Corps also states that the offloader and barges may likely be moved for use on other projects when dredged sediment is not actively being unloaded at Hamilton. Special Condition II-B-5 requires the removal of the offloader, attendant barges, electrical cable and pipeline within three months of final dredged sediment placement and that all Bay fill associated with the offloader will be fully removed once placement of the sediment is complete.

Because the proposed fill in the Bay is sized and configured for the existing weather and tidal conditions, and those required to safely offload sediment from the dredge scows, and the dredged sediment offloader facility and pipeline will be removed once the project development is complete, the Commission finds that the fill placed with the project will be the minimum necessary to construct the project.

- **Minimizing Impacts.** The EIS/EIR prepared for the project identified two potentially significant and unavoidable adverse impacts from the project. One was the potential for production of methylated mercury and the other was potential impacts to fish and marine mammals due to pile driving activities. All other potential adverse impacts could be mitigated and, with the incorporation of the mitigations measures required herein, could be reduced to insignificance.

  The methylated mercury issue is discussed in Section F, on water quality below.

  The second unavoidable impact identified in the EIS/EIR was the potential impacts of pile driving on fish and marine mammals. In the Corps' informal consultation with NOAA Fisheries, NOAA Fisheries has recommended that the project monitor the decibel levels that occur during pile driving. NOAA Fisheries has recommended that sound pressure generated during pile driving stay below 180 decibels. The Corps believes the pile driving can be completed without reaching a level of impact for Bay wildlife. If the pile driving generates sound pressure levels greater than 180 decibels, measures will be taken to attenuate the sound pressure levels. These measures are outlined in NOAA's consultation conclusion, and in Special Conditions II-B-4 and E-1.

  The EIS/EIR also contains a mitigation monitoring and reporting program that requires the Corps to comply with several measures that will reduce potentially significant environmental effects. The project's monitoring and reporting measures include: performing pre-construction surveys for special-status wildlife and plant species, monitoring subsidence and elevations, impacts to wildlife from public access use, and implementing best management practices during project construction and after tidal action is restored to the site. Special Condition II-G requires the Corps to implement the mitigation measures in the EIS/EIR.

  During the public hearing, a member of the public stated that the current project plans were in conflict with mitigation measure 4.6 of the 1998 EIS/EIR, that would limit the height of the fill to be placed against the City of Novato levee to prevent settlement of the levee and adjoining houses. While potential impacts to the City's levee cannot be considered impacts on Bay resources over which the Commission has authority to protect, the Commission and the Corps have addressed this issue directly.

The Corps has stated that as part of the proposed project that is subject to this consistency determination, a geotechnical study of the effects of loading the City of Novato levee is underway, and that no fill above the elevation described in the mitigation measure 4.6 of the 1998 EIS/EIR will be placed against the levee until and unless (1) that study is complete; (2) the findings of the study show the proposed elevation will not have significant impacts on the integrity of the levee or the nearby houses; and (3) the City of Novato has had an opportunity to peer review the study.

The Commission finds that the project has been designed to minimize harmful impacts because it includes provisions for monitoring and adaptive management techniques during all phases of the project, including construction, dredged material placement, re-establishment of tidal action, habitat development, and public access use.

B. **Maximum Public Access.** Section 66602 of the McAteer-Petris Act states that existing public access to the shoreline and waters of San Francisco Bay is inadequate and that maximum feasible public access, consistent with a proposed project, should be provided.

The Bay Plan policies on public access state that "... [I]n addition to the public access to the Bay provided by waterfront parks, beaches, marinas, and fishing piers, maximum feasible access to and along the waterfront and on any permitted fills should be provided in and through every new development in the Bay or on the shoreline, whether it be for housing, industry, port, airport, public facility, wildlife area, or other use, except in cases where public access would be clearly inconsistent with the project because of public safety considerations or significant use conflicts...."

The policies further state "...[P]ublic access to some natural areas should be provided to permit study and enjoyment of these areas. However, some wildlife is sensitive to human intrusion. For this reason, projects in such areas should be carefully evaluated in consultation with appropriate agencies to determine the appropriate location and type of access to be provided...." The policies go on to state, "...Public access should be sited, designed and managed to prevent significant adverse effects on wildlife..." and "...[P]ublic access improvements provided as a condition of any approval should be consistent with the project and the physical environment, including protection of Bay natural resources, such as aquatic life, wildlife and plant communities, and provide for the public's safety and convenience. The improvements should be designed and built to encourage diverse Bay-related activities and movement to and along the shoreline, should permit barrier free access for the physically handicapped to the maximum feasible extent, should include an ongoing maintenance program, and should be identified with appropriate signs...."

Policy No. Ten states that "Federal, state, regional, and local jurisdictions, special districts, and the Commission should cooperate to provide appropriately sited, designed and managed public access, especially to link the entire series of shoreline parks, regional trail systems (such as the San Francisco Bay Trail) and existing public access areas to the extent feasible without additional Bay filling and without significant adverse effects on Bay natural resources..."

And finally, Policy No. Twelve states: "Public access should be integrated early in the planning and design of Bay habitat restoration projects to maximize public access opportunities and to avoid significant adverse effects on wildlife."

The project site is designated by the Bay Plan as a wildlife refuge priority use area. As an abandoned former Army Airfield, most of the existing habitat values are those associated with disturbed upland habitats. While most of the site is closed to the public due to safety concerns and site remediation activities, the City of Novato levee adjacent to Hamilton is open to the public and used by local residents.

Once the project is complete, there will be a new, 2.66-mile, multi-use, paved segment of the Bay Trail along the western edges of the site. A number of different approaches to minimize potential conflicts between public access trail users and the newly restored project have been incorporated into the design. On the western edge of the site, the trail would be adjacent to the proposed seasonal wetland habitat on the project side of the levee. The trail will then proceed southwards along the western side of the site, adjacent to the tidal channel, which would act as a kind of moat and wildlife corridor, which will create distance between the trail users and endangered species habitat. The trail will continue southward along the edge of the perimeter levee with vegetated hummucks and fencing to assist in preserving habitat areas while allowing viewing of the site and wildlife for the pubic. Once the trail reaches Segment D, the trail will transition along the edge of the existing oak woodlands. On the southern end, the trail will be on the levee adjacent to the southern seasonal wetlands and behind the levee and six feet below the levee top thus screening wildlife from trail users. The public access improvements will end 700 feet before the existing outboard levee. The gap is intended to protect the endangered California clapper rail and salt marsh harvest mouse that currently reside in the existing coastal salt marsh adjacent to the project. In addition, the Corps has stated, and the USFWS has required, that dogs and motorized vehicles will not be permitted on the southernmost portion of the trail. Pacheco Pond, an existing wildlife refuge, exists immediately adjacent to and north of the project site. The Corps will place the proposed trail on the south side of the levee, and below the levee crest in this area, to provide screening for the existing wildlife habitat. Various additional methods of screening for wildlife compatibility are employed throughout the trail and include: habitat control fencing, vegetative buffers, distance, and using low vegetated berms to minimize physical and visual impacts to wildlife using the site.

Along the trail, there will be five scenic overlooks, and interpretive signs, viewing scopes, and benches placed in key locations. The overlooks are oriented to provide interesting views of adjacent habitat areas. Approximately 36 public parking places exist at an abutting community park to the southwest of the trail, and 6 public parking places exist at the trail connecting to the proposed trail in the north. Adjacent land uses are residential and commercial, and there is no feasible location to provide additional parking at this time, although a proposed interpretative center at the northwestern corner of the site may provide additional parking and restroom facilities in the future.

The Corps states that the restoration activities will enhance habitat for a number of plant, fish and wildlife species. Overall, these habitat quality enhancements will increase both wildlife use of the site and the recreational potential of the site. The site will be more interesting to the public as species populations and composition increase. Thus, the restoration activities will be expected to enhance existing access at the site and make it a more desirable destination for hikers, bikers and bird watchers.

There has been considerable public interest in this trail alignment and design. Many differing points of view have been expressed from the public and stakeholders regarding whether there is adequate public access, whether the public will have adequate views of the project and the Bay, whether existing or future wildlife would be impacted, and how to best protect the wildlife from humans, domestic pets, and feral animals. Fencing proponents argue that the entire site should be fenced to keep people, dogs and feral animals out of the habitat areas. Others have stated that fencing detracts from the feeling of openness in the public access areas and that fencing provides perches for raptors, which would detract from the habitat value for some species. The trail design uses fencing in areas where other management techniques were not available or appropriate. In addition, fencing the entire site would prohibit terrestrial animals from moving through the project site from adjacent open space areas. Providing a wildlife corridor through the site is one of the project's and the San Francisco Bay Habitat Goals Project stated objectives. The USFWS is concerned that segment E of the trail could have adverse impacts, particularly if the area immediately south is restored to endangered species habitats in the future. The Corps believes the proposal as designed struck a balance between providing adequate public access and protecting wildlife uses on the site.

To ensure that the project provides maximum public access, Special Conditions II-F-1 and II-F-5 require the Corps to provide the following public access amenities: (1) 2.66 miles of paved, twelve-foot-wide, multi-use trail, with a two-foot-wide shoulder on either side; (2) five overlooks with seating and observation scopes, and interpretative signage; (3) an appropriate number and types of seating along the trail and overlooks; and (4) a signage program, including public access signs, Bay Trail signs, and interpretive signage (history, marsh restoration, wildlife protection, and directional, etc.,) along the trail. Special Condition II-F-3 requires the Corps or its agent or assignee to permanently maintain the public access for the enjoyment of the public.

Due to the time needed to construct the restoration project and the needed fill to raise elevations of the site, the public access component of the project will be phased with the anticipated phased completion of the site. Special Condition II-F-10 requires that the public access be completed and opened as adjacent restored areas and completed or by fixed dates in the consistency determination. Special Condition II-F-9 allows the Corps to remove or redesign Section E of the Bay Trail in the event that the property immediately to the south of the project is restored to tidal marsh.

To ensure that the project is consistent with the Bay Plan policies on public access and wildlife, Special Condition II-F-6, F-8, and F-12 have been included in this authorization. These special conditions allow the Corps to impose reasonable rules and restrictions on public access areas, and requires maintenance of a buffer between existing endangered species habitat and the public trail. Special Condition II-F-12 requires the Corps to submit and implement a public access management and monitoring plan to the Commis-

sion for review and approval. This plan will contain information on monitoring effects of public access use on wildlife and adaptive management techniques to be implemented if impacts are identified.

Amendment No. Three added the Navy ball field parcel, which expands the restoration project and makes it possible for the project to complete the Bay Trail along the perimeter of Segment D, which provides additional access and variety of experience along the trail. Therefore, the alternate shown by for Segment D is no longer considered to be part of the project as it would cut through proposed seasonal wetlands and cause disruption to the restored habitat and its use by wildlife. (Amendment No. Three) Amendment No. Four adds the State Lands Commission parcel that is located along the current Bay shoreline. No additional public access is provided in this amendment (Amendment No. Four).

The Commission finds that the project, as conditioned, provides maximum feasible public access, consistent with the project, and that the access is consistent with the Bay Plan policies on public access, particularly those policies pertaining to public access and wildlife.

C. **Bay Plan Policies on Tidal Marshes and Tidal Flats.** The Commission's policies on tidal marshes and tidal flats state, "Tidal marshes and tidal flats should be conserved to the fullest possible extent. Filling, diking, and dredging projects that would substantially harm tidal marshes or tidal flats should be allowed only for purposes that provide substantial public benefits and only if there is no feasible alternative." In addition, "Where and whenever possible, former tidal marshes and tidal flats that have been diked from the Bay should be restored to tidal action in order to replace lost historic wetlands or should be managed to provide important Bay habitat functions...." Policy Three states that "Projects should be sited and designed to avoid, or if avoidance is infeasible, minimize adverse impacts on any transition zone present between tidal and upland habitats. Where a transition zone does not exist and it is feasible and ecologically appropriate, shoreline projects should be designed to provide a transition zone between tidal and upland habitats." The policies go on to state, "[a]ny tidal restoration project should include clear and specific long-term and short-term biological and physical goals, and success criteria and a monitoring program to assess the sustainability of the project. Design and evaluation of the project should include an analysis of: (a) the effects of sea level rise; (b) the impact of the project on the Bay's sediment budget; (c) localized sediment erosion and accretion; (d) the role of tidal flows; (e) potential invasive species introduction, spread and their control; (f) rates of colonization by vegetation, where applicable; (g) expected use of the site by fish, other aquatic organisms and wildlife; and (h) site characterization. If success criteria are not met, corrective measures should be taken...."

When completed, the project will provide intertidal channels, tidal marsh, seasonal marsh, tidal pannes, high tide refugia, and potentially subtidal channels and intertidal ponds in an area that has been diked off from the Bay for over 150 years. In addition, transitional habitat will be provided where none exists today due to the subsided nature of the site. The project will take approximately 8 years to build, and thirty years to reach early maturity. During the interim period, the developing habitats will vary, but will include more open water and mudflats. To accelerate marsh establishment, dredged

material will be placed on site and wind wave berms will promote additional sedimentation. Once the site is fully established, it is expected to provide a total of 378 acres of tidal marsh and 156 acres of seasonal wetland, 13 acres of tidal pannes, and 34 acres of transitional upland habitat. This restored habitat is anticipated to provide foraging, nesting, roosting and loafing areas for numerous fish, wildlife and plant species, including the California clapper rail, the salt marsh harvest mouse, steelhead trout and Chinook salmon. Because the State Lands Commission parcel is still involved in a FUDS clean up, the design and final habitat configuration is not known. Once the FUDS clean up is completed, the design team will complete the restoration plan for this area (Amendment No. Four).

As part of the project, 2.6 acres of existing marsh will be dredged to connect the site to the Bay, and to allow some of the restored areas to flood and drain with each tide cycle. The Corps has evaluated the site and determined that the breach location minimizes the marsh vegetation that will be lost and 378 acres of additional marsh will replace this marsh over time and the 2.6 acres of tidal marsh will simply be converted to intertidal and subtidal habitat, a vital component of the Bay's marsh system, creating an overall public benefit that far exceeds the loss.

As part of the project authorization, the Corps sought and received authorization from Congress to monitor and adaptively manage the site for thirteen years after the site is returned to tidal action. The Corps states that it will provide the Monitoring and Adaptive Management Plan (MAMP) for this project by June 30, 2006, for review and approval by or on behalf of the Commission. There is a draft MAMP provided in the 2003 EIS/EIR. That draft program includes monitoring of specified environmental parameters (e.g., invertebrates, bird and fish use, vegetation, sedimentation, etc.). The MAMP will be an integral part of the project as it is necessary to address project uncertainties, propose adaptive measures to improve project performance, and address unanticipated problems and ensure project success.

To ensure that the project is designed and built in a manner that protects the existing marsh and will lead to habitat development and use by the target species, Special Conditions II-C-1, C-2, require additional plans that further define the project, as well as maintain water quality on site. Special Conditions II-C-2-c through II-C-h requires surveys and long-term habitat monitoring on the site. Additionally, Special Condition II-C-2-j requires the Corps to submit monitoring information and data from all marsh monitoring studies conducted at the site. Special Condition II-C-4 requires the Corps to create a Technical Advisory Committee that will meet once a year to review the status of the project and to recommend adaptive management measures, if needed.

The Commission finds that, with the stated project goal of restoring a suite of Bay area habitats, and implementation of the Special Conditions contained herein, which will increase the likelihood that the project will be successful in restoring the desired habitat, the project is consistent with its policies regarding tidal marshes and tidal flats.

D. **Fish, Other Aquatic Organisms, and Wildlife.** The Commission's policies on fish, other aquatic organisms, and wildlife policies state that "To assure the benefits of fish, other aquatic organisms and wildlife for future generations, to the greatest extent feasible, the Bay's tidal marshes, tidal flats, and subtidal habitat should be conserved, restored and

increased," and that "[s]pecific habitats that are needed to conserve, increase or prevent the extinction of any native species, species threatened or endangered, species...or any species that provides substantial public benefits, should be protected, whether in the Bay or behind dikes." Further, the policies direct the Commission to "be guided by the recommendations in the Baylands Ecosystem Habitat Goals report and should...provide for a diversity of habitats to enhance opportunities for a variety of associated native aquatic and terrestrial plant and animal species", consult with the resources agencies when there is a potential for adverse affects to endangered or threatened species, and not authorize projects that would result in the "taking" of any state or federal listed species acts, unless a take authorization has been made by the appropriate resource agency.

The Corps states that the Hamilton Wetland project site was once baylands prior to the area being diked off for agricultural uses. The project will restore a mosaic of habitat types, including restoring 568 acres to marsh habitat, including both seasonal and tidal wetlands, contiguous to the existing 78-acre band of remnant tidal marsh outboard of the existing levee. While 2.6 acres of the existing marsh will be impacted by project activities, the remainder will be conserved as part of the restoration, creating at completion a 471-acre expanse of tidal marsh. This increase in habitat acreage will benefit fish and wildlife in San Pablo Bay by providing additional wetland habitat that has been severely reduced during the last century. As the project develops, it is anticipated that cordgrass, pickleweed, and subtidal channels will develop. These components of tidal marshes support the endangered California clapper rail, salt marsh harvest mouse, black rail, steelhead, Chinook salmon, and coho salmon. In addition, the wetland complex will support migratory waterfowl and shorebirds during their migration.

The Baylands Ecosystem Habitat Goals project, a five-year regional effort to outline broad habitat goals for wetland restoration in San Francisco Bay, recommends that in San Pablo Bay, a wide continuous band of tidal marsh should be restored between Las Gallinas Creek and Novato Creek, and a natural transition to uplands throughout the area should be provided. The project goals are consistent with these regional goals.

The Corps has concluded consultation with NOAA Fisheries and the USFWS. The Corps has agreed to, and NOAA Fisheries has concurred with, mitigation measures to reduce potential impacts to listed salmonid and managed species under the Essential Fish Habitats program. These measures include: (1) screening of the dredged sediment offloader intake pipes; (2) conducting pile driving when listed species are likely not present in the Bay; (3) minimizing sound pressure waves; and (4) using a vibratory hammer rather than an impact hammers to drive piles. With this concurrence, NOAA Fisheries agreed that the project is not likely to adversely affect threatened or endangered salmonids. In addition, Special Conditions II- B-3, B-4, and E-1 require the above listed protective measures to ensure the Corps complies with NOAA Fisheries' recommendation.

The Corps has also concluded consultation with the USFWS. However, after reviewing the USFWS biological opinion for the project, the Corps had concerns with specific terms and conditions contained in the biological opinion. The Corps and the USFWS are currently negotiating certain terms and conditions of the biological opinion, which are likely to change the number of contaminants required in evaluation of the dredged sediments placed on site. The Commission staff will be involved in these negotiations

and will review any revised opinion for consistency with this determination, if necessary. Currently, the Corps states that it will minimize impacts to USFWS/CDFG listed species by implementing the following measures: (1) no construction will occur within 250 feet of the existing coastal salt marsh during the clapper rail breeding season; (2) constructed public access will have 700-foot and 300-feet buffers from existing coastal salt marsh and proposed restored tidal marsh, and will be screened with vegetation or fenced to keep the public and their domestic animals out of tidal marsh and sensitive areas; (3) measures will be taken to prevent any adverse affects to the salt marsh harvest mouse during the excavation of the outboard levee and the pilot channel to the site, as described in the July 20, 2005 biological opinion; and (4) all upland areas will be surveyed for burrowing owl, and San Pablo Bay song sparrows prior to construction. If nests or burrows are located in areas where construction is about to commence, appropriate measures to protect the individuals will be employed. Special Conditions II-E-1 through II-E-5 requires surveying, avoidance measures, trapping (if approved by CDFG), protective barriers, and best management practices for the protection of special status species on the site. Potential impacts from use of the public access trails and overlooks are mitigated for in Special Condition II-F-8 and F-9. In addition, Special Condition II-F-8, which require the use of fences, buffers, berms, etc., to minimize potential conflicts between trail users and wildlife, the re-routing and possible removal of a segment of the trail if an adjacent area is restored and the continued monitoring of public access to determine if trail use is adversely impacting wildlife use of the area, authorizes the Corps to apply reasonable rules and restrictions on the public access to protect wildlife, and to provide safety for the public.

The placement of the booster pumps and electrical power poles along the transmission corridor and the Bay front levee are necessary to provide power for offloading dredged sediment from barges and pumping the sediment onto the site. The placement of additional pumps within the existing pump house are necessary to pump the dredged sediment decant water back into the Bay once it has met water quality standards. This portion of the project was reviewed informally by the U.S. Fish and Wildlife Service and determined to cause no adverse affect to threatened or endangered species. Further, the Corps has committed to using raptor deterrent devices on power poles within 1500 feet of the outboard marsh, and to remove existing decommissioned power poles that may currently provide perches for raptors that may prey on endangered species within the marsh. Therefore, the impacts to endangered species are minimized (Amendment No. Two).

Therefore, the Commission finds that, with implementation of the special conditions contained herein, the project is consistent with its policies regarding fish, other aquatic organisms, and wildlife.

E. **Subtidal Areas Policies.** The Bay Plan policies on subtidal areas state that "[a]ny proposed filling... in a subtidal area should be thoroughly evaluated to determine the local and Bay-wide effects of the project on: (a) the possible introduction or spread of invasive species; (b) tidal hydrology and sediment movement; (c) fish, other aquatic organisms and wildlife; (d) aquatic plants; and (e) the Bay's bathymetry. Projects in subtidal areas should be designed to minimize and, if feasible, avoid any harmful effects."

The Corps will temporarily (up to eight years) place approximately 2.2 acres of solid fill, and 2.3 acres of floating fill in San Pablo Bay, a subtidal habitat, to install a dredged sediment offloader to deliver dredged sediment to the project site. The solid fill involves placing pilings, an electrical cable, and a dredged material delivery pipeline. Some of the habitat beneath the pipeline and pilings is expected to be lost during the project period. However, once the equipment is removed, these habitats are expected to naturally recover within one to three years. No invasive species are expected as a result of the placement of the offloader facility or pipeline. The Corps states that the regional tidal hydrology and sediment movement in San Pablo Bay should not be affected by the placement of the offloader facility and pipeline, as the water and sediment will move around the placed pilings and pipeline. However, there may be some small, localized effects in sediment movement where the pipeline intersects with the shoreline as the pipeline will create a barrier to lateral movement of both water and sediment at lower tides. However, because the pipeline will only be in place for eight years, it is expected that this effect will be minimized. Fish and mobile invertebrates are expected to leave the immediate site during construction of the offloader facility and pipeline. Sessile and benthic invertebrates in the direct footprint of the pipeline would be smothered. However, because of the large acreage of this habitat in San Pablo Bay and because the relative footprint of the offloader is small when compared to the habitat available, the loss is considered negligible when considering the benefits of the overall project. Because the offloader facility, booster pump barges and much of the pipeline will be located in deep waters of San Pablo Bay, aquatic vegetation will not be affected by the project. Eel grass surveys completed by NOAA Fisheries have not identified this area as having high potential for sub-aquatic vegetation establishment. Finally, the offloader facility is not expected to affect the bathymetry of the Bay.

The Corps has worked with Commission staff to reduce and eliminate as much fill as possible consistent with safe operation of the facility, The Corps states that the dredged sediment offloader facility, attendant barges, cable and pilings are the minimum necessary to accomplish this portion of the project. Special Conditions II B-1, B-2, B-4, B-5 and II-I, will reduce project impacts to the subtidal area through minimizing fill, minimizing pile-driving effects, requiring the full removal of the offloader and pilings when the project is complete, and prohibiting the use of creosote treated pilings.

Therefore, Commission finds that, with implementation of the special conditions contained herein, the project is consistent with its policies regarding subtidal areas.

F. **Water Quality Policies.** The Bay Plan policies on water quality state, in part, that "[b]ay water pollution should be prevented to the greatest extent feasible. The Bay's tidal marshes, tidal flats, and water surface area and volume should be conserved and, whenever possible, restored and increased to protect and improve water quality. Fresh water inflow into the Bay should be maintained at a level adequate to protect Bay resources and beneficial uses...." The policies also state that "[w]ater quality in all parts of the Bay should be maintained at a level that will support and promote the beneficial uses of the Bay as identified in the *San Francisco Bay Regional Water Quality Control Plan, San Francisco Bay Basin* and should be protected from all harmful or potentially harmful pollutants. The policies, recommendations, decisions, advice, and authority of the State Water Resources Control Board and the Water Board, should be the basis for carrying out the

Commission's water quality responsibilities." Finally, the policies also state that "[n]ew projects should be sited, designed, constructed, and maintained to prevent or, if prevention is infeasible, to minimize the discharge of pollutants into the Bay by: (a) controlling pollutant sources at the project site; (b) using construction materials that contain non-polluting materials; and (c) applying appropriate, accepted, and effective best management practices, especially where water dispersion is poor and near shellfish beds and other significant biotic resources."

The proposed project would occur in and adjacent to San Pablo Bay, an area with open saline to brackish water, depending on the season, and fine mud to silty clay substrate. Several native and endangered species are also found in the area, including the salt marsh harvest mouse, the delta smelt, the winter run Chinook salmon, steelhead trout, and the California clapper rail.

The project could affect water quality by: (1) increasing turbidity through the release of unconsolidated sediments once the area is restored with dredged sediments and restored to tidal action; (2) removing large quantities of water from the Bay in order to pump dredged material onto the site; (3) releasing of contaminants contained in dredged materials into the water column; and (4) releasing existing low level site contaminants. The Corps has addressed these concerns in the consistency determination.

1. **Removing large quantities of water from the Bay.** The Corps states that between 17,000 and 40,000 acre-feet of water will be needed to pump the 7.1 million cy of dredged sediments onto the site. An additional 1,200 acre-feet of Bay water will be removed from the Bay to maintain water over the dredged material during the construction period. This water will be needed to prevent acidification, desiccation and over-consolidation of the material prior to breach. The Corps estimates that on an average day, when dredged material is being pumped onto the site, approximately 10,000 cy of water will be used. Once the slurried dredged material is placed on site, the sediment will settle out of the water. The water will be managed on site until it is clarified and meets the Water Board's waste discharge requirements, and then it will be pumped back into the Bay. (See the following section regarding return water)

   Drawing large quantities of water from the Bay has the potential to entrain or impinge organisms that live in that water. NOAA Fisheries, through its Essential Fish Habitat recommendations, discussed the issue of impingement and entrainment of invertebrates and larval fish through the pumping of Bay water onto the site during the dredged sediment transportation process. NOAA Fisheries provided the following opinion: "[t]he Corps estimates that pumping water from San Pablo Bay to the restoration site will occur for approximately 710 days within the 7 year construction period...." The Corps considered other options for slurrying dredged sediment or importing saline water onto the site, but did not identify a feasible option. According to NOAA Fisheries, "The Corps will minimize effects to juvenile and adult fishes by screening the intake to NMFS criteria, but impingement and entrainment of eggs and larve will still occur. Entrained organisms are assumed to experience 100 percent mortality. The effects of this intake cannot be quantified without a

full analysis of the population dynamics and densities in San Pablo Bay of the species and life stages entrained. In general, mortality resulting from water intake will be limited in space and time to the area and period of construction, and the long-term benefits from habitat restoration should more than compensate for the short term impacts of the project construction."

2. **The release of contaminants.** Dredging projects in the San Francisco Bay Area are reviewed by the Dredged Material Management Office (DMMO), which consists of representatives from the U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, the San Francisco Bay Regional Water Quality Control Board, the California State Lands Commission, and the San Francisco Bay Conservation and Development Commission. The California Department of the Fish and Game, NOAA Fisheries and the U.S. Fish and Wildlife Service are also to invited attend. Each dredging project's sediment samples are reviewed for chemical constituents, biological toxicity and grain size. Dredged material that does not meet the guidelines for wetland cover quality material would not be approved by the DMMO and will not be authorized for reuse at the Hamilton site. Thus, the Corps believes dredged material containing elevated levels of existing contaminants will not be placed at Hamilton.

3. **The release of existing site contaminants.** The former Hamilton Army Airfield has been owned and operated by various branches of the Department of Defense from 1932 until 2003, when it was transferred to the Conservancy through the Department of Defense's Early Transfer Process. The adjacent coastal salt marsh was transferred from the Department of Defense to the California State Lands Commission. The Army is in the final stages of clean up as required by the Base Realignment and Closure Act (BRAC), and will be finished by December 31, 2005.

   Through the BRAC process, the following relatively low level contaminants were identified on site: petroleum hydrocarbons, volatile and semi-volatile compounds, polychlorinated biphenyls, herbicides, pesticides and metals. Soils contaminated by Army activities on the airfield parcel were concentrated around underground storage tanks, above ground storage tanks, an aircraft maintenance facility, transformer and generator sites, a former sewage treatment plant, two burn pits, perimeter drainage ditch sediments, and coastal salt marsh sediments. A detailed discussion of site contamination is provided in the Record of Decision/Remedial Action Plan (ROD/RAP), which was issued in 2003 (Department of the Army et al, 2003) and which is on file at the Commission's office. The U.S. Army BRAC program has implemented a remediation program under the BRAC 1988 process to restore the airfield to a condition protective of human health and the environment for reuse as a wetland area. Water Board Order R2-2003-0076 established Site Cleanup Requirements for this site and to ensure completion of all actions required under the ROD/RAP. The Water Board issued Clean Up Order No. R2-2003-0076 on August 20, 2003, and is the lead agency regarding the BRAC clean up of the site and the coastal salt marsh.

   In addition to the contaminants identified by the Army, low levels of DDT were identified area-wide, as well as low levels of poly-aromatic hydrocarbons (PAH) around the southern end of the runway. These contaminants, while below the Army's action level, were considered of potential concern for wildlife, if exposed.

The Corps completed a risk analysis and determined that this material should be removed from areas that will be returned to tidal action. Therefore, the soils containing the low levels of DDT and PAH's were excavated from the tidal portion of the site and relocated to the northern seasonal wetland, where they will remain sequestered under a minimum of three feet of sediment (up to six feet in some areas). The design of the seasonal wetlands includes an impermeable layer of sediment that will be placed to create the shallow ponds desired for habitat. This impermeable layer will act as an added barrier between the habitat and the sequestered soils. Because these particular contaminants bind to sediment particles, they will not migrate to the surface where wildlife could be exposed.

Additionally, there are approximately 50,000 cy of soil in piles with low levels of contamination (DDT, PAH, inorganics, petroleum hydrocarbons, chlordane, etc) located on the main runway. The levels do not exceed the human health levels or exceed Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) action level, but are elevated enough to require three feet of clean cover. These soils will be placed at the basement level of the wildlife corridor. A minimum of three feet of clean material will be placed on top of these soils to isolate the material, to prevent exposure and to comply with the ROD/RAP. The Corps has developed a Soil Management Plan that includes monitoring of these soils both during construction and during the life of the project. The Soil Management Plan is on file at the Commission's office.

The Water Board approved the Waste Discharge Requirements for this project at its July 20, 2005 meeting. The Commission staff has reviewed the Board's Order for consistency with the Commission's water quality policies, and incorporated Special Conditions II-H-1 and II-H-2 to ensure that the Corps meets the obligations of the Water Board. In addition, specific monitoring requirements are included to address water quality issues.

The State Lands Commission parcel is a formerly used defense site (FUDS). It is currently being considered for clean up action. The primary contaminant of concern is lead. The Army has characterized the site and Exhibit F shows the areas that have contaminant issues. The area proposed for filling authorized by Amendment No. Four are outside of the contaminated areas. Berms will be raised to insure that none of the dredged sediment is placed in areas with contamination. Similarly, decant water from the dredged sediment is routed away from the contaminated area. Therefore, the Commission staff believes that the activity authorized by Amendment No. Four will not pose water quality issues for the Bay (Amendment No. Four).

4. **Methylated Mercury.** Recent studies in the Bay Area and nationwide have identified methylated mercury as an accumulative toxin that affects high order predators, including marine mammals, birds, fish and humans. Mercury methylization is a complex process in which elemental mercury is converted to methylated mercury (an organic form that is bioavailable) by bacteria, which is then available to fish, aquatic organisms and wildlife. Fresh, brackish and salt marshes have all been found to produce methylated mercury, but as methylation is occurring, so is demethyla

tion. The level of net methylation in wetlands is still a topic of research. While elemental mercury is found naturally in the environment, releases during the Gold Rush and from mercury mines in the Bay Area have lead to large quantities of mercury in Bay sediments.

Mercury is easily absorbed into the living tissue of aquatic organisms and is not easily eliminated. Therefore, it accumulates in predators. Methylmercury is highly toxic to birds and mammals and causes a number of adverse effects, including neurological and reproductive disorders. The degree to which mercury is transformed into methylmercury and transferred up the food chain depends on many site-specific factors (such as water chemistry and the complexity of the food web) through processes that are not completely understood.

The Corps 2003 Supplemental EIS/EIR for the expanded Hamilton project concluded that the production of methylmercury in the sediments of the restored wetland could be a significant, but unavoidable impact. However, the Corps stated that the environmental and economic benefits of the Hamilton Wetland Restoration project outweigh the potential impacts from mercury methylation. The SEIR recommends that the Corps carry out a Methylmercury Adaptive Management Plan, which would be drafted with input from key resource and regulatory agencies and which would describe monitoring and corrective actions, if necessary, to minimize the effects of methylmercury production.

Mercury production in aquatic systems is an area of active research; however, no corrective actions are currently known or recommended. Because scientific understanding of this impact is insufficient to provide definitive conclusions about the significance of this impact or the efficacy of mitigation, this impact is currently assumed to be significant and unavoidable. In efforts to further understand methylation of mercury, and ways to manage it, the Corps has been studying methylation at Hamilton and the nearby China Camp State Park over the last several years. The Corps committed approximately $490,000 in fiscal year 2005 to continue these efforts. The Corps has also been collaborating with other agencies and scientific research groups in these efforts. Special Condition II-H-2 requires the Corps to developing a Methylmercury Adaptive Management Plan for Hamilton.

The Commission finds that, by implementing those requirements contained in the RWQCB Order issued for the project, as well as Special Conditions II-H-2-a through II-H-2-c contained in this authorization, potential impacts from methyl mercury accumulation will be reduced.

G. **Dredging Policies.** Bay Plan Policies on dredging state, in part, that "[d]redging and dredged material disposal should be conducted in an environmentally and economically sound manner. Dredgers should reduce disposal in the Bay and certain waterways over time to achieve the LTMS goal of limiting in-Bay disposal volumes to a maximum of one million cubic yards per year..." and that "[d]redged materials should, if feasible, be reused or disposed outside the Bay and certain waterways." Further, "Further, dredging projects should maximize use of dredged material as a resource consistent with protecting and enhancing Bay natural resources, such as creating, enhancing, or restoring tidal and managed wetlands...."

Approximately 25,000 cy of dredging will take place to cut a tidal channel through the existing fringe marsh. The Corps states that the sediment dredged will either be used in the project, at the Bel Marin Keys V parcel (slated for future tidal restoration), or disposed at an appropriate upland disposal site. Special Condition II-E-1, 2, 3 require that the dredging take place during the environmental work window for this area. In the event that dredging cannot occur within the work window, the Corps will consult with both NOAA Fisheries and the USFWS to determine appropriate mitigation measures to avoid or minimize impacts to aquatic resources.

The material dredged by this project will be beneficially reused on site, at an adjacent site, or placed at an appropriate upland facility. Special Condition II-D-3 requires that any dredged sediment placed on site be reviewed by the DMMO to ensure that it meets the requirements set forth by the Regional Water Quality Control Board, and the consistency determination issued by the Commission.

A goal of the wetland restoration project is to beneficially reuse material from Bay area dredging projects to raise the site to an elevation appropriate for marsh plain development. 7.9 ~~7.1~~ million cy of wetland cover quality sediment from the Bay dredging projects will be utilized in developing the wetlands that would likely be disposed of at the in-Bay disposal sites. The addition of the Navy ball field parcel allows for the beneficial reuse of approximately 177,820 cy of dredged sediment. The addition of State Lands Commission parcel allows for beneficial reuse of an additional 650,000 cy of sediment. The site capacity is expanded to a total of 7,927,820 ~~7,277,820~~ cy. Therefore, this project not only will not dispose of any material in-Bay, it will also allow for the economically sound reuse of Bay-wide dredged sediments for eight years.

For these reasons, as conditioned, this consistency determination is consistent with Bay Plan policies on dredging.

H. **Navigation Safety and Oil Spill Prevention Policies.** The Bay Plan policies on navigation safety state that "[t]he Commission should ensure that marine facility projects are in compliance with oil spill contingency plan requirements of the Office of Spill Prevention and Response, the U.S. Coast Guard (USCG) and other appropriate organizations."

The Corps states in its consistency determination that all offshore and near-shore equipment will be properly signed and lighted with day shapes and navigation lights as required by the USCG and the Harbor Safety Committee of the San Francisco Bay Region. The project activities and locations will also be published in the USCG Local Notice to Mariners as required. During periods of non-operation, the equipment will be removed or secured in place. At the end of construction all equipment will be completely removed from the Bay. All contractors and equipment will be required to have spill prevention and cleanup plans, equipment and personnel training in compliance with U.S. Army Corps of Engineers, USCG and State regulations and requirements.

With these measures and as conditioned, the Commission finds that the project is consistent with the Bay Plan policies on Navigation Safety and Oil Spill Prevention.

I. **Priority Use Designation.** The project site is identified as a closed military base, and is designated as a wildlife refuge on Bay Plan Map No. 1. The project is consistent with the priority use designation of the site because the project will restore the site to tidal and

seasonal wetlands and will be maintained as habitat for wildlife, fish and plants. Once the restoration is complete, the Corps and the Conservancy intend to transfer the property into the stewardship of an appropriate resource agency as a wildlife refuge.

J. **Extension of Commission's Jurisdiction.** With the opening of the tidal restoration area to tidal waters, this project will extend the Commission's "Bay" jurisdiction inland to tidal marsh areas up to five feet above Mean Sea Level. The Commission's shoreline band will also move inland with tidal waters, and will begin at the inland edge of marsh vegetation up to the five foot Mean Sea Level contour. In addition, staff determined that the entire project should be included in the authorization section because the entire project is within the Coastal Zone and therefore the entire project is subject to the Amended Coastal Zone Management Act of 1972 (Amendment No. Three).

K. **Engineering Criteria Review Board (ECRB).** The project was not reviewed by the ECRB because it does not involve the construction of significant structures on fill that would provide seismic risks to large numbers of people.

L. **Design Review Board (DRB).** The Design Review Board reviewed the proposed project at its April 11, 2005 and June 6, 2005 meetings. At its first meeting, the Board concluded that the amount of public access is adequate and recommended that: (a) the proposed overlooks should not be "designed" objects, but should be more camouflaged to be compatible with the adjoining marsh habitat; and (b) more information about the levee along the City of Novato (segment C) was needed to determine the location of the trail in other areas. At the June meeting, the public access design had been modified to incorporate low berms in some areas to provide additional screening of the public access areas from wildlife, and the design of the overlooks had been altered to be more rustic and resemble duck blinds on their lower portion. While commenting that the project provided the most sensitive treatment of public access adjacent to wildlife habitat that the Board had ever seen, some Board members still expressed concern that wildlife might be impacted by the public use of the trail. Some Board members suggest that more of the trail could be screened from the restoration area with higher berms or by moving the trail further away from wetland areas. However, this measure could not be employed without loss of desired habitat.

M. **Environmental Review.** On June 16, 2005, the California State Coastal Conservancy, the CEQA lead agency for the project, certified the Supplemental EIR component of the *Supplemental EIS/EIR, entitled "Bel Marin Keys Unit V Expansion of the Hamilton Wetland Restoration Project"* (April 2003). The Corps, the NEPA lead agency for the project, issued a Record of Decision for the project in June 2005.

N. **Conclusion.** For all of the above reasons the Commission finds, declares and certifies that subject to the Special Conditions stated herein, the amended project authorized herein is consistent with the San Francisco Bay Plan, the McAteer-Petris Act, the Commission's Regulations, the California Environmental Quality Act, and the Commission's Amended Management Program for the San Francisco Bay segment of the California coastal zone.

IV. Standard Conditions

A. All required permissions from governmental bodies must be obtained before the commencement of work; these bodies include, but are not limited to, the U. S. Army Corps of Engineers, the State Lands Commission, the Regional Water Quality Control Board, and the city and/or county in which the work is to be performed, whenever any of these may be required. This consistency determination does not relieve the Corps of any obligations imposed by State or Federal law, either statutory or otherwise.

B. The attached Notice of Completion and Declaration of Compliance form shall be returned to the Commission within 30 days following completion of the work.

C. Work must be performed in the precise manner and at the precise locations indicated in your consistency determination request, as such may have been modified by the terms of the consistency determination and any plans approved in writing by or on behalf of the Commission.

D. Work must be performed in a manner so as to minimize muddying of waters, and if diking is involved, dikes shall be waterproof. If any seepage returns to the Bay, the Corps will be subject to the regulations of the Regional Water Quality Control Board in that region.

E. The rights, duties, and obligations contained in this consistency determination are assignable. When the Corps transfers any interest in any property either on which the authorized activity will occur or which is necessary to the full compliance of one or more conditions to this consistency determination, the Corps/transferors and the transferees shall execute and submit to the Commission a consistency determination assignment form acceptable to the Executive Director. An assignment shall not be effective until the assignee executes and the Executive Director receives an acknowledgment that the assignee has read and understands the consistency determination and agrees to be bound by the terms and conditions of the consistency determination, and the assignee is accepted by the Executive Director as being reasonably capable of complying with the terms and conditions of the consistency determination.

F. Unless otherwise provided in this consistency determination, all the terms and conditions of this consistency determination shall remain effective for so long as the consistency determination remains in effect or for so long as any use or construction authorized by this consistency determination exists, whichever is longer.

G. Unless otherwise provided in this consistency determination, the terms and conditions of this consistency determination shall bind all future owners and future possessors of any legal interest in the land and shall run with the land.

H. Unless otherwise provided in this consistency determination, any work authorized herein shall be completed within the time limits specified in this consistency determination, or, if no time limits are specified in the consistency determination, within three years. If the work is not completed by the date specified in the consistency determina-

tion, or, if no date is specified, within three years from the date of the consistency determination, the consistency determination shall become null and void. If a consistency determination becomes null and void for a failure to comply with these time limitations, any fill placed in reliance on this consistency determination shall be removed by the Corps or its assignee upon receiving written notification by or on behalf of the Commission to remove the fill.

I. This consistency determination shall not take effect unless the Corps executes the original of this consistency determination and returns it to the Commission within ten days after the date of the issuance of the consistency determination. No work shall be done until the acknowledgment is duly executed and returned to the Commission.

J. Any area subject to the jurisdiction of the San Francisco Bay Conservation and Development Commission under either the McAteer-Petris Act or the Suisun Marsh Preservation Act at the time the consistency determination is granted or thereafter shall remain subject to that jurisdiction notwithstanding the placement of any fill or the implementation of any substantial change in use authorized by this consistency determination.

K. Any area not subject to the jurisdiction of the San Francisco Bay Conservation and Development Commission that becomes, as a result of any work or project authorized in this consistency determination, subject to tidal action shall become subject to the Commission's "bay" jurisdiction.

L. Unless the Commission directs otherwise, this consistency determination shall become null and void if any term, standard condition, or special condition of this consistency determination shall be found illegal or unenforceable through the application of statute, administrative ruling, or court determination. If this consistency determination becomes null and void, any fill or structures placed in reliance on this consistency determination shall be subject to removal by the Corps or its assignees if the permit has been assigned to the extent that the Commission determines that such removal is appropriate. Any uses authorized shall be terminated to the extent that the Commission determines that such uses should be terminated.

M. **Conclusion.** For all the above reasons, the Commission finds that the project will minimize the amount of new fill in the Bay, and is designed to protect fish and wildlife resources and maintain water quality in the Bay to maximum extent practicable, and will mitigate for those impacts that are unavoidable. Therefore, the project is consistent, to the maximum extent practicable, with the Commission's amended coastal zone management program for San Francisco Bay.

Executed at San Francisco, California, on behalf of the San Francisco Bay Conservation and Development Commission on the date first above written.

WILL TRAVIS
Executive Director
San Francisco Bay Conservation and
Development Commission

By: _____
CAITLIN SWEENEY
Chief Deputy Director

WT/BG/rca

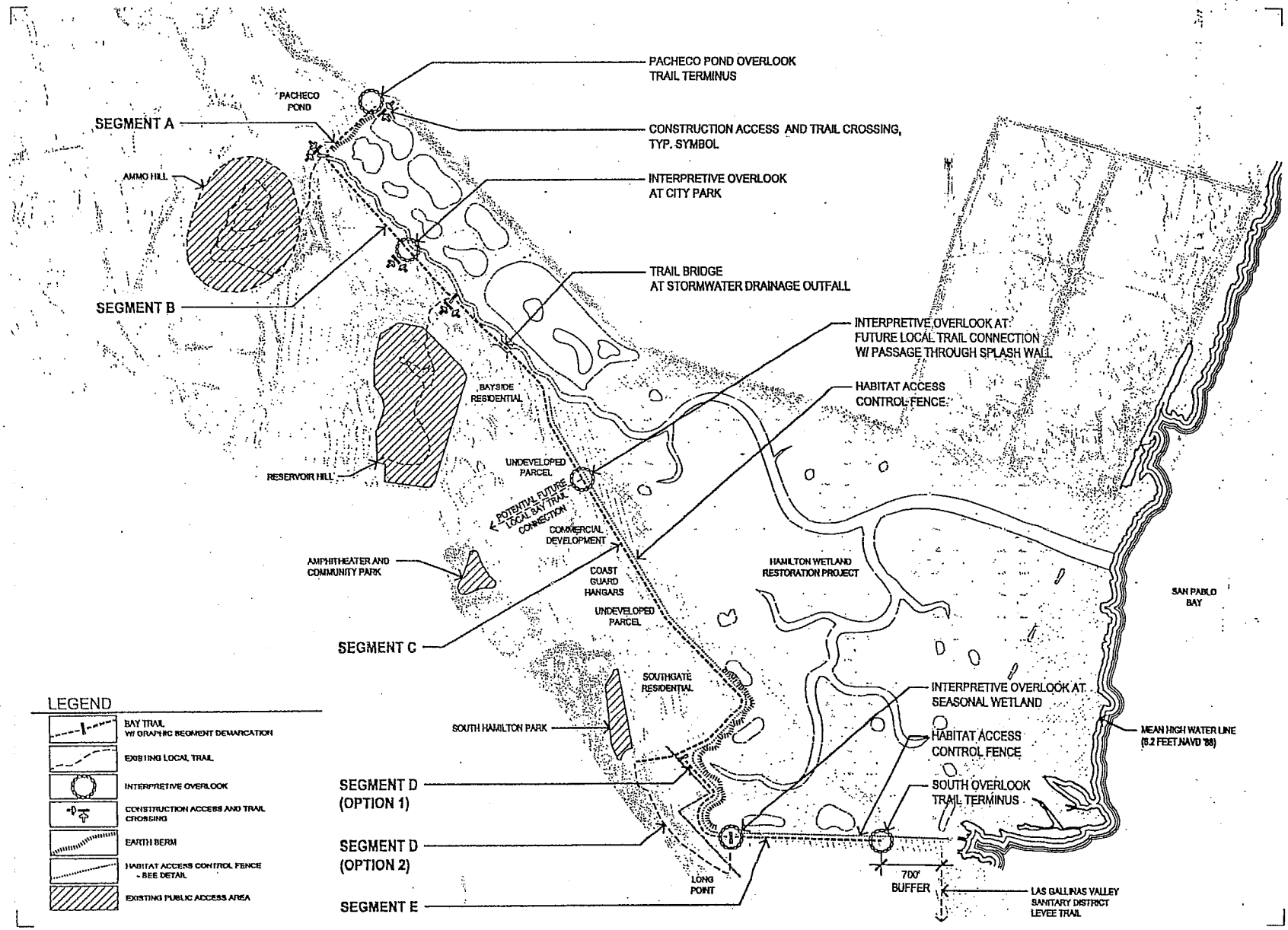
cc: Irene Lee, U.S. Army Corps of Engineers
Eric Jolliffe, U.S. Army Corps of Engineers
Dave Smith, U.S. Environmental Protection Agency
Naomi Feger, S.F. Bay Regional Water Quality Control Board
Donn Oetzel, State Lands Commission
George Isaac, California Department of Fish and Game
David Woodbury, NOAA Fisheries
Ryan Olah, U.S. Fish and Wildlife Service
Eric Polson, Polson Engineering
Tom Gandesbery, California State Coastal Conservancy

* *

Receipt acknowledged, contents understood and agreed to:

Executed at _____ _____
District Commander

On _____ By: _____



HAMILTON WETLAND RESTORATION PROJECT

PUBLIC ACCESS PLAN

SCALE
0 500' 1000'
NORTH

* This drawing is conceptual and for planning purposes only. Program information, scale, location of areas, and other information shown are subject to field evaluation and modification.

EXHIBIT A
PROPOSED
PUBLIC ACCESS PLAN

DRAFT
20 MAY, 05

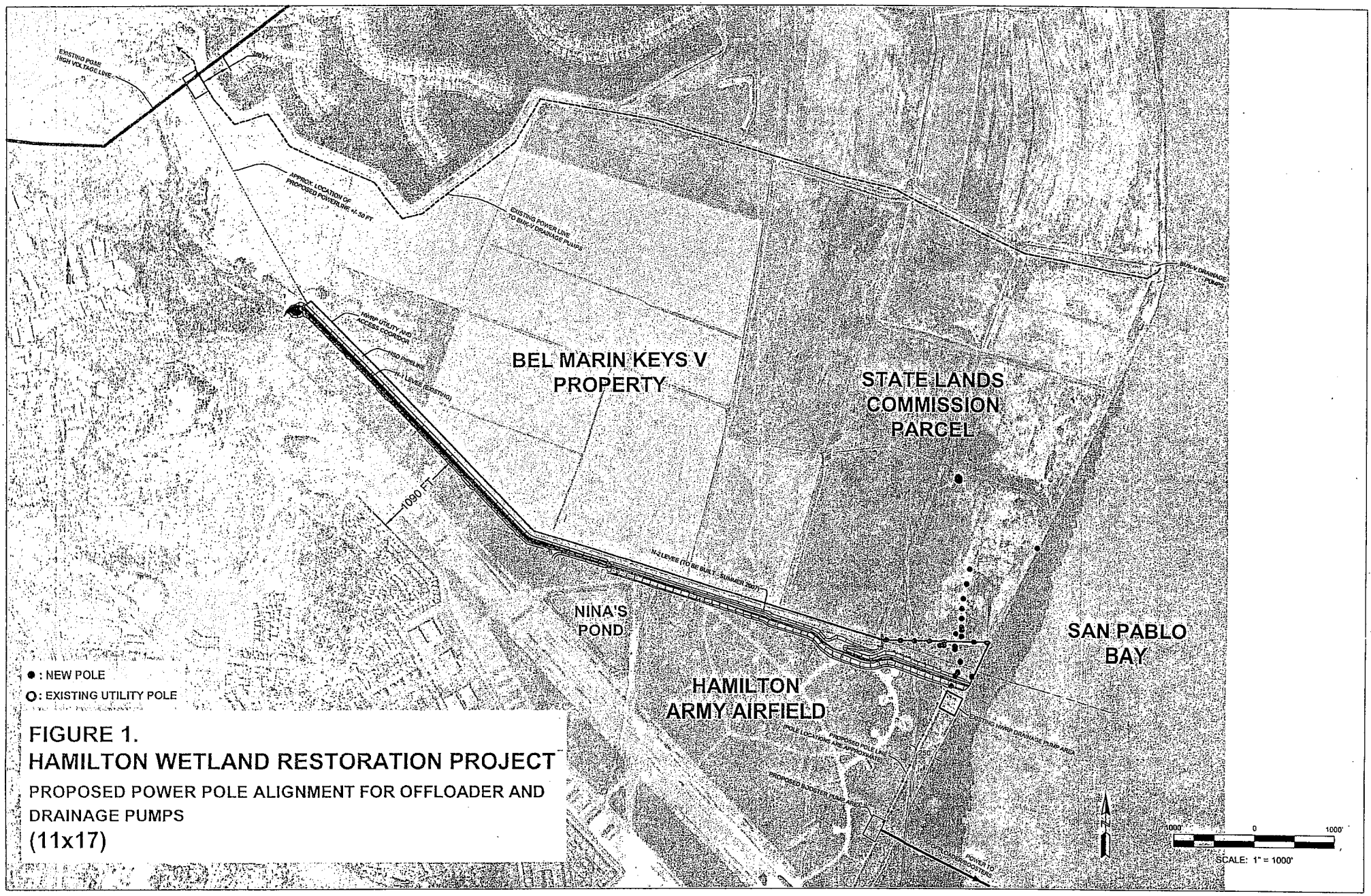


FIGURE 1.
HAMILTON WETLAND RESTORATION PROJECT
PROPOSED POWER POLE ALIGNMENT FOR OFFLOADER AND DRAINAGE PUMPS
(11x17)

EXHIBIT B

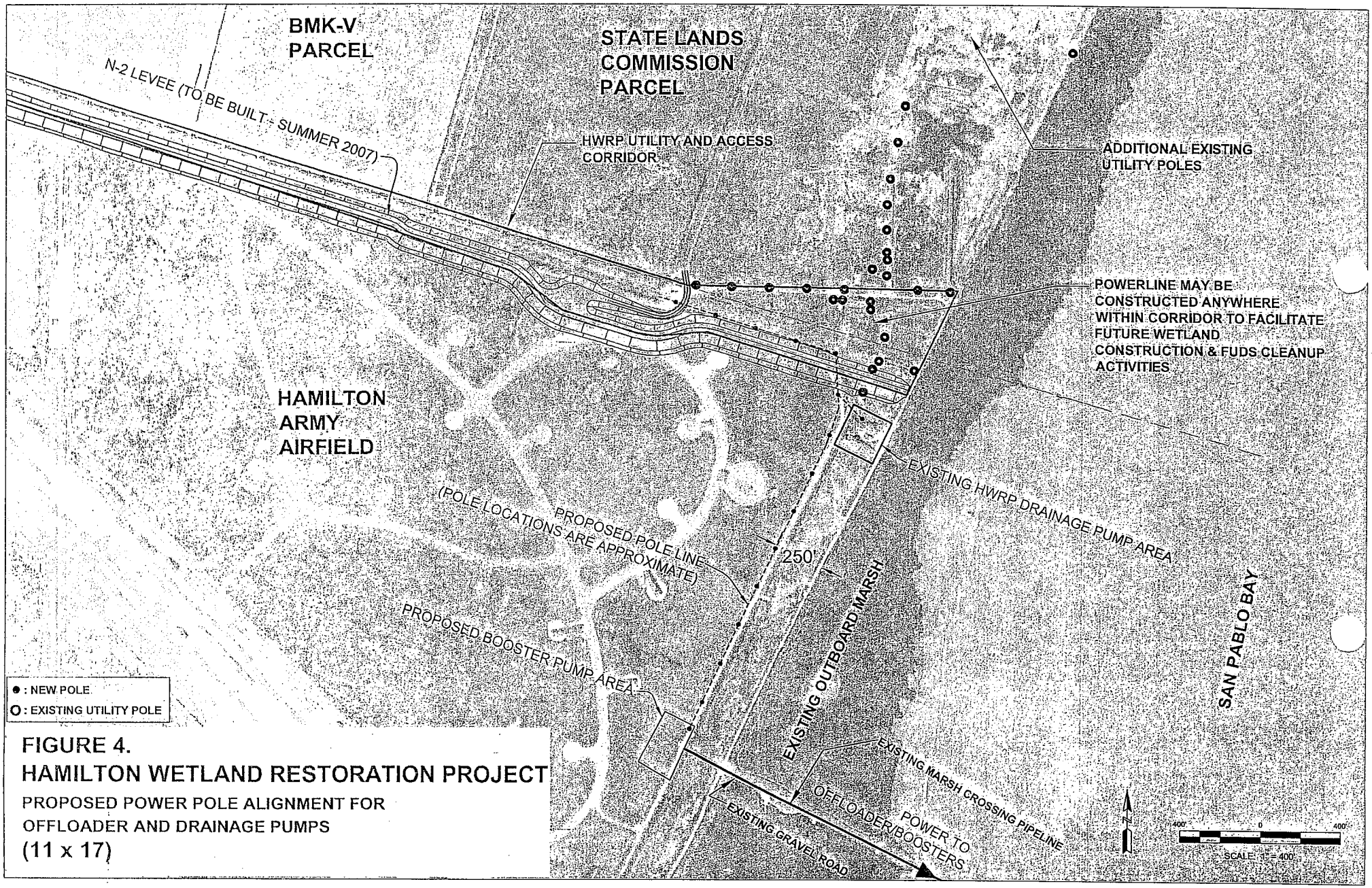
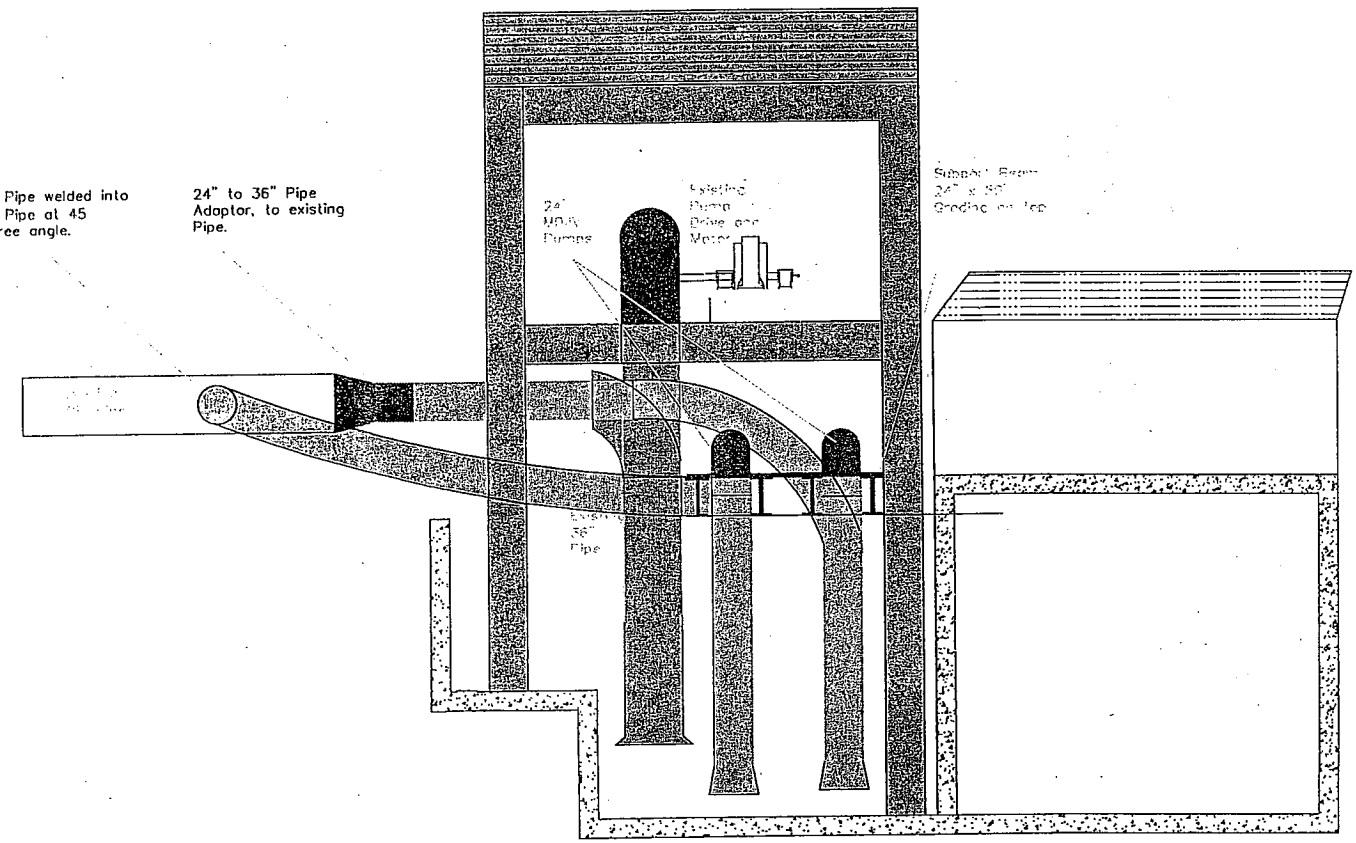


FIGURE 4.
HAMILTON WETLAND RESTORATION PROJECT
PROPOSED POWER POLE ALIGNMENT FOR
OFFLOADER AND DRAINAGE PUMPS
(11 x 17)

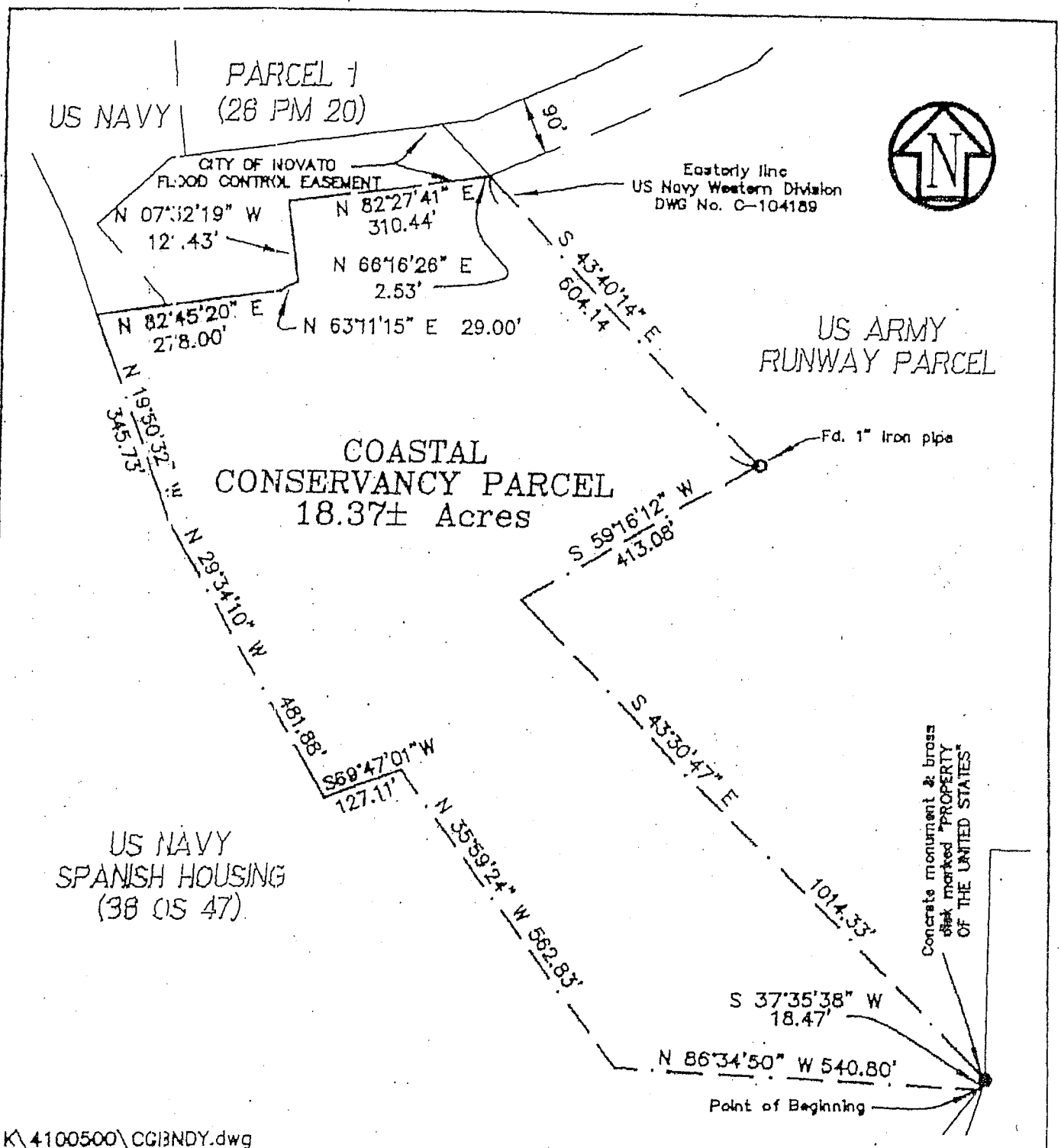
EXHIBIT C



Side View of Pump House

Sheet 3 of 4	Hamilton Field Pump Station	Notes:			MANSON CONSTRUCTION CO.
GRAPHIC BAR SCALE	Figure 12	Plot Date:	June 04, 2007		
	Manson Construction/Dutra Group	Drawn By:	Max Oviedo		
		Drawing Name:	Pump Station.dwg		

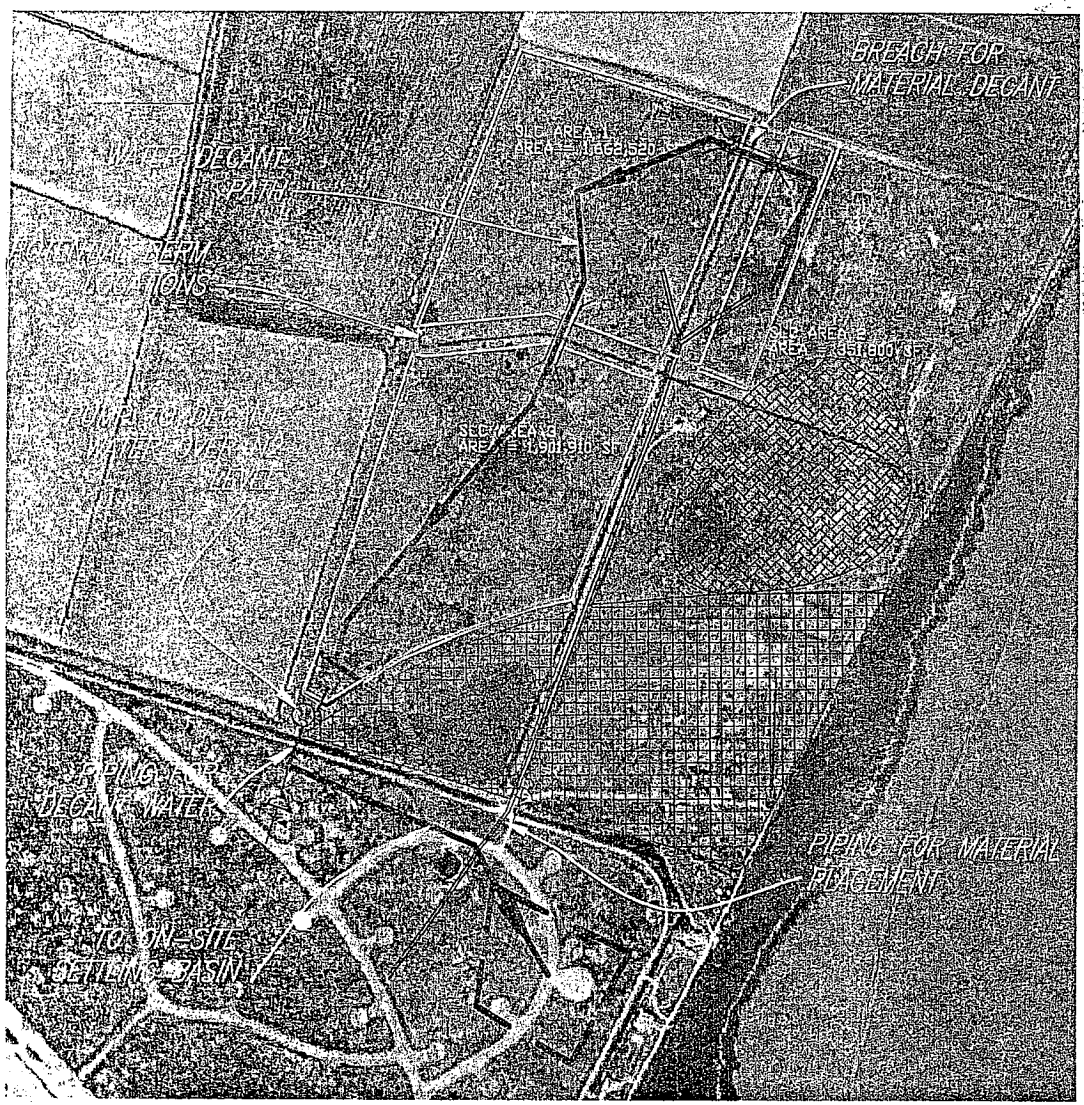
EXHIBIT D



K\4100500\CGIBNDY.dwg

CSW [St]² CSW/STUBER-STROEH ENGINEERING GROUP, INC. CONSULTING ENGINEERS 790 DeLong Ave., Novato, CA. 94945-3246 (415) 892-4763 FAX (415) 892-4502 © 1997	SCALE: 1" = 200' 18 NOVEMBER 1997	JOB No.: 4.1005.00
	HAMILTON ARMY AIRFIELD US NAVY DEDICATION TO COASTAL CONSERVANCY	
	NOVATO MARIN COUNTY CALIF.	

EXHIBIT E



SLC MATERIAL PLACEMENT NOTES

THE FOLLOWING NOTES APPLY TO MATERIAL PLACEMENT AND DECANT WATER WITHIN THE STATE LANDS COMMISSION PARCEL.

a. THE LOCATIONS OF ALL STRUCTURES AND PIPES IN THIS ATTACHMENT ARE APPROXIMATE AND MAY BE ALTERED SLIGHTLY DURING MATERIAL PLACEMENT.

b. THE CONTRACTOR SHALL PLACE MATERIAL HYDRAULICALLY INTO SLC AREAS 1 AND 3 AS NECESSARY FOR WATER QUALITY AND FILL LEVEL REQUIREMENTS. BREACHES WILL BE MADE BETWEEN THE SLC AREAS FOR MATERIAL AND WATER DECANT.

c. THE CONTRACTOR WILL ALLOW WATER TO DECANT OVER LAND FROM SLC AREA 2 TO SLC AREA 3 AS SHOWN IN THE DRAWING. WATER WILL DECANT TO A HOLDING PIT IN THE SOUTHWEST CORNER OF SLC AREA 3 AS INDICATED. WHERE IT WILL BE PUMPED INTO PIPING OVER THE NI LEVEE.

d. THE PIPING FOR THE SEDIMENT PLACEMENT AND THE PIPING FOR THE DECANT WATER WILL BOTH BE ROUTED OVER THE NI LEVEE AS SHOWN IN TYPICAL CROSS SECTION 1. THE CONTRACTOR WILL USE DIRT OR STEEL RAMP STRUCTURES OVER THE PIPING TO MAINTAIN LIGHT VEHICLE TRAFFIC ALONG THE NI LEVEE.

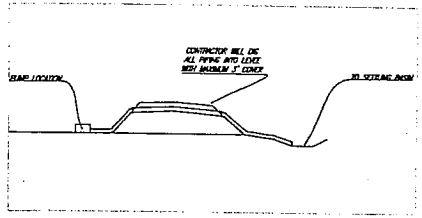
e. ONCE DECANT WATER IS PUMPED OVER THE NI LEVEE, IT WILL CONTINUE OVERLAND TO THE HAMILTON WETLAND RESTORATION PROJECT SETTLING BASIN AS SHOWN.

f. THE CONTRACTOR MAY POTENTIALLY CONSTRUCT SMALL FISHED BERMS IN THE AREAS SHOWN IN ORDER TO CONTAIN DECANT WATER TO A MAXIMUM HEIGHT OF +4.0 FEET NAVD 1988.

NO CONSTRUCTION ACTIVITY BUFFER FOR FUDS SITE

UXO HAZARD AREA

SOUTHWEST QUADRANT FUDS SITE



TYPICAL CROSS SECTION – PIPING OVER LEVEE

US Army Corps of Engineers

MATERIAL PLACEMENT AND DECANT WATER PLAN STATE LANDS COMMISSION PARCEL

Sheet reference number: FIGURE 22

EXHIBIT F

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

IN REPLY REFER TO:
1-1-05-F-0068

JUL 2 0 2005

Ms. Fari Tabatabai
Chief, Environmental Planning Section
(Attn: Eric Jolliffe)
San Francisco District
U.S. Army Corps of Engineers
333 Market Street
San Francisco, California 94105-2197

Subject: Endangered Species Consultation for the Proposed Wetland Restoration Project at the Former Hamilton Army Airfield, City of Novato, Marin County, California

Dear Ms. Tabatabai:

This is in response to the U.S. Army Corps of Engineers' (Corps) February 22, 2005, request for formal consultation with the U.S. Fish and Wildlife Service (Service) regarding the proposed wetland restoration project (proposed action) at the former Hamilton Army Airfield in Marin County, California. Your request for formal consultation was received in our office on February 26, 2005. The wetland restoration design of the proposed action has been developed and will be implemented by the Corps' San Francisco District and the California State Coastal Conservancy (Conservancy) (collectively the "project proponents"). The Bay Conservation and Development Commission (BCDC) is involved in the proposed action in an advisory role and active in its planning and design. This document represents the Service's biological opinion on the effects of the proposed action on the endangered California clapper rail (*Rallus longirostris obsoletus*) and salt marsh harvest mouse (*Reithrodontomys raviventris*) in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

This biological opinion is based on information provided in the following documents: (1) the Service's August 22, 2003, biological opinion for the U.S. Department of Army's transfer and environmental remediation of the Hamilton Army Airfield; (2) the Service's September 10, 2003, amendment of the biological opinion for the transfer and environmental remediation of the Hamilton Army Airfield; (3) the Corps' *Biological Assessment for the Hamilton Wetland Restoration Project, Marin County, California* dated February 2005; (4) the *Hamilton Wetland Restoration Project Draft Public Access Plan* dated March 25, 2005 and revised May 20, 2005; (5) information and comments received from the independent design group that reviewed the

project proponents' wetland restoration design originally submitted for formal consultation; and (6) miscellaneous correspondence and electronic mail concerning the proposed action between the Service, project proponents, and interested or involved parties. This opinion also is based on other relevant published and unpublished studies, and communications on the distribution and abundance of the California clapper rail and salt marsh harvest mouse, and information available to the Service.

Consultation History

August 22, 2003: The Service issued a biological opinion for the transfer and environmental remediation of the Hamilton Army Airfield by the U.S. Department of the Army. The biological opinion did not include an analysis of potential adverse effects to listed species or provide take authorization from restoration of the site because of the conceptual nature of the restoration design at the time. The biological opinion stated that formal consultation would be required when a detailed wetland restoration design was available for analysis.

September 10, 2003: The Service amended the biological opinion for the transfer and environmental remediation of the Hamilton Army Airfield to clarify certain elements and modify certain contaminant criteria in the original opinion.

February 22, 2005: The Corps requested formal consultation for the proposed action.

February 26, 2005: The Service received the Corps' request for formal consultation for the proposed action.

April 21, 2005: Staff from the Service and project proponents met to discuss the proposed action.

June 2, 2005: The Corps presented the proposed action to an independent wetland restoration design group formulated by the project proponents and the Service to review and comment on the restoration design proposed by the project proponents.

June 13, 2005: The Corps provided the Service and members of the design group with proposed changes to the original restoration design based on the comments received at the June 2, 2005, presentation.

June 16, 2005: The Corps and Service received comments from the members of the design group on the design changes proposed by the project proponents.

June 23, 2005: The Corps provided the Service with a revised project description which reflected changes made to the original project design based on the design group review.

July 18, 2005: The Corps provided the Service with their last revised project description.

July 19, 2005: The Corps requested that the Service provide a final biological opinion to their office on July 20, 2005.

BIOLOGICAL OPINION

Description of Proposed Action

The Hamilton Army Airfield is a former Department of Defense installation that was transferred in 2003. The former airfield property is now owned by the Conservancy and has been subject to environmental remediation by the Department of the Army since 2003 with an expected date of completion in October 2005. The California State Lands Commission currently owns the area of tidal marsh adjacent to the airfield property beyond 100 feet from the outboard levee towards San Pablo Bay. The project proponents are proposing to restore the former airfield property to wetlands as authorized in the Water Resources Development Act of 1999. The goal of the proposed action is to provide a diversity of wetlands and wildlife habitat with about 20 percent of the authorized restoration area comprised of seasonal wetlands and 80 percent of tidal wetlands.

Sequence of Construction

The following tasks would be performed to prepare the airfield area for restoration:

1. The N-1 levee and containment berm would be constructed during the summer/fall of 2005.

2. The intertidal berms, wildlife corridor berm, and Settling Basin 1 would be constructed in the fall of 2005.

3. The South levee in the tidal wetland area would be constructed in 2005 and 2006. This work would include some demolition work to remove some revetments and part of the main runway.

4. The Novato Sanitary District's (District) de-chlorination plant would be relocated to a location outside of the action area and the District's outfall pipeline may be modified if necessary.

5. The N-2 levee and all remaining features within the proposed tidal wetland restoration area would be constructed in 2006 and 2007. This work would include the demolition of building 82 on the airfield property.

6. Dredged material would be placed from 2005 through 2008 to develop the proposed seasonal wetland area in the northwest portion of the airfield.

7. Dredged material would be placed to develop the proposed seasonal wetland area in the southwest portion of the airfield.

8. Dredged material would be off-loaded and placed in the proposed tidal wetland area of the airfield.

9. As much as 7.1 million cubic yards of dredged material likely would be placed on the airfield during a six to eight year time period. The outboard levee would be lowered and a channel excavated through the outboard marsh and levee after the dredged material has been placed and consolidated. This work would include removal of the existing pump houses. This work would be accomplished no later than 2013, but could occur two years earlier depending on the availability of dredged material.

Perimeter Levee Construction

Initially, a perimeter levee system would be constructed around the proposed restoration area, either modifying existing levees or constructing new ones. The Pacheco Pond and Bulge segments were constructed in 2004. These segments along with the western portion of the existing City of Novato levee and the N-1 segment form the perimeter of the seasonal wetland area to be created in the northwestern portion of the airfield. The N-1 segment would extend from the northern end of the Pacheco Pond segment and run along the northern edge of the seasonal wetland area. The tidal wetland portion of the airfield would be bordered by the remainder of the existing City of Novato levee and the N-2 and South levee segments. The N-2 and South levee segments differ from the others in that both would have an intertidal bench with a 10:1 slope to protect the levee from the wind waves generated in the tidal wetland portion of the airfield. These benches also would provide a gradual slope, increasing the width of the transitional habitat along these levee segments. A temporary levee would be constructed to protect the Navy Ball Field parcel southwest of the airfield until the parcel is transferred to the Conservancy and available for restoration. The perimeter levee system would be completed in sections within the scheduled six to eight year construction period.

Power Line Installation and Removal of Hardened Structures

Electrical power would be installed to the existing drainage pumps, dredged material off-loader and possibly other locations within the airfield during project construction. As many as three twelve-inch diameter electrical conduits would be placed and buried on the outboard levee and other locations within the action area as needed. Three existing buildings would be demolished and paved areas on the property removed to ensure that they do not interfere with the formation of tidal channels. A 700 foot wide section of the concrete main runway would be removed to open up the area where the primary tidal channel may form. An area paved with asphalt at the bayward end of the runway would be excavated. In addition, concrete and asphalt revetment areas would be removed in areas where deeper tidal channels are expected to form. A portion of

Settling Basin 1 would be excavated to increase the likelihood that a tidal channel will develop there.

Construction of Containment Berms and Dredged Material Placement Cells

A berm would be constructed in the northwest portion of the airfield from the eastern end of the N-1 levee segment to the City of Novato levee to contain dredged material. This berm would create a basin, referred to as Cell 1, in the northwest portion of the airfield. Dredged material would be placed in Cell 1 to create seasonal wetlands. A smaller berm, Berm 1A, would be constructed approximately 450 feet east of the Cell 1 containment berm. Dredged material would be placed between these two berms in Cell 1A to create a 100:1 slope descending into the restored tidal marsh area. A system of tidal pannes would be constructed within this sloping area by creating shallow poorly drained depressions.

A wildlife upland corridor would be created by placing dredged material along the eastern edge of the City of Novato's levee. A berm would be constructed to create a basin, identified as Cell 2, which would contain dredged material placed there to create the wildlife upland corridor. Dredged material would be placed in the basin to create a 100:1 slope descending from the City of Novato levee to the restored tidal marsh plain.

An additional placement cell, identified as Cell 4, would be created by constructing temporary berms to make a continuous sill between the N-2 levee segment, wildlife upland corridor berm, seasonal wetland containment berm, and two intertidal berms. Cell 4 would be constructed to provide capacity for any dredged material remaining after cells 1 and 2 are filled.

Dredged material placement cells 3 and 5 would be created by excavating material from these areas to construct the perimeter levee. No containment berms would be constructed around cells 3 and 5. It is currently anticipated that suitable (wetland cover quality) dredged material from the Bel Marin Keys Community Service District's Maintenance Dredging Project would be placed in cell 3. Cells 3 and 5 also would provide capacity for any additional material from other dredging projects deemed suitable for wetland restoration on the airfield in the period before the remainder of the perimeter levee is completed. Once the perimeter levee system is completed the tidal restoration area would be treated as one cell, and dredged material would be placed throughout the airfield area, including on top of these cells, until target elevations are reached.

An additional berm would be constructed around Settling Basin 1 just inboard of the future breach location in the outboard levee. This berm would be lowered to the dredged material surface elevation before the outboard levee is breached.

During the construction phase, the containment berms would have two feet of hydraulic freeboard for the placement of dredged material and would be constructed slightly higher than the final design height. The containment berms for cells 1 and 2 would be lowered to the dredged material surface elevation after the material has been placed and consolidated. All containment berms constructed in the future tidal marsh plain would be lowered below anticipated channel invert elevations to avoid impacts to future channel development prior to breaching the outboard levee and inundating the airfield area with the tides.

Construction of Intertidal Berms

Intertidal berms would be constructed within the proposed tidal wetland restoration area. The primary functions of the intertidal berms would be to (1) reduce wind wave fetch and the potential for erosion of the perimeter levees by wave action, (2) guide tidal flows across the airfield area, (3) influence sediment deposition, and (4) guide tidal channel formation. The original design parameters for the intertidal berms, as identified in the 1998 Feasibility Study, were (1) crest elevation five feet NGVD 1929 (7.6 feet NAVD 1988); (2) crest width of 10 feet, side slopes 3 feet horizontal: 1 foot vertical; and (3) maximum fetch lengths of 3,000 feet with the minimum distance between the berms and the perimeter of the airfield area to be 200 feet.

The following changes were made in the original project design and are now incorporated into the design.

- Changes to berm alignments have been made to further reduce wave heights and increase sedimentation rates.
- Fetch lengths would be limited to 2,000 to 3,000 feet in areas below 3.6 feet NAVD 1988 and fetch lengths of 3,000 to 4,000 feet in areas above 3.6 feet NAVD 1988.
- The distance between the berms and the site perimeter has been increased to 250 feet to limit predator access.
- The crest elevations would be constructed at 7.3 feet (NAVD 1988) with the expectation that they would subside to mean higher high water (MHHW) 6.3 feet (NAVD 1988) at the time of the outboard levee breach to allow for more frequent overtopping and accelerated sediment settlement into the restored tidal marsh plain.
- The berm side slopes have been reduced to 1 foot vertical: 5 feet horizontal to provide improved habitat area and value.
- The effectiveness of the currently-designed berms as wave attenuation structures continues to be evaluated. Additional measures may be necessary and may include planting *Baccharis* spp., which is anticipated to die back after the outboard levee is breached, to provide additional roughness along the berm crests. Other methods to increase the wave attenuation of the berms may be considered and would require the approval of the Service.

Relocation of De-chlorination Plant

The District's existing de-chlorination plant, maintained just north of the airfield on adjacent State Lands Commission property, is currently being relocated to the District's Ignacio Treatment Plant outside the airfield area. Relocating the de-chlorination plant would prevent the need to protect the plant from damage due to dredged material placement and tidal action, alleviate the need to provide an alternative power supply to the plant, and make the plant more easily accessible to District personnel for operation and maintenance purposes. This work should be completed by the end of 2005.

Placement of Dredged Material

To import dredged material to the airfield, a hydraulic off-loader would be placed in San Pablo Bay and piping would be installed to connect the off-loader to the airfield property using the existing outboard marsh pipeline. The off-loader would be properly marked and lighted, and most of the pipeline would be submerged and marked 24 hours each day, consistent with U.S. Coast Guard regulations, to prevent navigational hazards to watercraft using the area. The off-loader would be powered by electricity from shore, onboard diesel powered equipment, or a combination of both, and could be in operation for as long as eight years while suitable dredged material is placed on the airfield area to create seasonal wetlands and restore tidal wetlands. The existing pipeline crossing the tidal marsh is constructed of heavy-walled steel pipe, should require limited maintenance, and is situated along an existing roadway on high ground in the tidal marsh adjacent to the airfield. A pipeline system would be constructed around the perimeter levees and berms to allow the placement of material throughout the airfield area and to prevent mounding and re-handling that could result from discharging in one location.

Sources of Dredged Material

Dredged material for the wetland restoration project could originate from many sources. All dredged material proposed for placement at the airfield would be subject to approval with respect to chemical and biological suitability by the Dredged Material Management Office (DMMO), which is a consortium of agencies involved in the permitting of dredging and disposal activities within San Francisco Bay. Initially, 2.1 million cubic yards of primarily sandy material dredged by the Oakland Harbor Navigation Improvement Project is anticipated to be used as bulk fill for the seasonal wetland area and wildlife upland corridor. Other potential sources of dredged material include several new work and maintenance projects such as Oakland Harbor, Richmond Harbor, Pinole Shoal Channel, Redwood City Harbor, Bel Marin Keys, and Petaluma River Across the Flats Channel. In addition, dredged material could come from a variety of permitted non-Federal dredging operations, provided the material is determined to be suitable for wetland cover and meets the qualifications set forth in the Regional Water Quality Control Board's (RWCQB) waste discharge requirements. Evaluating impacts associated with dredging and transporting material to the off-loader would be the responsibility of the sponsor of each dredging project.

Water quality standards would be specified in the waste discharge requirement stipulated by the RWQCB for water discharged from the airfield into San Pablo Bay. The discharge standards for the process water would have to meet RWQCB's standards for water quality parameters such as total suspended solids before the water could be discharged to San Pablo Bay.

Dredged Material Water and Stormwater Management

The off-loading of dredged material would involve mixing the material with water drawn from San Pablo Bay to form a mixture of approximately 80 percent water and 20 percent solids. After the dredged material slurry is pumped into the cells on the airfield, the suspended sediment would separate from the mixture and mostly settle onto the surface of the cells. The slurry water

would be held temporarily in a primary settling pond using containment cells and then into secondary settling ponds to clarify the water prior to discharge into San Pablo Bay.

A layer of water, either as a constituent of the dredged material slurry or pumped directly from San Pablo Bay, would be maintained on top of the dredged material at all times to prevent undesirable compaction, and acidification of the material until the outboard levee is breached. Based on rainfall and evaporation records for the airfield area from April through October, mean evaporation exceeds mean rainfall by about 36 inches. This period is when dredging and off-loading operations typically would be occurring. Because of the large volume (80 percent) of water that would be part of the dredged material slurry, a minimal amount of additional water from San Pablo Bay is expected to be pumped onto the tidal wetland areas. During the periods when the off-loader is not operational, some water from San Pablo Bay likely would need to be imported onto the airfield to keep the dredged material in the targeted tidal wetlands area wet. During the winter months it is unlikely that San Pablo Bay water would be needed due to typically low evaporation and high rainfall rates. When the off-loader is not operating during the summer months, there would be a need to pump San Pablo Bay water onto the airfield to keep it submerged. During the summer months when no pumping of dredged material is occurring and after dredged material placement is complete but prior to breaching the outboard levee and reintroducing tidal action, water from San Pablo Bay would be imported to keep the tidal wetlands area wet. If no pumping of dredged material is occurring, the maximum amount of water needed from San Pablo Bay to keep the 395-acre area of the airfield submerged would be about three feet which constitutes about 1,200 acre feet of water that would be removed from San Pablo Bay and evaporate in the restored tidal wetlands area.

During construction, storm water management facilities would continue to function to deal with the approximately 390 acre-feet of storm water that annually enters the airfield area from offsite areas. The existing outboard levee pump station would be relocated as necessary to maintain its operation. During construction a third pump station would be constructed at the northwestern end of the airfield to manage storm water entering the airfield from the northwest.

To provide drainage for rainfall and stormwater from adjacent properties and to process excess water resulting from dredged material placement onto the airfield, drainage ditches would be constructed to allow water to flow from the containment cells into temporary secondary settling ponds. The containment cells would function as the primary settling ponds. Settling Basin 2 would be the first secondary settling pond constructed and would service cells 1, 2, 3 and 4. A subsequent secondary settling pond, identified as Settling Basin 1, would be constructed near the proposed levee breach using the pre-excavated area for the primary channel and would clarify decant water from the restored tidal wetland area.

The clarified decant water from these settling ponds would flow through adjustable weirs and into the perimeter drainage ditch where the water would accumulate at the existing drainage pump station intake, and the clarified water would be pumped into San Pablo Bay. Portable, screened pumps would be temporarily utilized whenever necessary to pump San Pablo Bay water onto the airfield for soil conditioning of the imported dredged material. The discharge weirs from the containment cells and the secondary settling ponds would be designed to release only

the upper portion of the water column because this portion of the water column is likely to be clarified due to fine sediment settlement. The adjustable weirs would have wooden or plastic boards that can be added or removed, as needed, to control the water elevation of the cells or secondary ponds prior to discharge.

Lowering and Breaching of the Outboard Levee

The outboard levee bordering the airfield on the east would be lowered to MHHW elevation immediately prior to breaching the levee. Any remaining substrate unsuitable as tidal marsh substrate would be excavated and removed. Any over-excavated section(s) of the levee would be backfilled with dredged material to MHHW elevation.

Following completion of site preparation work and dredged material placement and consolidation, the outboard levee would be breached. The breach initially would be a trapezoidal channel approximately 280 feet wide at the top of the side slopes and 183 feet wide at the bottom with a depth of 12 feet (bottom invert at -6 NAVD 88). A pilot channel with an approximately 165 feet top width and 40 feet bottom width and an invert elevation of approximately -6 NAVD 88 would be excavated through the existing outboard marsh and connected to San Pablo Bay. These breach dimensions are anticipated to convey the maximum tidal prism onto the airfield at the time of breach without any tidal muting. Regardless of the availability of dredged material, the levee breach would be completed no later than eight years after dredged material placement begins to ensure that tidal marsh establishment is not further delayed.

Public Access Trail

A public access trail would be constructed as part of the proposed action. From north to south, the trail would travel along the perimeter levee on the western edge of the airfield, except in the southern seasonal wetland area where it would be situated on top of the levee, and then would descend to the back side of the levee adjacent to the seasonal wetland and tidal marsh areas. The trail would be twelve feet wide, paved and have a two-foot wide vegetated shoulder on either side. On the northernmost section of levee, a low vegetated berm would extend along the edge of the trail in an effort to minimize visual disturbance to wildlife using the seasonal wetland area, and vegetation would be established to provide screening for the adjacent wildlife area. Along the western edge of the northwestern seasonal wetland, the tidal channel is anticipated to provide a buffer with emergent vegetation between the trail and adjacent habitat areas. Adjacent to the Hamilton residential and commercial areas, the trail would be adjacent to the levee and two feet below the levee crest. A fence would be placed approximately 20 feet from the trail and is anticipated to aid in restricting humans and their dogs from entering the wildlife upland corridor and tidal marsh areas. Along the southernmost seasonal wetland area, the trail would be constructed on the top of the levee and then down the backside of the levee. In the area where the trail would be on the top of the levee, a low vegetated berm would be placed. A fence also would be placed adjacent to the trail to further assist people and their pets in staying on the trail and out of the adjacent habitat areas. At the southern terminus, the trail would be situated along the backside of the levee with two overlooks constructed at the terminus and west of the terminus. A fence would be placed between the top of the levee and the trail to deter people

from entering the adjacent habitat areas. The southern terminus of the constructed trail would be established 700 feet from the existing tidal marsh along San Pablo Bay and is expected to provide a buffer between human disturbances along the trail and endangered species habitat. In the future, the project proponents would remove portions of the trail along Segment E, as far west as Long Point, if tidal wetlands restoration occurs on the property to the south of the action area. This realignment of the trail would be designed to connect with the regional trail system that is anticipated to extend southward along the boundary of any wetlands restoration that may occur south of the action area.

Anticipated Habitat Types

About 156 acres of seasonal wetlands would be created in the northwestern and southwestern portions of the airfield. A 34-acre wildlife upland corridor would be created along the western edge of the airfield between the two seasonal wetland area, and provide a gradual transition between the future tidal marsh and the western perimeter levee that marks the boundary of the airfield.

The design for the seasonal wetland areas envisions minimal maintenance needed to maintain the wetlands created there. Created surface elevations would be critical to achieving habitat goals. The seasonal wetland areas would be filled with dredged material and allowed to consolidate. After consolidation the elevations would be adjusted if necessary. Then the areas would be graded to the desired contours and elevations with land-based heavy equipment. Native vegetation would be planted in the seasonal wetland and upland areas after grading is completed.

Approximately 2.1 million cubic yards of dredged material would be placed to create the seasonal wetland areas and wildlife upland corridor. Sandy material would be placed to design elevations in the wildlife upland corridor. Finer dredged material such a bay mud would not be placed on top of this sandy material to prevent the establishment of non-native, invasive plant species. The upland wildlife corridor would be planted with native grasses such a creeping wild rye. Similar sandy material would be placed in the seasonal wetland areas and covered with finer sediments. To prevent cracking of the mud and the resulting loss of water out of the ponds, some soil preparation may be necessary. This may require using heavy equipment to shape and compact the sediment, and may include blending the upper layers of sand with the mud to prevent cracking and water loss that could affect the hydroperiod of the seasonal wetlands. The elevations of the seasonal wetland areas are designed to be close to the water table and allow infrequent periodic tidal flooding during the summer, both which should serve to prevent soil cracking.

The design team is currently considering further lowering the elevation of the northern seasonal wetlands and including additional water control structures that would allow for adaptive management of this area. If the expected habitat does not develop as designed, an alternative muted tidal system could be created in this area.

The northern and southern seasonal wetland would mature differently as the design envisions two variations of seasonal wetlands. These habitats would most closely resemble managed wetlands,

but active management of theses areas is minimized on the airfield. The habitat planned for these areas would be unvegetated to sparsely vegetated seasonally ponded wetlands suitable as shorebird habitat, along with vegetated transitional wetland/upland habitat. Water to the seasonal wetland areas would come from precipitation and tidal inundation on extreme spring tides. The salt from the infrequent tidal inundation as well as the periodicity and duration of inundation is anticipated to limit the introduction of invasive plant species. Some ponds would be placed at higher elevations and would be inundated less frequently by extreme high tides, and thus would be less saline.

Upland and urban runoff from the Hamilton residential development area and surrounding hills would continue to be pumped onto the airfield by the City of Novato after the seasonal wetlands are created. Outfalls from the housing area would discharge to each seasonal wetland area. The water would be conveyed by swales created in the seasonal wetland areas to the restored tidal wetland area. A new pump station would be built to drain the low-lying area adjacent to the Bulge levee. This pump station would be operated by the City of Novato and would pump water into a swale in the seasonal wetland area at the northwestern end of the airfield. At higher elevations swales in the seasonal wetlands are anticipated to support some riparian vegetation, while lower elevations would support more salt tolerant plant species.

At maturity, the northern seasonal wetlands would be sparsely vegetated and provide shorebird feeding, roosting and loafing habitat. The ponds would vary in elevation, be flooded during portions of the year and support different native vegetation depending on the inundation periods and soil and water salinity. The ponds in the lower part of the northern seasonal wetland would include unvegetated islands for loafing and foraging. The ponds are expected to typically fill with rain water in late fall, and remain ponded until the following spring. A tidal channel eventually would develop in the area and provide saline waters during the highest tides monthly and fresh water from the adjacent residential area during storms. The water would range from fresh water in the winter to hyper saline as the ponds dry in the summer. Native plant communities would be planted during the construction phase of the project and mature with time, but the wetlands are anticipated to remain sparsely vegetated by design. Salt from the infrequent tidal inundation as well as the periodicity and duration of inundation is anticipated to limit the introduction of non-native, invasive plant species. The tidal channel at the far northern reach would support riparian plant species.

The southern seasonal wetland area at maturity would contain a complex of shallow ponds. Low vegetation would develop between the ponds, and emergent vegetation will be present along the back of the site where fresh water flows in from the neighboring property. Shorebirds will utilize the edge of the ponds, while waterfowl will use both the area between the ponds for loafing, while foraging in the ponds themselves. Vegetation in this area is similar to the northern seasonal wetland. The southern wetland edge will have a gradual slope of a maximum of one hundred to one, and blend into the marsh as the plants transition to high marsh species.

The main habitat type targeted for restoration on the airfield is tidal wetland. It is anticipated that about 378 acres of tidal marsh would be created with deep primary channels and smaller denser channels in about 30 years after the outboard levee is breached. After site preparation is

completed, the targeted tidal wetland area of the airfield would be filled with an estimated five million cubic yards of dredged material suitable for wetland cover. Fill elevations are planned to be 1 to 1.5 feet below marsh plain elevations to allow sediments borne on the tides to naturally accrete, completing the filling of the tidal wetland area and the final development of tidal channels. Site preparation, including the placement and consolidation of dredged material, is estimated to require six to eight years to complete and would terminate with the breaching of the outboard levee. Some fill material would consolidate for as long as six to eight years, but the minimum amount of time that any fill material would consolidate would be one year before breaching of the outboard levee. Prior to breaching and lowering the outboard levee, the dredged material would be kept wet to prevent excessive consolidation and allow suitable tidal channel development after the levee is breached. Tidal channel formation would be monitored after the levee is breached and corrective measures would be implemented to ensure adequate channel formation. The specific measures to be undertaken would be developed in the preparation of the monitoring and adaptive management plan for the proposed action and would include mechanically dredging areas with inadequate channel formation.

The anticipated time lines for restoring tidal wetlands on the airfield after the outboard levee is breached are the following:

- Sediment accretion to MHHW (years 7 through 21)
- Development of mean high water marsh plain (years 12 through 21), and
- Development of MHHW marsh plain (years 17 through 31).

When the restoration project reaches maturity, the restored tidal marsh is anticipated to have elevations between mean sea level and extreme high tide and features similar to nearby tidal marshes such as at China Camp State Park. The existing outboard salt marsh is expected to mainly remain in place except for the portion where the primary tidal channel into the airfield would be excavated. The outboard levee would have been lowered to marsh plain elevation and is anticipated to become vegetated with salt marsh plant species. The primary tidal channel would have a mud bottom with a natural equilibrium and depth determined by the tidal prism. The edges of the channel would be colonized and vegetated with Pacific cordgrass (*Spartina foliosa*), pickleweed (*Salicornia virginica*) and gumplant (*Grindelia stricta* var. *angustifolia*). The restored tidal marsh area would receive natural tidal action from San Pablo Bay through the primary channel excavated through the outboard tidal marsh. Dendritic intertidal channels are anticipated to form naturally and be interspersed with expanses of pickleweed. The edges of the tidal channels would support native cordgrass, as well as gumplant. The mature restored marsh is expected to support low, middle and high marsh areas, and tidal mudflats.

Tidal ponds, which are shallow (less than one foot in depth) and receive water from rainfall and monthly extreme tides, are natural, unvegetated ponds which form within tidal marsh plains. These ponds are not connected with tidal channels, so the water evaporates, and can become hypersaline during the summer and fall. Tidal ponds are expected to form as a feature of the mature restored tidal marsh. The project design does not include plans to specifically construct these features, but due to the underlying site topography, are likely to form and add habitat diversity to the tidal marsh area.

Tidal pannes, which are elongated shallow ponds with highly variable salinity levels that parallel boundaries between high marsh and upland habitat, likely would be constructed within the 13-acre area at the western boundary of the high marsh between the tidal wetlands and the seasonal wetlands. Tidal pannes also may develop naturally along the periphery of the airfield next to the perimeter levees, and the wildlife upland corridor as the grade transitions upward. It is estimated that about 13 acres of tidal pannes would form on the airfield.

The restored high marsh on the western boundary of the airfield would gradually transition into the created seasonal wetland areas and wildlife upland corridor with a gradual 100:1 slope. This gradual gradient is designed provide opportunities for high tide refugia within the wildlife upland corridor and seasonal wetland areas. As the elevations transition from tidal marsh to seasonal wetland and upland habitat, the vegetation also would transition into plant species indicative of these habitat types. The perimeter levees around tidal wetland area would have a shallowly sloping bench, which at maturity likely would support transitional marsh plants.

Proposed Conservation Measures

The following conservation measures are proposed as part of the proposed action to directly or indirectly minimize or eliminate potential adverse effects to California clapper rails and/or salt marsh harvest mice:

1. Operation of construction equipment within the tidal marsh areas adjacent to the airfield would be avoided during the clapper rail breeding season from February 1 through August 31 each year. If construction activities in these areas could not be avoided during the clapper rail breeding season, then preconstruction surveys would be conducted using survey methods approved by the Service. If individuals and/or nests are not located within 250 feet of the construction area, then construction would proceed. If individuals and/or nests are located within 250 feet of the construction area, then the project proponents, or their successors in interest, would consult with the Service to determine what, if any, additional measures may be required to allow construction work to proceed. No maintenance work would be conducted on the existing dredged material pipeline in the tidal marsh area adjacent to the airfield during the clapper rail breeding season from February 1 through August 31 each year. In the case of an unforeseen emergency requiring maintenance of the dredged material pipeline in the tidal marsh area adjacent to the airfield during this time period, the Service would be notified within 24 hours to discuss the proper course of action.

2. To minimize or avoid the loss of individual salt marsh harvest mice from construction activities in the tidal marsh areas adjacent to the airfield, pickleweed vegetation would be hand-removed, if the California Department of Fish and Game (Department) does not allow trapping to occur, and a barrier fence placed 20 feet from the boundaries of construction areas in and adjacent to the tidal marsh areas after the vegetation was removed. Alternatively, if the Department does allow trapping to occur, a barrier fence would be constructed 20 feet from

the boundaries of construction areas in and adjacent to the tidal marsh areas. The fence would be held in place with three-foot long stakes and would have a bottom buried in a trench. A qualified biologist approved by the Service would trap salt marsh harvest mice within the fenced construction area and release any individuals into suitable habitat outside the fenced area. Before trapping begins, a qualified biologist would inspect and confirm the adequacy of the fence as a barrier to movement of salt marsh harvest mice. Once initiated, trapping would continue and no construction would take place until the biologist onsite believes that all salt marsh harvest mice within the construction area have been trapped and removed.

3. To address potential adverse effects from construction of the southward extension (Segment E) of the proposed trail, signs would be placed at the eastern terminus of the trail along the perimeter levees. Physical buffers (*e.g.* vegetation), periodic signage, or barriers (*e.g.* fencing) would be placed, as determined in consultation with the Service and Department, to prevent or discourage public access and intrusion into tidal marsh habitat areas. All dog and motorized vehicle access, except for emergency and maintenance vehicles, would be prohibited along Segment E of the trail. Based on consultation with the Service and Department, the project proponents would consider seasonal closures for Segment E on the trial along the levee during the peak breeding season of the California clapper rail after the restored tidal wetlands are used by this species.

4. An adaptive management plan would be developed and implemented to address methylmercury production and accumulation in the restoration areas. The plan would be developed in consultation with the Service and other regulatory agencies. Elements of the plan would include constituents to be monitored, monitoring protocols, duration and frequency of monitoring, and corrective actions to be undertaken to minimize any potential adverse effects of methylmercury. Monitoring would be conducted for a minimum of ten years after the outboard levee is breached.

5. A qualified botanist would conduct a non-native plant assessment of areas subject to construction activities and recommend specific measures to control the spread of non-native plant species. Control measures could include the establishment of wash stations for construction vehicles and equipment, or the development of an herbicide spray program to eliminate invasive, non-native plant species prior to construction.

6. The restored wetland areas would be monitored for infestation by non-native cordgrasses (*Spartina* spp.), perennial pepperweed (*Lepidium latifolium*), and other invasive, non-native plant species. All infestations occurring within the wetlands would be controlled and removed to the extent feasible without substantially hindering or harming the establishment of native vegetation in the restored wetlands. A long-term monitoring plan would be developed and remain

in effect until tidal marsh habitat is established. The plan would be subject to review and approval by the Service and Department.

7. The proposed off-loader would be designed to fully comply with all applicable U.S. Coast Guard regulations and include features or measures to reduce the potential for fuel or oil to enter San Pablo Bay and associated tidal marshes during pump operations, fueling, or maintenance. Institutional controls (*e.g.* adoption of a safety plan) would be implemented to provide additional spill protection.

8. The Corps, in coordination with the Conservancy, would develop and implement a monitoring and adaptive management program to determine the rate of tidal wetland restoration and quantity and quality of the wetlands established. The project proponents would present the proposed action to a panel of wetland restoration experts prior to developing a detailed plan for monitoring and adaptive management. A draft plan would be prepared by June 2006. After the outboard levee is breached, monitoring would occur each year for the first five years and in Years 10 and 15. The Corps would be responsible for monitoring during the first 13 years after the levee is breached and the Conservancy or its successor in interest would be responsible for monitoring thereafter. The monitoring program would be designed to determine whether tidal marsh is developing at the estimated rate of development. Monitoring of the development of the restored areas is intended to enable the Corps, in conjunction with the Conservancy or its successors in interest, to assess the success of habitat development and make decisions regarding corrective measures if necessary. Potential corrective measures could include changing the breach and subtidal channel dimensions, altering the structure of the perimeter levee berm, and/or modifying the channel characteristics within the tidal wetland restoration area. Key elements of the plan would include:

   a. measuring the extent of tidal marsh habitat development to ensure that sufficient habitat is restored to replace the amount of tidal marsh habitat lost by the proposed action at a 2:1 ratio;
   b. monitoring habitat parameters such as tidal stage, tidal current, wind speed and direction, wave characteristics, suspended sediment concentrations, sediment rates and distribution, marsh elevations, mudflat elevations, extent and location of tidal marsh vegetation, composition and density of vegetation, characteristics of subtidal channel and marsh surface sediments, and San Pablo Bay shoreline characteristics;
   c. monitoring locations, including the interior and perimeter of the restored tidal wetlands, subtidal channels, and existing San Pablo Bay marsh shoreline;
   d. comparing predicted and measured restoration development and function;
   e. analyzing monitoring data to identify possible reasons for differences between predicted and measured or observed conditions; and

f. recommending remedial actions to be implemented if restoration does not proceed as designed.

9. Monitoring reports would be submitted by the Corps or Conservancy, or their successors in interest) for each year in which monitoring is conducted. At the end of the initial five-year monitoring period, the Corps, in conjunction with the Conservancy or its successor in interest, would review status of the proposed action with the Service, Department, and NOAA Fisheries to determine if additional monitoring, adaptive management actions, or modifications are needed to ensure that the functions and values of the affected tidal marsh would be replaced. The Corps, in conjunction with the Conservancy or its successor in interest, may initiate a similar review of the tidal marsh development following completion of monitoring in Year 10 if the Corps or Conservancy concludes that additional actions or modifications are needed to meet restoration goals. The Conservancy or its successor in interest may initiate a similar review of the tidal marsh development following completion of monitoring in Year 15 if the Conservancy concludes that additional actions or modifications are needed to meet restoration goals.

Action Area

The action area is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." For the proposed action, the action area includes the 662-acre former Hamilton Army Airfield area bounded by the Bel Marin Keys Unit V property and California State Lands Commission parcel on the north, Pacheco Pond on the northwest, the Hamilton residential development area on the west, the Las Gallinas Valley Sanitary District property on the south, and San Pablo Bay on the east. The action area includes about 88 acres of tidal marsh adjacent to San Pablo Bay.

Status of the Species/Environmental Baseline

California Clapper Rail

The California clapper rail was federally listed as endangered in 1970 (35 **FR** 16047). Critical habitat has not been proposed or designated. This subspecies is one of three subspecies in California listed as endangered under the Act. The other subspecies include the light-footed clapper rail (*R. l. levipes*) which is found in tidal marshes in southern California and northwestern Baja California, and the Yuma clapper rail (*R. l. yumanensis*) which is restricted to the Colorado River basin. A detailed account of the taxonomy, ecology, and biology of the California clapper rail is presented in the *Salt Marsh Harvest Mouse & California Clapper Rail Recovery Plan* (Service 1984) (Recovery Plan) and the references cited therein. The California clapper rail is a fully protected species under California law (See California Fish and Game Code Section 3511).

The California clapper rail is endemic to tidally influenced salt and brackish marshes of California. Historically, the California clapper rail occurred in tidal marshes along California's coast from Morro Bay, San Luis Obispo County, to Humboldt Bay, Humboldt County. Currently, California clapper rails are known to occur in tidal marshes in the San Francisco Estuary (San Francisco, San Pablo, Grizzly, Suisun and Honker bays).

The California clapper rail is distinguishable from other rails by its large body size of 13-19 inches from bill to tail, and weighs approximately 8.8-12.3 ounces. It has an orange bill, a rufous breast, black and white barred flanks, and white under tail coverts (Albertson and Evens 2000). California clapper rails are sexually dimorphic; the males are slightly larger than females (Garcia 1995). Juveniles have a pale bill and dark plumage. California clapper rails are capable of producing several vocalizations, most common of which is a series of keks or claps.

California clapper rails are typically found in the intertidal zone and sloughs of salt and brackish marshes dominated by pickleweed, Pacific cord grass, gumplant, saltgrass (*Distichlis spicata*), jaumea (*Jaumea carnosa*) and adjacent upland refugia. They may also occupy habitats with other vegetative components, which include, but are not limited to bulrush *(Scirpus americanus* and *S. maritimus*), cattails (*Typha* spp.), and Baltic rush (*Juncus balticus*).

Evens and Page (1983) concluded from research in a northern San Francisco Bay marsh that the California clapper rail breeding season, including pair bonding and nest construction, may begin as early as February. Field observations in south San Francisco Bay marshes suggest that pair formation also occurs in February in some areas (J. Takekawa, pers. comm.). The end of the breeding season is typically defined as the end of August, which corresponds with the time when eggs laid during renesting attempts have hatched and young are mobile. Harvey (1988) and Foerster (1990) reported mean clutch sizes of 7.27 and 7.47 for California clapper rails, respectively. The California clapper rail builds a bowl shaped platform nest of marsh vegetation and detritus (DeGroot 1927, Foerster *et al.* 1990, Garcia 1995). The California clapper rail typically feeds on benthic invertebrates, but its diet is wide ranging, and includes seeds, and occasionally small mammals such as the salt marsh harvest mouse.

An estimated 40,191 acres of tidal marshes remained in 1988 of the 189,931 acres of tidal marsh that historically occurred in the Estuary; this represents a 79 percent reduction from historical conditions (Goals Project 1999). Furthermore, a number of factors influencing remaining tidal marshes limit their habitat values for California clapper rails. Much of the east San Francisco Bay shoreline from San Leandro to Dumbarton Bridge is rapidly eroding, and many marshes along this shoreline could lose their California clapper rail populations in the future, if they have not already. In addition, an estimated 600 acres of former salt marsh along Coyote Creek, Alviso Slough, and Guadalupe Slough, has been converted to fresh- and brackish-water vegetation due to freshwater discharge from wastewater facilities in the southern part of San Francisco Bay and is of lower quality for California clapper rails. This conversion has at least temporarily stabilized as a result of the drought since the early 1990s. The introduction of non-native, invasive plant species such as smooth cordgrass (*Spartina alterniflora*) and its hybrids into tidal wetlands within the Estuary is potentially impacting California clapper rails by reducing the amount of foraging habitat within tidal channels. The suitability of many marshes for California clapper

rails is further limited, and in some cases precluded, by their small size, fragmentation, and lack of tidal channel systems and other micro-habitat features. These limitations render much of the remaining tidal marsh acreage unsuitable or of low value for the species.

Throughout the San Francisco Estuary, the remaining California clapper rail population is impacted by a suite of mammalian and avian predators. At least 12 native and 3 non-native predator species are known to prey on various life stages of the California clapper rail (Albertson 1995). Artificially high local populations of native predators, especially raccoons (*Procyon lotor*) and skunks (*Mephitis mephitis*), result as development occur in the habitat of these predators around the San Pablo and San Francisco bay margins (J. Takekawa, pers. comm.). Encroaching development not only displaces lower order predators from their natural habitat, but also adversely affects higher order predators, such as coyotes, which would normally limit population levels of lower order native and non-native predators, especially red foxes (Albertson 1995). Hunting intensity and efficiency by raptors on California clapper rails also is increased by electric power transmission lines, which cris-cross tidal marshes and provide otherwise-limited hunting perches and nesting opportunities (J. Takekawa, pers. comm.). Non-native Norway rats (*Rattus norvegicus*) long have been known to be effective predators of California clapper rail nests (DeGroot 1927, Harvey 1988, Foerster *et al.* 1990). Placement of shoreline riprap, levees, buildings, and landfills favor rat populations, which results in greater predation pressure on California clapper rails in certain marshes. Raven (*Corvus corax*) populations have recently increased dramatically within the Estuary and evidence of egg predation by this species has been detected (Joy Albertson, pers. comm.). Feral cats also represent another predation threat on adult and young California clapper rails near residential areas and landfills (Joy Albertson, pers. comm.). These predation impacts are exacerbated by a reduction in high marsh and natural high tide cover in marshes.

The proliferation of non-native red foxes into tidal marshes of southern San Francisco Bay since 1986 has had a profound effect on California clapper rail populations. As a result of the rapid decline and almost complete elimination of California clapper rail populations in certain marshes, the San Francisco Bay National Wildlife Refuge (Refuge) implemented a predator management plan in 1991 (Foerster and Takekawa 1991) with an ultimate goal of increasing rail population levels and nesting success through management of red fox predation. This program initially was successful in increasing the overall south San Francisco Bay populations from an all-time low (see below); however, it has been difficult to effectively conduct predator management over such a large area as the south San Francisco Bay, especially with the many constraints associated with conducting the work in urban environments (J. Takekawa, pers. comm.).

Predator management for California clapper rails is not being regularly practiced in San Pablo and Suisun bays, and California clapper rail populations in this area remain susceptible to red fox predation. Red fox activity has been documented along Sonoma Creek and in the bayshore marshes between Sonoma Creek and the Petaluma River (Evens 2000) and along Dutchman Slough and in Guadalcanal Village on the west side of the Napa River (J. Collins, pers. comm.). Red fox activity also has been documented along the levees at Carl's Marsh and in baylands on the east side of the Petaluma River (Peter Baye, pers. comm.). Along Wildcat Creek near

Richmond, where red fox activity was observed in the mid-1990's, the rail population level in one tidal marsh area declined considerably after 1987 (J. Evens, pers. comm.). Red fox predation may be a major reason for recent decreases in California clapper rail populations within certain parts of San Pablo Bay.

Mercury accumulation in eggs is perhaps the most significant contaminant problem affecting California clapper rails in the Estuary, with south San Francisco Bay containing the highest mercury levels. Mercury is extremely toxic to embryos and has a long biological half-life. The Service collected data from 1991 and 1992 on mercury concentrations in rail eggs in the southern portion of the estuary and found that the current accumulation of mercury in rail eggs occurs at potentially harmful levels. The percentage of non-viable eggs ranged from 24 to 38 percent (mean = 29 percent) (Service, unpubl. data).

The California clapper rail was listed as endangered primarily as a result of habitat loss. The factors described above have contributed to the more recent population reduction, which has occurred since the mid-1980s. Although many factors are at work, predation by native and non-native predators, in conjunction with historic habitat loss and fragmentation, are the current known primary threats. With historic populations at Humboldt Bay, Elkhorn Slough, and Morro Bay now extirpated, the San Francisco Estuary represents the last stronghold and breeding population of this subspecies.

Although Gill (1978) may have overestimated the total California clapper rail population in the mid-1970s at 4,200 to 5,900 birds, surveys conducted by the Department and the Service estimated that the California clapper rail population approximated 1,500 birds in the mid-1980s (Harvey 1988). In 1988, the total rail population was estimated to be 700 individuals, with 400 to 500 rails in south San Francisco Bay (Foerster 1989). The total rail population reached an estimated all-time historical low of about 500 birds in 1991, with about 300 rails in south San Francisco Bay (Service unpubl. data). In response to predator management, the south San Francisco Bay rail population rebounded from this lowest population estimate to an estimated 650 to 700 individuals in 1997-98 (Service unpubl. data). Subsequently, the south San Francisco Bay population declined again the following year to about 500 individuals and remained at that level through early 2002 (Service unpubl. data). However, the south San Francisco Bay population declined further in 2002-2003 and was estimated to be 400-500 individuals (Service unpubl. data), which represented the lowest estimated population level in this area since the late 1980's and early 1990's. The south San Francisco Bay population apparently increased slightly in 2004 with the population estimated at 500 individuals (Service unpubl. data). A conservative estimate of the population in north San Francisco, San Pablo, and Suisun bays, was 195 to 282 pairs based on a synoptic survey conducted in 1992-93 (Collins *et al.* 1994). In 2004, Avocet Research Associates conducted surveys within San Pablo Bay and estimated about 200 pairs of California clapper rails in that area. These surveys did not include some marshes in north central San Francisco Bay and Suisun Bay that were surveyed in 1992-93. Between the surveys conducted in 1992-93 and 2004, several population centers in San Pablo Bay have declined precipitously. The population in the White Slough tidal marshes on the west side of the Napa River declined from an estimated 16-23 pairs as recent as 2000 to an estimated 2-5 pairs in 2002

and 3-5 pairs in 2004, while the population in the Sonoma Creek marshes declined from 13 pairs in 1992 to no pairs in 2001 and 2004 (Avocet Research Associates 2004).

California clapper rails are known to occur in the tidal marshes along San Pablo bay adjacent to the outboard levee of the airfield. Surveys conducted during a 9-week period in March and April 1998 recorded numerous observations of California clapper rails in the tidal marshes adjacent to the airfield and State Lands Commission parcel (LSA Associates Inc. 1998). Two to three breeding pairs of California clapper rails were estimated to be present in the tidal marshes adjacent to the airfield, while another pair apparently was present in the tidal marshes adjacent to the State Lands Commission Parcel early in the breeding season but abandoned their nesting attempt later in the season (LSA Associates Inc. 1998). Surveys conducted in January and February 2004 documented California clapper rails in the tidal marshes adjacent to the airfield (J. Evens pers. comm.). It was estimated that as many as six pairs of California clapper rails were present, with the majority occurring in the southern portion of these marshes. California clapper rails also were detected at the extreme southern boundary of the tidal marshes during surveys conducted in January 2005 (Avocet Research Associates 2005). It was estimated that two to three pairs were nesting along a large channel system (Avocet Research Associates 2005). It is believed that California clapper rails use the tidal marshes adjacent to the airfield for nesting, sheltering, and foraging.

The Recovery Plan (Service 1984) identifies the recovery objectives or conservation needs of the California clapper rail. The fundamental tenet of the Recovery Plan is to preserve and increase existing populations of the California clapper rail to assure the survival of this species. To accomplish this, the Recovery Plan identifies the preservation and restoration of essential habitat areas throughout the Estuary that are important in meeting the recovery objectives for this species. Within the project area, the tidal marshes adjacent to the airfield are identified as essential habitat for this species along the western side of San Pablo Bay (Recovery Plan Task 1233). At the time of preparation of the Recovery Plan, the diked baylands of the former Hamilton Army Airfield were not considered to constitute essential habitat for the California clapper rail because it was not envisioned that this area would be restorable to tidal marsh in the future. In the intervening years, the military installation has been closed and plans have been developed to restore a large portion of the diked baylands on the former airfield to tidal wetlands. The current recovery planning, which will result in a revision to the Recovery Plan of 1984, envisions restoration of the majority of the diked baylands on the airfield area as necessary to meet the recovery needs of this species. This goal would be consistent with the recommendation of the Goals Project (1999) to restore a wide, continuous band of tidal marsh habitat along the west side of San Pablo Bay. Because of the continuing threats to California clapper rails and the current low population levels rangewide, maintaining existing tidal marsh habitat and restoring additional optimal habitat on or adjacent to the airfield are important elements to ensuring the survival and recovery of this species.

Salt Marsh Harvest Mouse

The salt marsh harvest mouse was federally listed as endangered in 1970 (35 **FR** 16047). Critical habitat has not been proposed or designated. A detailed account of the taxonomy,

ecology, and biology of the salt marsh harvest mouse is presented in the Recovery Plan (Service 1984) and the references cited therein. The salt marsh harvest mouse is a fully protected species under California law (See California Fish and Game Code Section 4700).

The salt marsh harvest mouse is a rodent endemic to the salt and brackish marshes of the San Francisco Estuary and adjacent tidally influenced areas. The salt marsh harvest mouse closely resembles the western harvest mouse (*R. megalotis*). The salt marsh harvest mouse typically weighs about 0.35 ounce, has a head and body length ranging from 2.7-2.9 inches, a tail length ranging from 2.6-3.2 inches, and a hind foot length of about 0.7 inch (Fisler 1965). As stated in the recovery plan, the salt marsh harvest mouse, when compared to the western harvest mouse, have darker ears, belly and back, and a slightly thicker, less pointed and unicolored tail. The salt marsh harvest mouse is further distinguished taxonomically into the northern and southern subspecies, *R. raviventris halicoetes* and *R. raviventris raviventris*, respectively. Of the two subspecies, *R. r. halicoetes* more closely resembles *R. megalotis*, and can be difficult to differentiate in the field; body color and color of ventral hairs as well as the thickness and shape of the tail have been used to distinguish the two.

The salt marsh harvest mouse has evolved to a life in tidal marshes. Specifically, they have evolved to depend mainly on dense pickleweed as their primary cover and food source. However, salt marsh harvest mice may utilize a broader source of food and cover which includes saltgrass (*Distichlis spicata*) and other vegetation typically found in the salt and brackish marshes of this region. In natural systems, salt marsh harvest mice can be found in the middle tidal marsh and upland transition zones. Upland refugia is an essential habitat component during high tide events. Salt marsh harvest mice are highly dependent on cover, and open areas as small as 10 meters wide may act as barriers to movement (Shellhammer 1978, as cited in Service 1984). The salt marsh harvest mouse does not burrow. It has been noted that the northern subspecies may build nests of loose grasses.

As described by Fisler (1965), male salt marsh harvest mice are reproductively active from April through September, but may appear active throughout the year. Females are reproductively active from March to November, and have a mean litter size of approximately four offspring.

The historic range of the species included tidal marshes within the San Francisco and San Pablo bays, east to the Collinsville-Antioch areas. Agriculture and urbanization has claimed much of the former historic tidal marshes, resulting in a 79 percent reduction in the amount of tidal marshes in these areas (Goals Project 1999). At present, the distribution of the northern subspecies occurs along Suisun and San Pablo Bays north of Point Pinole in Contra Costa County and Point Pedro in Marin County. The southern subspecies is found in marshes in Corte Madera, Richmond, and South San Francisco Bay mostly south of the San Mateo Bridge (Highway 92).

Although no surveys for salt marsh harvest mice have been conducted within the action area, this species has been documented in the tidal marshes adjacent to the airfield and just south of the airfield. During environmental remediation work in December 2004 and January 2005, numerous salt marsh harvest mice were observed in the tidal marshes adjacent to the airfield (E.

Keller pers. comm.). Extensive, suitable habitat for this species occurs throughout the tidal marshes adjacent to the airfield. This habitat is contiguous with other habitat areas along San Pablo Bay, in particular with habitat areas south of the airfield where salt marsh harvest mice also have been documented. Therefore, given the biology and ecology of this animal, the presence of suitable habitat in the tidal marshes adjacent to the airfield, and recent records, the salt marsh harvest mouse is highly likely to inhabit the tidal marshes adjacent to the airfield.

Similar to the California clapper rail, the preservation and growth of existing populations of the salt marsh harvest mouse is considered important to assuring the survival of this species. The Recovery Plan (Service 1984) identifies essential habitat areas to be preserved or restored throughout the Estuary to meet the recovery objectives for this species. Within the action area, the tidal marshes adjacent to the airfield are identified as essential habitat for the salt marsh harvest mouse along the western side of San Pablo Bay (Recovery Plan Task 1233). At the time of preparation of the Recovery Plan, the diked baylands of the former Hamilton Army Airfield were not considered to constitute essential habitat for the salt marsh harvest mouse because it was not envisioned that this area would be restorable to tidal marsh in the future. In the intervening years, the military installation has been closed and plans have been developed to restore a large portion of the diked baylands on the former airfield to tidal wetlands. The current recovery planning, which will result in a revision to the Recovery Plan of 1984, envisions restoration of the majority of the diked baylands on the airfield area as necessary to meet the recovery needs of this species. This goal would be consistent with the recommendation of the Goals Project (1999) to restore a wide, continuous band of tidal marsh habitat along the west side of San Pablo Bay. Because of the continuing threats to salt marsh harvest mice, maintaining existing tidal marsh habitat and restoring additional optimal habitat on or adjacent to the airfield are important elements to ensuring the survival and recovery of this species.

Effects of the Proposed Action

The proposed action would: (1) eliminate about 3.6 acres of suitable tidal marsh habitat available for California clapper rails and salt marsh harvest mice along San Pablo Bay; (2) eliminate about 0.48 acre of high tide refugial habitat available for California clapper rails and salt marsh harvest mice along the outboard levee of the airfield; (3) affect California clapper rails and salt marsh harvest mice due to construction and maintenance activities; (4) affect California clapper rails and salt marsh harvest mice as a result of public access; (5) potentially affect California clapper rails and salt marsh harvest mice through chemical exposure; and (6) if successful, restore about 378 acres of tidal marsh habitat on the former airfield.

Habitat Loss and Restoration

The proposed excavation of a channel through the tidal marsh adjacent to the airfield would permanently eliminate about 3.6 acres of suitable habitat currently available for California clapper rails and salt marsh harvest mice. Lowering and breaching the existing outboard levee of the airfield would eliminate about 0.48 acre of upland refugial habitat available for these two listed species. This loss also would be permanent but the area affected is anticipated to be reestablished as tidal marsh habitat over a 40-year period as a result of the implementation of the

proposed action. The proposed action would attempt to restore about 378 acres of tidal marsh habitat on the former airfield property. However, there are no certainties that successful restoration of tidal marsh habitat within this area would result in actual use and occupancy by breeding California clapper rails based on past tidal marsh restoration projects. Avocet Research Associates (2003) noted that California clapper rails have been detected in only six of 14 tidal marsh restoration projects completed in San Pablo and northern San Francisco bays. Therefore, proper design of the tidal wetlands restoration area within the action area is critical to optimizing the success of the proposed action.

During formal consultation with the Service, the project proponents addressed certain restoration design issues and concerns raised by the Service and an independent design review panel. As a result, the project proponents made changes to certain aspects of the restoration design originally provided to the Service for consultation. These changes overall are anticipated to improve the likelihood that suitable habitat for California clapper rails and salt marsh harvest mice would be restored on the airfield property in the future. However, one design element still remains highly problematic. The project proponents propose to construct the crest elevations of the intertidal berms within the proposed tidal marsh restoration area at 7.3 feet (NAVD 88) with the prediction that the berms would settle to 6.3 feet (NAVD 88), which is near MHHW in the airfield area, by the time that the outboard levee is lowered and breached in six to eight years. The project proponents also may plant *Baccharis* spp. vegetation along the 10-foot wide tops of the constructed berms for wave attenuation. The project proponents have not provided any empirical data to demonstrate or support that the elevations of the constructed berms would be at MHHW at the time the outboard levee is breached. Failure of the constructed intertidal berms to settle to MHHW or below likely would result in the elevated berms providing refuge and access for terrestrial predators of California clapper rails and salt marsh harvest mice, and supporting non-native, invasive plant species within the restored tidal marsh plain.

California clapper rails and salt marsh harvest mice could be harmed if the action area is colonized by non-native, invasive plant species, especially perennial pepperweed and non-native cordgrasses. The proposed action could result in the invasion of these non-native plant species in the action area. If established within the proposed tidal marsh restoration areas or the existing tidal marsh adjacent to the airfield, these non-native plant species could reduce the habitat value of these areas for California clapper rails and salt marsh harvest mice by out competing and preventing or limiting the establishment of native tidal marsh plant species. Successful implementation of a properly-designed monitoring and adaptive management plan could prevent, or at least severely reduce, the establishment of non-native, invasive plant species and ensure that habitat values for California clapper rails and salt marsh harvest mice within the action area are maximized.

The permanent loss of habitat resulting from implementation of the proposed action would occur in areas identified as essential habitat for clapper rails and harvest mice in the Recovery Plan (Service 1984). Successful implementation of the proposed action is expected to restore about 378 acres of tidal marsh habitat within 40 years after initiation of construction work for the proposed action. Lowering of the outboard levee also likely would have the beneficial effect of reducing terrestrial predator threats by removing access corridors within the existing and restored

tidal marshes and eliminating resting/denning areas. Although restoration of tidal marsh habitat on the airfield property is not identified in the Recovery Plan (Service 1984), successful establishment of this habitat is likely to substantially benefit California clapper rails and salt marsh harvest mice, and to assist with their recovery within San Pablo Bay and rangewide. However, there will be a residual temporal effect of habitat loss for up to 40 years until restoration is successfully completed.

Construction-related Effects

The proposed action is likely to result in disturbance in several ways to California clapper rails within tidal marsh habitat. These disturbances are likely to result from work activities associated with creating the channel to provide tidal circulation into the restored tidal wetlands, lowering and breaching the outboard levee, and construction of other elements of the proposed action along or adjacent to the western side of the outboard levee. Disturbance effects also could result from operational and maintenance activities of the existing dredged material pipeline.

Six breeding pairs of California clapper rails were estimated to occur throughout the tidal marsh adjacent to the airfield based on surveys conducted in 2004 (Jules Evens pers. comm.), but only two to three pairs were estimated to occur in the southern portion of this area based on surveys conducted in 2005 (Avocet Research Associates 2005). The change in the number and distribution of birds between 2004 and 2005 was attributed to the environmental remediation work conducted in the area in December 2004 to January 2005 which resulted in a substantial amount of disturbance and destruction of suitable habitat (J. Evens pers. comm.). The areas affected by the remediation work are anticipated to revegetate with time and could provide suitable habitat for California clapper rails by the time that the channel is excavated and the outboard levee lowered and breached.

To avoid or minimize disturbance effects to breeding rails during construction activities within the tidal marsh adjacent to the airfield, the project proponents propose to avoid operation of construction equipment in this area during the clapper rail breeding season from February 1 through August 31 each year. If construction activities cannot be avoided during the clapper rail breeding season, then preconstruction surveys would be conducted using survey methods approved by the Service. If individuals and/or nests are not located within 250 feet of the limits of construction, construction would proceed. If individuals and/or nests are located within 250 feet of the limits of construction, then the project proponents, or their successors in interest, would consult with the Service to determine what, if any, additional measures may be need to allow construction to proceed. The project proponents postulate that California clapper rails or their nests located more than 250 feet from construction or work areas are unlikely to be adversely affected by construction activities because this distance should provide an adequate buffer from construction-related disturbances. However, a buffer distance of 250 feet may not always be adequate to ensure that an individual rail would not be adversely affected by constriction activities, especially if the activities occur within the rail's actual breeding territory. Also, any preconstruction surveys which involved actively searching for nests within tidal marsh habitat likely would be highly disruptive to rail breeding activities and could cause moderate to extensive destruction of habitat as a result of nest search activities by surveyors within the tidal

marsh. Because rail nests are not easy to detect within marsh vegetation and surveys to detect them can be disruptive and destructive, current survey protocols to detect presence or absence of rails breeding within tidal marshes involve the establishment and use of listening stations adjacent to or in habitat areas. These survey methods eliminate impacts to habitat, while providing information on locating clapper rail breeding territories within tidal marsh habitat.

California clapper rails vary in their sensitivity to human disturbance, both individually and between marshes. Certain types of disturbances have occurred within or adjacent to some marsh areas for a long time and certain California clapper rails appear to have habituated or become tolerant of these disturbances, while others appear to habituate over time or are unable to habituate to these disturbances at all. For example, certain California clapper rails in Palo Alto Baylands Nature Preserve appear to be somewhat tolerant of the relatively common pedestrian traffic on the public boardwalk that dissects the marsh. California clapper rail nests have been documented within 10 feet of trails in Elsie Romer and Cogswell marshes in Alameda County, and within 65 feet of a busy street near White Slough (Solano County). In contrast, Albertson (1995) documented a California clapper rail abandoning its territory in Laumeister Marsh in south San Francisco Bay, shortly after a repair crew worked on a nearby transmission tower. The bird did not establish a stable territory within the duration of the breeding season, but eventually moved closer to its original home range several months after the disturbance. As a result of this territorial abandonment, the opportunity for successful reproduction during the breeding season was eliminated (J. Takekawa, pers. comm.). California clapper rails in Laumeister Marsh have little contact with people, and are apparently quite sensitive to human-related disturbance. A similar sensitivity to disturbance could exist with California clapper rails within the tidal marsh adjacent to the airfield where human access activity is presently limited. California clapper rails apparently abandoned territories within the central portion of the tidal marsh adjacent to the airfield following environmental remediation work that destroyed habitat conditions in the area (J. Evens pers. comm.).

California clapper rail reactions to disturbance may vary with season, however both breeding and non-breeding seasons are critical times. Disturbance during the nonbreeding season may primarily affect survival of adult and subadult rails. Adult California clapper rail mortality is greatest during the winter (Albertson 1995; Eddleman 1989), and primarily due to predation (Albertson 1995). Human-related disturbance of clapper rails in the winter, particularly during high tide and storm events, may increase the bird's vulnerability to predators. The presence of people and their pets in the high marsh plain or near upland areas during winter high tides may prevent rails from leaving the lower marsh plain (Evens and Page 1983). Rails that remain in the marsh plain during inundation are vulnerable to predation due to minimal vegetative cover available (Evens and Page 1986).

The project proponents propose to avoid construction activities associated with excavating the channel in the tidal marsh adjacent to the airfield and to conduct this work during the non-breeding season between September 1 and January 31. These construction activities, work associated with lowering and breaching the outboard levee, and maintenance work on the dredged material pipeline conducted during the California clapper rail non-breeding could result in harassment, harm, or mortality of California clapper rails that occur in the tidal marsh adjacent

to the airfield. California clapper rails could be forced to adjust the boundaries of their territories, or to disperse to other habitat areas within this area or to other nearby or distant tidal marshes. Further, the project proponents may attempt to conduct construction or maintenance activities in the tidal marsh adjacent to the airfield during the breeding season from February 1 through August 31. Although surveys would be conducted and certain precautions would be followed accordingly if work needs to be performed in these areas during the breeding season, these activities still could result in harassment, injury, or mortality of California clapper rails. Disturbances associated with construction activities in the tidal marsh adjacent to the airfield and lowering and breaching of the outboard levee could harass nesting California clapper rails. Disturbances from these activities could cause individual California clapper rails to abandon their nests or reduce the ability of adults to properly care for their eggs or young. Displaced individuals and their eggs or young could be subjected to injury or mortality from starvation, physiological stress, and increased predation. California clapper rails disturbed by work activities also could be subjected to predation if they increase their movements within the tidal marsh adjacent to the airfield or disperse to other nearby or distant tidal wetlands.

The project proponents' proposal to attempt to avoid construction activities in the tidal marsh adjacent to the airfield during the breeding season and to limit these activities to the non-breeding season does not assure that California clapper rails dispersed within or away from this area would establish new breeding territories and successfully breed. California clapper rails forced to disperse as a result would need to either maintain existing pair bonds or develop new pair bonds and establish new breeding territories in other suitable habitat areas. The ability of these rails to reestablish new breeding territories would be hampered by the fact that California clapper rails maintain year-round home ranges and defend established breeding territories from intrusions by other California clapper rails. As observed in the Laumeister Marsh example, California clapper rails could be forced to move considerable distances in search of unoccupied suitable habitat. Such movement by rails from established territories is likely to significantly increase the risk of predation and mortality. The farther rails must range in search of other suitable habitat outside of the tidal marsh adjacent to the airfield, the more vulnerable they are to predation. DeGroot (1927) noted that rails were extremely vulnerable to predation by raptors during high tide events when they were forced to seek refuge in exposed locations. Similarly, Johnston (1956, 1957) and Fisler (1965) observed heightened predator activity in marshes coinciding with extreme high tides. Evens and Page (1986) also documented the susceptibility of black rails (*Laterallus jamaicensis coturniculus*) to predation during extreme high tides

Dispersal or movements by clapper rails in California occurs between and outside of marshes (Orr 1939; Zembal *et al.* 1985; San Francisco Bay Bird Observatory 1986; Page and Evens 1987; Albertson 1995). Eddleman (1989) identified movements by Yuma clapper rails outside of their territories as juvenile dispersal; dispersal by an unmated individual bird; and shifts in home ranges after the breeding, in the winter, and during high water periods; and attributed these movements to a search for more suitable habitat where territories, mates, food or safe refuge were better available. Juvenile dispersal apparently constitutes the main type of long distance movements by light-footed clapper rails, while adult birds tend to stay within territories once they are established (Zembal and Massey 1988, Zembal *et al.* 1989, Ledig 1990; Zembal 1990, Zembal 1994, Zembal *et al.* 1996, Zembal *et al.* 1997, Zembal *et al.* 1998). Similarly, California

clapper rails tend to stay within established territories or home ranges year-round (San Francisco Bay Bird Observatory 1986; Albertson 1995). Survivorship of California clapper rails displaced from the tidal marsh adjacent to the airfield likely would be less than if they are allowed to remain in established and familiar territories within this area. Increased movements by clapper rails likely result in lower survivorship through increased exposure to predators (Zembal and Massey 1988; Eddleman 1989; Albertson 1995). Zembal and Massey (1988) noted that three of six telemetered light-footed clapper rails that moved extensively were preyed upon within a relatively short period of time. By comparison, seven other birds that remained sedentary within established territories were not preyed upon during the telemetry period. Loss of any female rails would be compounded by the loss of potential future progeny. Reduced survival of adult California clapper rails would likely impact the long-term viability of the population. A population viability analysis under development for California clapper rails identifies changes in adult survivorship as causing the greatest change in the population growth rate (M. Johnson, pers. comm). Another model also indicates that adult survivorship of California clapper rails is the primary demographic variable for maintaining a stable population or causing the population to either increase or decline (Foin *et al.* 1997). These models indicate that survival of adult birds has the strongest effect on the perpetuation or extinction of the overall population. Based on the information stated above, we anticipate that a maximum of three pairs of California clapper rails forced to disperse within or away from the tidal marsh adjacent to the airfield from construction or maintenance activities in this area and along the outboard levee would be harmed or killed.

Construction and maintenance activities within the tidal marsh and along the outboard levee could affect individual salt marsh harvest mice through increased disturbance and habitat destruction. Increased levels of disturbance to harvest mice would result from noise and vibrations from equipment and construction activities. Operation of construction equipment and associated loss of habitat would result in displacement of harvest mice from protective cover and their territories/home ranges (through noise and vibrations) and/or direct injury or mortality (through crushing). These disturbances likely would disrupt normal behavior patterns of breeding, foraging, sheltering, and dispersal, and likely result in the displacement of harvest mice from their territory/home range in the areas where their habitat is destroyed. Displaced harvest mice may have to compete for resources in occupied habitat, and may be more vulnerable to predators. Female harvest mice are reproductively active from March through November (Fisler 1965), so disturbance during this period may mean abandonment or failure of the current litter. Thus, displaced harvest mice may suffer from increased predation, competition, mortality, and reduced reproductive success.

The project proponents propose to implement one of two plans designed to minimize the loss of individual salt marsh harvest mice from construction activities in the tidal marsh areas and along the outboard levee. One plan would involve pickleweed vegetation being hand-removed with the construction or work areas and a barrier fence being placed 20 feet from the boundaries of construction areas in and adjacent to the tidal marsh areas after the vegetation was removed to prevent salt marsh harvest mice from reentering the cleared area. Another plan would involve placement of a barrier fence would be constructed 20 feet from the boundaries of construction areas in and adjacent to the tidal marsh areas. After installation of the fence, salt marsh harvest mice would be trapped by a qualified biologist and any captured individuals would be released

into suitable habitat outside the fenced area. Implementation of either one of these plans is likely to reduce the number of salt marsh harvest mice harmed or killed by the proposed action.

Disturbance and Predation Effects from Public Access

The proposed action would include development of a public access trail around the western perimeter (Segments A-D) of the action area and an extension (Segment E) of the trail along the southern boundary with the Las Gallinas Sanitation District property. The total length of the public access trail would be 2.66 miles. The first segments of the trail are planned for construction in three to five years. The trail would connect with several existing and proposed trails from the west and would include five interpretative overlooks. The proposed trail would contain various design features to minimize the potential for adverse effects to California clapper rails and salt marsh harvest mice in the existing and restored tidal wetlands of the action area.

Along Segments A-D, the project proponents propose to minimize potential disturbance effects by maintaining a minimum 300-foot buffer, with construction of the wildlife upland corridor and seasonal wetland areas, between the trail and any restored tidal marsh habitat. The project proponents also propose to implement various measures and design features such as planting vegetation, constructing fences, and posting signs, to further minimize any potential disturbances. To address potential adverse effects from construction and use of Segment E, the project proponents propose to place signs at the eastern terminus of this trail to deter access beyond that point along the undeveloped levee tops towards and along San Pablo Bay. The developed trail along Segment E would end about 700 feet from any existing tidal marsh habitat adjacent to San Pablo Bay. The distance between the terminus of Segment E and tidal marsh habitat would diminish over time as tidal wetlands are restored on the airfield and the distance would ultimately be 300 feet or less. Physical buffers (*e.g.* vegetation), periodic signage, or barriers (*e.g.* fencing) also would be placed along Segment E to prevent or discourage public access and intrusion into tidal marsh habitat areas. All dog and motorized vehicle access, except for emergency and maintenance vehicles, would be prohibited along Segment E. The project proponents also would consider seasonal closures for Segment E on the trial along the levee during the peak breeding season of the California clapper rail after the restored tidal wetlands are used by this species.

Human activity and associated pet use would be funneled onto the perimeter trail at several access points from adjacent residential and commercial development areas and would likely increase above current levels. The ability to management or control potential disturbances in adjacent habitat areas from this human activity may not be effectively regulated or controlled, even with the measures proposed by the project proponents to maintain public use and activities along the developed trail. On numerous occasions at the Corte Madera Ecological Preserve, rails have been observed seeking refuge from unrestrained dogs entering tidal marshes from adjacent levees with public access (J. Garcia, pers. comm. 1994). These disturbances have occurred despite the presence of signs notifying users that they are entering sensitive wildlife species areas and that pets must be under restraint while in the preserve area. Similarly, along the Redwood Shores Peninsula in San Mateo County, fences and signs installed to prevent access into areas with endangered species habitat have been repeatedly vandalized and people continue to enter the prohibited areas beyond the fences and signs (Popper and Bennett 2005). Planting of native

vegetation along the periphery of the trail likely would have limited effect in deterring these types of disturbance since people could easily trample or remove any planted vegetation.

Construction of the public access trails proposed in the action area likely would result in an increase above current conditions in predator pressure on California clapper rails and salt marsh harvest mice in restored and existing tidal marshes in and around the general vicinity of the action area. Small mammals, including rats, feral and domestic cats, skunks, and raccoons, which could prey upon California clapper rails and salt marsh harvest mice, likely would emanate from the nearby residential and commercial development along the proposed trail connectors onto the main perimeter trail. Increases in the number of domestic and feral animals could cause territorial abandonment by California clapper rails in adjacent tidal marshes. Evens and Page (1983) documented 4 rail breeding territories along the Greenbrae boardwalk in the Corte Madera Ecological Preserve. In 1993, no rail breeding territories were discovered along the boardwalk even though rail habitat conditions remained unchanged (J. Garcia, pers. comm.). This territorial abandonment is attributed to an increase in domestic and feral dogs and cats along the boardwalk resulting from new residents moving into nearby residential areas since 1983 (J. Garcia, pers. comm.). According to Harvey (1980) and Foerster et al. (1990), predators, especially rats, accounted for nest losses of 24 to 29 percent in certain South Bay marshes. Rats and cats entering the action area could become prey for higher order predators such as red foxes and raccoons, as well as representing predators to endangered species. Therefore, the carrying capacities for higher and lower order predators in the action area could increase above current levels.

The effects described above could be most problematic along Segment E of the trail where increased numbers of people and predators could continue beyond the terminus of this trail segment along the existing levees and into adjacent tidal marsh habitat areas. These effects would be even more pronounced if the property south of the action area is ultimately restored to tidal wetlands. To address this possibility, the project proponents would remove portions of the trail along Segment E, as far west as Long Point, if tidal wetlands restoration occurs on the property south of the action area. This realignment of the trail would be designed to connect with the regional trail system that is anticipated to extend southward along the boundary of any wetlands restoration that may occur south of the action area.

Potential Contaminant Effects

Potential effects of contaminants on listed species, including development of risk-based cleanup numbers for protection of the California clapper rail and the salt marsh harvest mouse, were discussed in detail in the August 22, 2003, biological opinion for the transfer and environmental remediation of the airfield. That analysis resulted in sediment cleanup criteria for the action area defined in this biological opinion for inorganic and organic chemicals (Tables 20 and 21 of the August 23, 2003, biological opinion, as modified for DDT by the Service's September 10, 2003, amendment to the biological opinion). These cleanup criteria were required as terms and conditions to minimize the potential for mortality or harm of California clapper rails and salt marsh harvest mice associated with exposure to contaminants. These terms and conditions required that contamination above the cleanup criteria within three feet of the surface in the area

west of the outboard levee shall be excavated and disposed of off-site or covered by the placement and maintenance in perpetuity of three feet of stable cover, and any exceedances of these criteria at depths greater than three feet required that the stability of at least three feet of overlying material be maintained in perpetuity.

The August 22, 2003, biological opinion also included terms and conditions regarding use of dredge material or on-site soils for remediation or wetland restoration, specifically stating that chemical concentrations and associated sampling activity of dredged material or site soils planned for use on-site shall be reviewed and approved by the Service. Concentrations of chemicals in these materials shall not exceed the no adverse effect concentrations for clapper rails or harvest mice or adversely impact the organisms on which they depend unless these values are exceeded by elevated regional concentrations, in which case appropriate ambient concentrations will apply. The cleanup criteria from the August 22, 2003, biological opinion (as amended for DDT) are based on Low Toxicity Reference Values (essentially no adverse effect concentrations) or ambient concentrations and are, therefore, applicable criteria for evaluating suitability of dredge material for use in the wetland restoration.

The RWQCB issued a Tentative Order for Waste Discharge Requirements and Water Quality Certification for the proposed action (Tentative Order) on May 23, 2005. The Tentative Order identifies dredged material acceptance criteria for wetland surface (cover) reuse that shall be used to screen prospective dredging projects for placement of dredged material at the airfield. With the exceptions of cadmium and chlordane, these acceptance criteria are the same as or lower than the cleanup criteria in the Service's August 22, 2003, biological opinion, for those constituents that are addressed in both documents (see following table).

Constituent	Inboard (West of Outboard Levee) Cleanup Criteria from August 22, 2003, Biological Opinion (as amended)	Dredged Material Acceptance Criteria from Regional Board Tentative Order
Inorganics (mg/kg):		
Arsenic	16.7	15.3
Barium	190	Not addressed
Beryllium	1.03	Not addressed
Boron	36.9	Not addressed
Cadmium	0.7	1.2
Chromium	112	112
Cobalt	27.6	Not addressed
Copper	68.1	68.1
Lead	43.2	43.2
Manganese	943	Not addressed
Mercury	0.43	0.43
Nickel	114	112
Selenium	Not addressed	0.64
Silver	1	0.58

Vanadium	118	Not addressed
Zinc	158	158
Organics (ug/kg):		
PAHs, total	4,022	3,390
Pentachlorophenol	17	Not addressed
Phenol	130	Not addressed
TPH-diesel/motor oil	144,000	Not addressed
TPH-gasoline/JP-4	12,000	Not addressed
BHCs, total	0.99	Not addressed
Chlordanes, total	1.1	2.3
DDTs, total	24	7
Dichlorprop	140	Not addressed
Dieldrin	Not addressed	0.72
Endrin Aldehyde	6.4	Not addressed
Heptachlor	0.3	Not addressed
Heptachlor epoxide	0.3	Not addressed
MCPA	7,900	Not addressed
MCPP	3,000	Not addressed
Methoxychlor	90	Not addressed
PCBs, total	90	22.7
Dioxins (total TCDD TEQ)	0.02	Not addressed

The Service's cleanup criteria for cadmium and chlordane were based on ambient concentrations (revised Inboard ambient for cadmium, San Francisco Bay ambient for chlordane) because the calculated no adverse effect concentrations for California clapper rails or salt marsh harvest mice were lower than ambient concentrations. Ambient values were applied as cleanup criteria because they represent concentrations likely occurring on-site absent military activities and the typical chemical concentrations in sediment that will be deposited on-site once it is open to tidal action. These ambient concentrations (0.7 mg/kg cadmium and 1.1 ug/kg total chlordanes) are appropriate as screening criteria for dredge materials or on site-soils that will be used within three feet of the surface in wetland restoration on the airfield. The other screening criteria identified in the RWQCB's Tentative Order are protective for California clapper rails and salt marsh harvest mice. For constituents that were not addressed in the Tentative Order, the Service's cleanup criteria are appropriate as screening criteria for the reasons discussed in the August 22, 2003, biological opinion for the transfer and environmental remediation of the airfield.

The Port of Oakland's (Port) 50-Foot Harbor Deepening Project has been identified as a potential initial source of dredged material for the restoration of wetlands at the airfield. Sediments from the area of this proposed harbor deepening project were sampled and analyzed for suitability in wetland restoration and other uses or disposal options (EVS 1998). The Service has reviewed the data, analyses, and conclusions presented in the EVS report (EVS 1998). The Service concurs

with the use of the sediments identified as preferred by the Port for cover or noncover wetland restoration uses in Table 5-1 (Dredging Unit suitability qualification for various disposal options and the Port's preferred option) of the EVS report (EVS 1998) for wetland restoration at the airfield.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local or private actions affecting listed species and their critical habitat that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. The Service is not aware of any non-Federal actions which are likely to result in cumulative effects to California clapper rails or salt marsh harvest mice within the action area considered in this biological opinion.

Conclusion

After reviewing the current status of the California clapper rail and salt marsh harvest mouse, the environmental baseline for the action area, the effects of the proposed action and cumulative effects, it is the Service's biological opinion that the wetland restoration project, as proposed, at the former Hamilton Army Airfield is not likely to jeopardize the continued existence of the California clapper rail and salt marsh harvest mouse. We base this determination on the following: (1) the relatively limited amount of habitat for these species that would be permanently lost; (2) the relatively low number of California clapper rails that likely would be harassed, harmed, or killed; and (3) the large amount of habitat that would be restored with successful implementation of the proposed action. No critical habitat has been proposed or designated for either species, therefore none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9(a)(1) of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened fish and wildlife species without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this incidental take statement.

The incidental take statement accompanying this biological opinion exempts take of California clapper rails and salt marsh harvest mice carried out in accordance with the reasonable and prudent measures and terms and conditions from the prohibitions contained in section 9 of the Act. It does not address the restrictions or requirements of other applicable laws. Since the California clapper rail and salt marsh harvest mouse are fully protected species under California law (California Fish and Game Code Sections 3511 and 4700, respectively), the exemption from section 9 of the Act provided by this incidental take statement for these two species does exempt the Corps, the Conservancy, or its contractors from complying with State law.

The measures described below are non-discretionary, and must be implemented by the Corps. If the Corps (1) fails to require to adhere to the terms and conditions of the incidental take statement, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

Amount or Extent of Take

Conservation measures proposed by the project proponents and described above in the "Description of the Proposed Action" section will reduce, but do not eliminate, the potential for incidental taking of California clapper rails and salt marsh harvest mice. The Service anticipates incidental take of individual salt marsh harvest mice will be difficult to detect or quantify because of the variable, unknown size of any resident population over time, and the difficulty of finding killed or injured small mammals. The level of take of individual salt marsh harvest mice can be anticipated by the amount of available habitat lost from the proposed action. The Service expects that incidental take of the California clapper rail will be difficult to detect because of the reclusive nature of this species. The Service considers the number of salt marsh harvest mice and California clapper rails subject to harassment from noise and vibrations to be difficult to estimate. The Service, therefore, anticipates the following levels of take as a result of implementation of the proposed action.

Incidental take of California clapper rails and salt marsh harvest mice is expected in the form of:

1. mortality, injury, or harassment of a maximum of three (3) pairs of California clapper rails due to creating the tidal channel, lowering and breaching of the outboard levee, and maintaining the dredged material pipeline; and

2. 3.6 acres of suitable tidal marsh habitat and 0.48 acre of upland refugial habitat available for these two listed species permanently lost as a result of the excavation of the tidal channel and lowering and breaching of the outboard levee, respectively; and

3. harm or mortality of California clapper rails or salt marsh harvest mice (either directly or by affecting their food sources and habitat) in the action area due to residual chemical contamination from on-site and off-site soils or dredged material, predation, disturbance, and invasion of non-native plant species.

Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize the impact of take on the salt marsh harvest mouse and California clapper rail:

1. Minimize the potential for harm, harassment, or killing of salt marsh harvest mice and California clapper rails.

2. Minimize the effects of permanent loss and degradation of habitat on California clapper rails and salt marsh harvest mice by habitat restoration and protection.

3. The project proponents shall ensure their compliance with this biological opinion.

Terms and Conditions

To be exempt from the prohibitions of section 9 of Act, the Corps must comply with the following terms and conditions, which implement the reasonable prudent measures described above. These terms and conditions are nondiscretionary.

The following terms and conditions implement all of the reasonable and prudent measures:

a. The project proponents shall minimize the potential for harm, harassment, injury, or killing of California clapper rails and salt marsh harvest mice resulting from the proposed action by implementing the wetlands restoration of the Hamilton Army Airfield, as proposed, with the inclusion of or modifications by Terms and Conditions b-m of this biological opinion.

b. An employee education program shall be conducted prior to the initiation of construction or maintenance activities within the tidal marsh adjacent to the airfield or along any portion of the outboard levee. The program shall consist of a brief presentation by persons knowledgeable in California clapper rail and salt marsh harvest mouse biology and legislative protection to explain endangered species concerns to contractors and their employees. The program shall include the following: a description of the California clapper rail and salt marsh harvest mouse and their habitat needs; a report of the occurrence of California clapper rail and salt marsh harvest mouse in the project area; an explanation of the status of this species and its protection under the Act; and a list of measures being taken to reduce impacts to these species during project construction and implementation. A fact sheet conveying this information shall be prepared for distribution to the above mentioned people and anyone else who enters the project site.

c. A representative(s) shall be appointed by the project proponents who will be the contact source for any employee or contractor who might inadvertently kill or injure a California clapper rail or salt marsh harvest mouse or who finds a dead,

injured, or entrapped individual. The representative(s) shall be identified during the employee education program. The representative's name and telephone number shall be provided to the Service prior to the initiation of any construction or maintenance activities in the tidal marsh adjacent to the airfield or along any portion of the outboard levee.

d. Preconstruction surveys for California clapper rails shall follow the Service's January 21, 2000, draft survey protocol (or any subsequent revision). A survey protocol(s) shall be developed for any construction or maintenance work within the tidal marsh adjacent to the airfield or along any portion of the outboard levee. Prior to initiation of the planned work activities, the proposed survey protocol(s) shall be provided to the Service for review and approval. After the surveys are completed and prior to initiation of the planned work activities, the results of the surveys shall be provided to the Service for review to evaluate the appropriateness of work being proposed by the project proponents. Work activities shall not be initiated until after the Service has approved the planned work based on the review of the survey results.

e. An adequate plan shall be developed that describes how pickleweed vegetation will be removed and barrier fences will be constructed in the tidal marsh adjacent to the airfield and along the outboard levee. The plan shall be provided to the Service for review and approval at least 90 calendar days prior to its implementation by the project proponents.

f. A draft monitoring and adaptive management plan shall be submitted to the Service and a panel of independent wetland restoration experts approved by the Service on or before June 1, 2006, for review and comment. The final monitoring and adaptive management plan shall be submitted to the Service on and before September 1, 2006, for review and approval.

g. A Service-approved biologist shall be present on-site for any construction or maintenance activities within the tidal marsh adjacent to the airfield or along the crown and bayside slope of the outboard levee. The biologist shall have oversight over implementation of all Terms and Conditions in this biological opinion, and shall have the authority to stop project activities if any of the requirements associated with these Terms and Conditions are not being fulfilled. If the biologist requests to stop work due to take of any listed species, the Service and Department will be notified within one (1) working day via electronic mail or telephone. If requested, during or upon completion of construction activities, the biologist and/or representative from the Corps or Conservancy shall accompany Service or Department personnel on an on-site inspection of the action area to review project effects to California clapper rails and salt marsh harvest mice.

h. The project proponents shall prepare and implement an adequate plan that describes how the public access, including restrictions and prohibitions, designed and planned for the action area will be effectively enforced and maintained by the

project proponents. The document shall describe how the requirements of the plan will be transferred to future property owner(s) or manager(s) of the action area. This plan shall be subject to review and approval by the Service prior to the construction of any segment of the proposed trail.

i. The project proponents shall prepare an adequate plan that describes how the channel in the tidal marsh adjacent to the airfield will be excavated and the outboard levee will be lowered, breached, and prepared for tidal marsh restoration. This plan shall be subject to review and approval by the Service at least 90 calendar days prior to its implementation.

j. To ensure that the intertidal berms designed within the prospective tidal marsh restoration area will be at or below MHHW at the time the outboard levee is breached and lowered, the crest elevations of the intertidal berms shall be constructed at 6.10 feet (NAVD 88) with an error tolerance of 0.15 feet. The berm crest widths shall not exceed 10 feet with berm side slopes no steeper than 1 foot vertical: 5 feet horizontal. The project proponents shall provide final design drawings of the intertidal berms to the Service for review and approval to confirm consistency with these criteria prior to their construction. The crests of the intertidal berms may be planted with native *Baccharis pilularis* vegetation at the discretion of the project proponents after the levees are constructed provided the actual as-built crest elevations are confirmed to be subject to local tidal flooding frequencies sufficient to cause full mortality of upland vegetation. The project proponents shall provide as-built construction diagrams of the intertidal berms to the Service for review and approval prior to planting any upland vegetation on the crests of the berms.

k. Based on the project proponents' measure contained in the "Description of the Action," the project proponents shall consult with the Service on the removal of Segment E of the public access trail should the property south of the action area be restored to tidal wetlands in the future. Should Segment E be left in place, the project proponents shall develop and implement a predator management program that effectively manages predation threats along Segment E of the trail in perpetuity after tidal marsh is restored in the action area. The project proponents shall prepare a plan that provides a comprehensive description of all aspects of the program. The plan shall be subject to the review and approval of the Service, and shall include, but not be limited to the following elements:

1. An agreement with Wildlife Services of the U.S. Department of Agriculture, shall be made to provide an amount of service that Wildlife Services deems necessary to effective manage the proposed restoration area. Wildlife Services personnel shall be authorized to operate wherever and whenever on the restoration sites to accomplish their mission. Wildlife Services personnel also shall report any potential problems and the status of their work to the Service. If Wildlife Services is not available

to do the work, an alternative method of management must be submitted to the Service for review and approval.

2. An adequate funding plan shall be developed and implemented to finance the predator management program.

3. Enforceable performance standards and associated contingency measures that provide tangible improvements to the management program should actual performance fall short of the standards shall be developed and implemented.

4. Means shall be developed to ensure implementation of the management program in perpetuity, regardless of possible changes in land use or ownership, or the availability of Wildlife Services. Such means may include the establishment of a covenant running with the title to the property, establishing the obligation of the then current owner to fulfill the obligations set out in this term and condition.

l. Concentrations of chemicals in materials to be used within three feet of the surface shall not exceed the no adverse effect concentrations for California clapper rails or salt marsh harvest mice or adversely impact the organisms on which they depend, unless these values are exceeded by elevated regional concentrations, in which case appropriate ambient concentrations will apply. Chemical concentrations and associated sampling plans and activity of dredged material or site soils planned for use on-site shall be reviewed and approved by the Service. The data for dredged material proposed for use in the action area shall be provided to the Service for review and approval at least 60 calendar days prior to the proposed date of placement of the material. The following table identifies screening criteria required for acceptability of dredge material to be used as cover on the airfield.

Constituent	Required Screening Criteria	Source of Criteria
Inorganics (mg/kg):		
Arsenic	15.3	RWQCB Tentative Order
Barium	190	Previous (August 22, 2003) Biological Opinion
Beryllium	1.03	Previous Biological Opinion
Boron	36.9	Previous Biological Opinion
Cadmium	0.7	Previous Biological Opinion
Chromium	112	Previous Biological Opinion and RWQCB Board Tentative Order
Cobalt	27.6	Previous Biological Opinion
Copper	68.1	Previous Biological Opinion and RWQCB Board Tentative Order

Lead	43.2	Previous Biological Opinion and RWQCB Board Tentative Order
Manganese	943	Previous Biological Opinion
Mercury	0.43	Previous Biological Opinion and RWQCB Board Tentative Order
Nickel	112	RWQCB Board Tentative Order
Selenium	0.64	RWQCB Board Tentative Order
Silver	0.58	RWQCB Board Tentative Order
Vanadium	118	Previous Biological Opinion
Zinc	158	Previous Biological Opinion and RWQCB Board Tentative Order
Organics (ug/kg):		
PAHs, total	3,390	RWQCB Board Tentative Order
Pentachlorophenol	17	Previous Biological Opinion
Phenol	130	Previous Biological Opinion
TPH-diesel/motor oil	144,000	Previous Biological Opinion
TPH-gasoline/JP-4	12,000	Previous Biological Opinion
BHCs, total	0.99	Previous Biological Opinion
Chlordanes, total	1.1	Previous Biological Opinion
DDTs, total	7	RWQCB Board Tentative Order
Dichlorprop	140	Previous Biological Opinion
Dieldrin	0.72	RWQCB Board Tentative Order
Endrin Aldehyde	6.4	Previous Biological Opinion
Heptachlor	0.3	Previous Biological Opinion
Heptachlor epoxide	0.3	Previous Biological Opinion
MCPA	7,900	Previous Biological Opinion
MCPP	3,000	Previous Biological Opinion
Methoxychlor	90	Previous Biological Opinion
PCBs, total	22.7	RWQCB Board Tentative Order
Dioxins (total TCDD TEQ)	0.02	Previous Biological Opinion

m. The project proponents shall place a restrictive covenant upon the property prior to any transfer of interest in the property; such covenant to be recorded against the title to the property prior to the recordation of a deed transferring an interest in the property. The restrictive covenant shall ensure that all restricted and prohibited uses stated in this biological opinion are identified to and legally binding on the future property owner(s). A draft restrictive covenant shall be provided to the Service for review and approval at least 90 days prior to the document being finalized and recorded. The language of the covenant may also provide the language necessary to comply with k(4) above. A copy of the final recorded restrictive covenant shall be provided to the Service within 30 days after recordation.

Reporting Requirements

The Service and Department must be notified within 24 hours of the finding of any injured or dead salt marsh harvest mouse or California clapper rail, or any unanticipated damage to salt marsh harvest mouse or California clapper rail habitat associated with the proposed action. Any injured California clapper rails and salt marsh harvest mice must be cared for by a licensed veterinarian or other qualified person such as a biological monitor; any dead individuals should be preserved according to standard museum techniques and held in a secure location. Notification must include the date, time, and precise location of the specimen/incident, and any other pertinent information. The Service contact persons are Chris Nagano, Chief, Deputy Assistant Field Supervisor of the Sacramento Fish and Wildlife Office at (916) 414-6648, and Scott Heard, Resident Agent-in-Charge of the Service's Law Enforcement Division in Sacramento, California, at (916) 414-6660.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purpose of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities that can be implemented to further the purposes of the Act, such as preservation of endangered species habitat, implementation of recovery actions, or development of information and databases.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations. We propose the following conservation recommendations:

1. Assist the Service in implementing recovery actions identified within most current recovery plans for the California clapper rail and salt marsh harvest mouse.

2. Encourage or require the use of appropriate California native plant species in revegetation and habitat enhancement efforts associated with projects authorized by the Corps.

3. Encourage participation of prospective permittees in a program being developed by Federal and State resource agencies to limit and reverse the spread on non-native *Spartina* within the San Francisco Bay Estuary.

REINITIATION STATEMENT

This concludes formal consultation on the proposed Hamilton Wetlands Restoration Project outlined in the Corps' request. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental

take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation. If you have any questions regarding this biological opinion on the proposed Hamilton Wetlands Restoration Project, please contact this office at the letterhead address or at (916) 414-6600.

Sincerely,

for Cay C. Goude
Acting Field Supervisor

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PERSONAL COMMUNICATIONS

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Dr. Peter Baye. Environmental Consultant. Annapolis, California.

Dr. Josh Collins. San Francisco Estuary Institute. Oakland, California.

Mr. Jules Evens. Avocet Research Associates. Point Reyes Station, California.

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California Regional Water Quality Control Board
San Francisco Bay Region

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Arnold Schwarzenegger
Governor

Date: AUG 0 4 2005
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Lieutenant Colonel Philip T. Feir
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Return Receipt Requested

SUBJECT: Transmittal of Order No. R2-2005-0034 – Waste Discharge Requirements and Water Quality Certification, Hamilton Wetlands Restoration Project, Novato, Marin County.

Dear Mssrs.:

Enclosed is Order No. R2-2005-0034 Waste Discharge Requirements and Water Quality Certification for the Hamilton Wetlands Restoration Project. The Order was adopted by the Regional Board at its July 20, 2005 hearing. Should you have any questions please contact me at 510-622-2328, or by e-mail at nfeger@waterboards.ca.gov.

Naomi Feger
Groundwater Protection Division

Enclosure: Order No. R2-2005-0034

cc (w/enclosure): Attached Mailing Lists

CC Mailing List:

Jay Kinberger, Army Corps of Engineers, San Francisco District

Eric Polsen, Polsen Engineering
Tom Gandesbery, State Coastal Conservancy
Steve Goldbeck, BCDC
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Edward Keller, U.S. Army BRAC
Lance McMahan, DTSC
Theresa, McGarry, DTSC
Tom Roth, Senior Field Representative to Rep. Lynn Woolsey

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD

SAN FRANCISCO BAY REGION

ORDER NO. R2-2005-0034

WASTE DISCHARGE REQUIREMENTS AND WATER QUALITY CERTIFICATION FOR:

UNITED STATES ARMY CORPS OF ENGINEERS, SAN FRANCISCO DISTRICT; CALIFORNIA STATE COASTAL CONSERVANCY

HAMILTON WETLAND RESTORATION PROJECT NOVATO, MARIN COUNTY

The California Regional Water Quality Control Board, San Francisco Bay Region, hereinafter called the Water Board or the Board, finds that:

Purpose of Order

1. This Order serves as Waste Discharge Requirements and Water Quality Certification under Section 401 of the Federal Clean Water Act for the placement and discharge of sediments for use in a wetland restoration project. This Order also provides monitoring and reporting requirements, including effluent limits, for the offloading and placement of dredged material, the discharge of return-flow or "decant" water, and the restoration of the wetlands. This Order also supercedes Provision 5.b of Order 96-113, pertaining to mitigation for wetland impacts at the site due to the placement of a landfill cap on an adjacent property.

Dischargers

2. As the current owner of the property, the California State Coastal Conservancy (SCC), an agency of the State of California, is hereinafter referred to as a Discharger. The SCC is the local sponsor of the wetland restoration project and shares in the cost of the construction of the wetlands.

3. As the operator of the site, the United States Army Corps of Engineers, San Francisco District (Corps) is hereinafter referred to as a Discharger. The Corps is responsible for the planning, design and construction of the project.

4. Collectively, the Corps and the SCC are referred to in this Order as the Discharger.

Certification Application and Report of Waste Discharge

5. On March 16, 2005, the Corps and the SCC jointly submitted an application for a Section 401 Water Quality Certification and a Report of Waste Discharge for the proposed placement of sediment dredged from San Francisco Bay at the site of the Hamilton Wetland Restoration Project (interchangeably, HWRP or project).

Site Description and Location

6. The site of the HWRP is the former Hamilton Army Airfield (HAAF), located in Novato, Marin County (refer to Figure 1). The HWRP was authorized by the United States Congress in Section 101(b) of the Water Resources Development Act of 1999. The project is located on 630 acres of diked and subsided bayfront property and is located adjacent to San Pablo Bay, in the northern portion of San Francisco Bay (refer to Figure 2). A portion of the proposed project includes a one-acre channel cut through existing tidal marshes. Former agricultural lands and salt marshes bound the property to the north and south. A 319-acre parcel to the north of the site is owned by the California State Lands Commission (SLC parcel) and was previously owned and operated by the Army as a rifle range and an antennae field with associated support buildings. The U.S. Navy currently owns an 18-acre parcel (Navy Ballfields parcel) to the south of the site. These two parcels are part of the current congressionally authorized Hamilton Wetland Restoration Project but were not included in the Discharger's application because site remediation activities are not completed and the State of California is not currently the owner of the Navy Ballfields parcel. In addition, there is a parcel of land north of the project, known as the Bel Marin Keys Unit V that is not part of the HWRP. The SCC and Corps prepared a General Reevaluation Report in July 2002 evaluating the expansion of the HWRP to include this parcel. The proposed expansion would increase the total acreage of the HWRP to 2,598 acres, and is anticipated to be part of the HWRP upon congressional approval of a future Water Resources Development Act.

Site History

7. The site, previously known as Marin Meadows, was used as ranch and farm land since it was part of a Mexican Land Grant. In 1932, the U.S. Army Air Corps constructed Hamilton Army Airfield. Military operations began in December 1932, first as a base for bombers, later as a base for transport and fighter aircraft and then for Army and Army Reserve operations and training. In 1988, the property was declared surplus property under the Base Realignment and Closure Act (BRAC). In 2003, title to the property was transferred from the Army to the California Coastal Conservancy for use in wetland creation, with the requirement that the Army complete site cleanup actions. Since the transfer in 2003, the Army has been conducting cleanup activities as required under Board Order R2-2003-0076, and anticipates completing its removal actions by October 2005.

Current Regulatory Status

8. Board Order R2-2003-0076 established Site Cleanup Requirements for this site to ensure completion of all actions required under a Remedial Action Plan/Record Of Decision (RAP/ROD) signed by the U.S. Army, the Department of Toxic Substances Control and the Water Board. At the time of transfer of the property to the Coastal Conservancy, the Water Board became the lead State Agency for the property. Board Order R2-2003-0076 and the RAP/ROD required removal of contaminated sediments in the existing coastal salt marsh at Hamilton, resulting in impacts to about seven acres of wetlands. The creation of wetlands as a part of this project mitigates for these impacts.

9. In the 1990's, a 12-acre wetland site was constructed on the property as required under Board Order 92-029 and subsequent Order 96-113, to mitigate for impacts to wetlands due to construction of a landfill cap on Landfill 26, adjacent to the HWRP property. This Order supercedes Provision 5.b of Order 96-113, requiring that a Closure Certification Report include documentation of the implementation of the approved wetland mitigation plan (Formerly Provision 8 of Board Order 92-029).

10. The Corps, as the federal lead agency for the project, initiated formal consultation with the United States Fish and Wildlife Service (Service) and is continuing informal consultation with National Oceanic and Atmospheric Administration (NOAA) Fisheries and the California Department of Fish and Game.

11. The San Francisco Bay Conservation and Development Commission (BCDC), a State regulatory agency, is responsible for issuing a permit and a Consistency Determination (CD) to the State Coastal Conservancy and the Corps, respectively. The CD evaluates the consistency of the federal project with the Coastal Zone Management Act. BCDC also has an active role in the planning and design of the project. One element of BCDC's permit/CD will address public access via the Bay Trail.

Project Description

12. The Discharger proposes to construct the HWRP using dredged material from various Bay Area dredging projects (See Figure 3 for plan view of project). The HWRP has several planned elements: tidal wetland, seasonal wetlands, including upland ponds, upland grassland, tidal ponds, tidal pannes, a wildlife corridor, intertidal channel and mudflat area. There are an existing 124.5 acres of wetlands onsite and 543 acres of grasslands, uplands or developed lands (refer to Table 1). A total of 547 acres are planned for restoration as wetlands. Of the existing 124.5 acres of wetlands, 40 acres will be directly impacted by the project and 85 acres in the existing coastal salt marsh may be impacted. Three acres of the existing coastal salt marsh will be excavated for the levee breach.

13. The project would contribute to the restoration of priority habitats for San Pablo Bay (Goals Project, 1999 – references provided as an attachment to this Order), including tidal marshes, tidal sloughs, subtidal channel and seasonal wetlands. The restoration of

these habitats on the project site would provide ecological benefits for many target species, including California Clapper Rail, California Black rail, Chinook salmon, steelhead, Salt Marsh Harvest Mouse, San Pablo song sparrow, Salt Marsh Common Yellowthroat, shorebirds, wading birds and waterfowl, and others.

14. Specific project objectives detailed in the Discharger's permit application include:

    a. To design and engineer a restoration project that stresses simplicity and has little need for active management following placement of dredged material and breaching to allow tidal inundation.
    b. To demonstrate beneficial reuse of dredged material.
    c. To recognize existing site opportunities and constraints, including the runway and remediation of contaminated areas, as integral components of design.
    d. To ensure no net loss of wetland habitat functions.
    e. To create and maintain wetland habitats to sustain viable wildlife populations, particularly for Bay Area special-status species.
    f. To include buffer areas along the upland perimeter of the project area, particularly adjacent to residential areas, so that wildlife will not be impacted by adjacent land uses.
    g. To be compatible with adjacent land uses and wildlife habitats.
    h. To provide for public access that is compatible with protection of resource values and regional and local public access policies.

HWRP Design Overview

15. **Seasonal Wetland Design and Layout**

Seasonal wetlands will be created in two locations on the HWRP site. Figures of the two seasonal wetland areas, the panhandle seasonal wetland and the southern seasonal wetland are provided as Figures 4 and 5, respectively. The target habitat will be unvegetated to sparsely vegetated seasonally-ponded wetlands suitable as shorebird habitat, along with vegetated transitional wetland/upland habitat. Water to the seasonal wetland areas will come from precipitation, surface water runoff and tidal inundation on extreme spring high tides. The salt from the infrequent tidal inundation as well as the periodicity and duration of inundation will serve to limit the introduction of invasive plant species. Some ponds will be placed at higher elevations and will not be inundated.

Board Order R2-2003-0076 required excavation of DDT and PAH-contaminated soils from the planned tidal area to an area where three feet of stable cover could be maintained. These soils have been moved to the planned panhandle seasonal wetland and will be buried beneath 4-6 feet of cover material, 2 feet of which will be compacted fine-grained material. The gentle topographical slope, compacted nature of the soil material and limited conditions for rapid draw down of water levels combine to protect the soils interior to the seasonal wetland complex from channel cutting. Incursion of tidal channels into the seasonal wetland site is prevented by the containment berm (described in finding 16 below) and the storm water/tidal channel berm.

A stormwater/tidal channel will be engineered to flow through the panhandle seasonal wetland. A berm, separating the seasonal wetland from the stormwater/tidal channel will be constructed from compacted muds and sands excavated in the construction of the stormwater/tidal channel. This berm will be 40 feet wide with a crest elevation of 8.5 feet North American Geodetic Vertical Datum of 1988 (NAVD).

A wildlife corridor is a design element of the HWRP and encompasses 34 acres along the length of the existing City of Novato's (NHP) levee. Figure 6 is a cross section of the design for the wildlife corridor. The 300-foot wide gently sloping wildlife corridor will be supported by a toe berm also referred to as the wildlife berm. The wildlife corridor itself is considered transitional habitat and is expected to provide refuge for endangered species. The wildlife berm will provide a level of protection to the wildlife corridor from wave and channel cutting. Further protection from waves will be provided by the accreting salt marsh plain. At the time of levee breach, the project anticipates that the fill in the tidal marsh will have initially consolidated to about 4.7 feet NAVD 88. The slope of the wildlife corridor is planned to be gradual, approximately 125:1. The wildlife berm will be graded to this same slope, from the marsh plain up to the City of Novato's levee. The grading will occur prior to levee breach. Portions of, or all of, the wildlife corridor may be planted. The planned design requires surcharging the NHP levee by the hydraulic placement of dredged materials onto the side slope of the levee for construction of the upland wildlife corridor and southern seasonal wetland areas. The Discharger is currently conducting a geotechnical evaluation of the planned design for the wildlife corridor.

The bulk of the fill for the panhandle seasonal wetland and the wildlife corridor is expected to be sand from the Port of Oakland 50-Foot Project, described in Finding 18. This sandy material will be topped with approximately two additional feet of finer sediments more suitable to vegetation. Approximately 2.1 million cubic yards of dredged material will be placed to create the seasonal wetland areas and wildlife corridor. Mechanical rehandling of the material will be necessary to form the desired ponds, islands and drainage system features, which will be part of the seasonal wetland design.

16. **Tidal Wetland Design and Layout**

An estimated 5 million cubic yards of dredged material will be placed in the planned tidal wetland area, which is currently diked, subsided baylands. The outboard levee will be breached to tidal action after a period of consolidation, approximately one year. The tidal wetland areas will be filled to elevations that will consolidate to +2.65 to +4.65 feet NAVD, primarily with fine-grained maintenance dredging material. These fill elevations are planned to be 1 to 1.5 feet below marsh plain elevations to allow sediments borne on the tide to naturally accrete, completing the filling of the site. Proper development of the tidal marsh requires that the fill elevation be low enough to allow additional sedimentation and the development of tidal channels on the site after breaching.

Intertidal berms will be built within the tidal area to reduce levee erosion by decreasing internal wave heights, reducing wave runup and promote sedimentation by limiting internal wave energy (Figure 8). A gap of at least 250 feet will be established between the intertidal berms and the site perimeter to limit predator access. Intertidal berm number 8 is an exception to the 250 ft gap because this small berm is considered necessary to prevent

a channel from forming in this area. Intertidal berms will be constructed to settle to an elevation similar to the final tidal marsh plain. Coyote Brush (Baccharis species) will be planted at their crests to aid in reducing wave energy. They will not be visible in the marsh plain when it is fully developed.

A containment berm will be built between the panhandle seasonal wetland and the tidal wetland to control tidal inflows. This containment berm will be constructed to achieve a design crest elevation of 8.5 feet NAVD after subsidence over a 30-50 year consolidation period. Initially the levees will be built higher than this design elevation. The containment berm is anticipated to be erosion resistant and to control the rate of spring (extreme high) tide flow rates over the levee crest. The 10-year and 100-year flood elevations are 8.8 and 9.8 feet NAVD, respectively.

A channel will be constructed in the containment berm prior to levee breach. An adjustable weir in this channel will allow the needed spring tidal flows into and out of the seasonal wetland area while controlling the potential for erosion. As water levels fall on outgoing tides, discharge will be controlled via the weir precluding erosional damage to the containment berm and allowing for variable ponding in the seasonal wetlands for vegetation and habitat control. A road suitable for maintenance vehicles and equipment will be maintained on the crest of this berm providing access for site management and maintenance.

HWRP Construction Overview

17. The construction of both seasonal and tidal wetlands as planned by the HWRP requires placement of up to 7.1 million cubic yards of dredged material from San Francisco Bay. The Discharger will employ an off-loader and barge facility (off-loader) located in San Pablo Bay approximately five miles off-shore of the HWRP, where the Bay is sufficiently deep for navigation (refer to Figure 8). The sediments will be transported to the off-loader in barge scows escorted by tugboats. Each scow will carry between 3,000 to 8,000 cubic yards of sediment. Hopper dredges may be used in addition to barge scows to transport sediments. Water from San Pablo Bay will be pumped to the off-loader, mixed with the sediment from the barge scows, and the resulting slurry will then be pumped through 35,000 feet of pipeline to the HWRP site. A portion of the pipeline was constructed in 2002 across an existing 1700 feet of coastal salt marsh. Flexible pipelines and pumps will be utilized to move sediment across the site and place sediment into containment cells also referred to as primary placement cells. Millions of gallons of water are required to pump the dredged material through the pipeline. The excess water will then become return-flow or "decant" water. The discharge of the decant water will occur via an existing stormwater outfall pipe located adjacent to the outboard levee.

Once sediment placement is complete, the water management system (e.g., weirs, water control structures) will be dismantled and the existing outboard levee will be breached to allow full tidal exchange with San Pablo Bay. The Corps will monitor the project for 13 years post-breach and conduct any required maintenance after which the SCC will continue to monitor the development of the wetlands and maintain the site.

Sources of Dredged Material

18. Dredged material for the wetland restoration project is anticipated to come from the Oakland Harbor Navigation Improvement (Port of Oakland 50-Foot Project) as well as other sources. The Port of Oakland 50-Foot Project is a congressionally authorized (Water Resources Development Act of 1999) dredging project to deepen channels of the Oakland Harbor and port-maintained births to a depth of 50 feet below mean lower low water. The Port of Oakland material is primarily Merritt sands, loose, well-sorted fine to medium-grained sand with silt. Other sources of dredged material include San Francisco Bay federal maintenance projects such as the Oakland Harbor, Richmond Harbor, Pinole Shoal Channel, Redwood City Harbor, and Petaluma River Across the Flats Channel; and non-federal permitted projects such as the Bel Marin Keys Community Services District, Larskpur, Chevron, and others.

Dredged Material Testing

19. All dredging in the Bay Area is regulated by the agencies that make up the Dredged Material Management Office (DMMO). The project will adhere to testing requirements set forth by the DMMO. Sediments must be analyzed for contaminants prior to approval of each dredging project. The Discharger and Water Board will review sediment testing data from pending dredging projects to evaluate their conformity with the Dredged Material Acceptance Criteria (DMAC) given in this Order's Specification B.4. The Water Board intends to make sediment recommendations available to the public via the DMMO. The Port of Oakland material was evaluated in 1998 in anticipation of its use for constructing wetlands and it was found to be suitable (Letter from Corps to Port of Oakland, dated December 9, 1998). It will not be reevaluated for its suitability as part of this Order.

Water Quality Concerns

20. Dredged material approved for beneficial reuse at the project from the various sources identified in Finding 18, has been or will be characterized during the pre-dredge testing phase and must be shown to meet DMAC to be suitable for placement in the biologically active zone (the layer of sediment where most organisms live and/or feed). Impacts to water quality resulting from dredged material placement at the site are expected to be mostly related to the potential for suspended solids in the decant water causing excess turbidity in the vicinity of the discharge point.

    The pollutants of concern in the dredge slurry are expected to be bound to suspended sediment particles. Effluent limitations for total suspended solids (TSS) and/or turbidity can be used as surrogate parameters for the quality of the decant water. To achieve desired effluent water quality, the mean residence time in the final settling basin must be greater than the time required for solids to settle out of suspension. The Self-Monitoring Program attached to this Order requires monitoring the dredged material decant water continuously for TSS and periodic monitoring for other water quality parameters, prior to and during discharge into San Pablo Bay.

21. **Mercury methylation:** Mercury occurs naturally in the San Francisco Bay environment and has been introduced as a contaminant in various chemical forms from a variety of anthropogenic sources. Ambient levels of sediments in San Francisco Bay are elevated in total mercury above naturally occurring background levels. Although mercury often resides in forms that are not hazardous, it can be transformed through natural processes into toxic methylmercury. Natural accretion processes in salt marshes continually supply fresh layers of sediment that release mercury in a form that can become biologically available for mercury-methylating bacteria. The resulting concentration of methylmercury is dependent on numerous variables: salinity, pH, vegetation, sulfur, dissolved organic carbon, redox potential, and seasonal variations in each of the identified variables.

    Placement of dredged material at Hamilton for restoration purposes has the potential to increase the availability of mercury for methylation. However, it is not clear at this time whether the act of placement causes more methylation than the natural methylation processes. In addition to dredged material placement, natural sedimentation occurring from sediments brought in on the tides from nearby Novato Creek or San Pablo Bay may also provide a source of mercury that may be methylated in the HWRP. Although models are being developed to address these issues, it is not currently possible to estimate the methylmercury concentrations, bioaccumulation, and biomagnification in the food chain. The potential for increased methylmercury production is identified as a significant unavoidable impact of the project (HWRP SEIR 2002). The project will develop an overall wetland monitoring and adaptive management plan (MAMP), an element of which will address concerns about the potential for methymercury to impact beneficial uses. The MAMP is required in Provision E.7 of this Order.

22. **Mosquito abatement:** Of the wetland habitats in the project areas, only brackish marsh and seasonal wetlands are considered to have the potential to produce problem numbers of mosquitoes. The HWRP is in the jurisdiction of the Marin Sonoma Mosquito Abatement District (District). The project is coordinating with the District during the design, implementation and operation phases of the project to mitigate for any increases in potential mosquito breeding habitat at the site (HWRP EIR 1998).

Construction Sequencing

23. The full restoration of tidal wetlands is estimated to take 30 years. Initial site construction is estimated to take 6-8 years to complete and would end with the breaching of the outboard levee. Site construction tasks are provided in the Table below.

Project Tasks through Levee Breach in 2014.

Completed Tasks
A. Installation of the outboard marsh pipeline
B. Demolition of majority of abandoned buildings on the Army and Navy parcels.
C. Construction of the Bulge Levee and Pacheco Pond Levee.

D. Removal of soils with low level of PAHs and DDT from the tidal wetland area to the planned seasonal wetland in the panhandle area. This work was required under Board Order R2-2003-0076 and the 2003 RAP/ROD and was completed in February 2005.
Planned 2005 Tasks
E. Construction of the N-1 Levee and Containment Berm – Receive Port of Oakland and Bel Marin Keys Community Services District dredged material.
F. Construction of the Intertidal Berms, Wildlife Corridor Berm and Settling Basin #1.
G. Sampling and characterizing the outboard levee.
Planned 2006 – 2013 Tasks
H. Construction of the South Levee in the tidal wetland area. Demolition work to remove some revetments and part of the main runway.
I. Relocating the Novato Sanitary District (NSD) dechlorination facility. NSD will construct the replacement facility in May 2006.
J. Construction of the N-2 levee and all remaining site features in the planned tidal wetland area. Placement of dredged material in the tidal area.
K. Completion of the seasonal wetland in the panhandle area, including placement of dredged material.
L. Construction of the seasonal wetland in the Navy parcel, including placement of dredged material.
Planned 2014 Tasks
M. Lowering the outboard levee, cutting a channel through the outboard marsh and breaching the outboard levee for the primary channel. This work also includes the removal of the pump houses.

24. Sediment placement is planned to start with placement of sandy materials from the Port of Oakland 50-Foot Project in the seasonal wetland area. The Bel Marin Keys Community Services District may request placement of dredged materials from Novato Creek and/or the North Lagoon in 2005-2006 as well. The HWRP site is large enough to start dredged material placement before the end of all site preparation. There are approximately two to three years of overlap in which dredged material will be placed in the northern area of the site while the southern area of the site will be prepared for the subsequent placement of additional dredged material.

25. The channel breach is the last step in the construction and will consist of the following steps: (1) excavating a channel in the outboard marsh leading up to the breach, (2) lowering the outboard levee and (3) excavating the breach. The outboard levee will be breached at the location shown in Figure 7. Levee Breach may occur within 8 years, despite less placement of dredged material than the 7.1 million cubic yards planned, with the Executive Officer's approval as required in Specification B.3 of this Order. Breaching would occur in order to ensure that marsh establishment is not delayed. When it is breached, most of the outboard levee on the airfield would be lowered to an elevation similar to the elevation of the marsh plain adjacent to the levee.

26. After the breach of the levee it is anticipated that the following would occur:
    a. Natural sediment accretion to mean high water level (year 7 through year 11)
    b. Development of mean high water marsh plain (year 12 through year 21), and
    c. Development of mean higher high water marsh plain (year 17 through year 31).

Off-Loader and Barge Facility Details

27. The current off-loader system design includes the off-loader, main off-loader barge and 6 adjacent mooring and fleeting barges. One or two booster pump barges will be required to pump material onto the site. The off-loader system with 2 booster pump barges will be placed in water depths of approximately –28 feet MLLW. The off-loader and barge facility will be anchored by steel piles or dolphins (pile clusters). The first 2,000 feet of pipeline adjacent to the off-loader will be floating. Portions of the rest of the planned pipeline will be anchored to prevent floating or movement that might occur when the pipeline is not in use. Anchoring will be accomplished using weighted collars or similar anchorage method. The off-loader would be powered by electricity from shore, or by onboard diesel powered equipment, or a combination of both, and could be in operation for as long as 8 years.

Impacts to Navigation, Fisheries and Water Quality from Off-Loader

28. The off-loader and barge facility is located north of the main San Pablo Bay Straits ship channel where there should not be any impacts to large deep draft vessels using the main ship channel. Smaller draft commercial and recreational vessels have ample room to navigate around the off-loader. The floating portion of the pipeline will be lighted as will the off-loader facility to prevent navigation accidents.

    The off-loader will likely be built on piles that are driven into bay mud. Pile-driving equipment may produce localized noise that may affect listed fish species and marine mammals in areas immediately adjacent to San Pablo Bay. Construction of the off-loader may result in mortality of individual fish and harassment of individual marine mammals present in the immediate vicinity of pile-driving activity (HWRP SEIR 2002). The Discharger will consult with NOAA Fisheries regarding the planned pile driving and implement the appropriate mitigation measures to reduce impacts by either decreasing the level of underwater sound or decreasing the number of fish exposed to the sound.

In order to prevent entrainment and impingement of fish and other aquatic organisms at the off-loader, the intake pump placed in San Pablo Bay will have a mesh size of 3/32 inches and an approach velocity of 0.33 feet per second.

Implementation of the project would not result in a measurable change in tidal fluctuation or salinity of waters in San Pablo Bay (HWRP EIR 1998).

Decant Water Discharge Description

29. The decant water discharge point is located adjacent to the levee at the existing pump station outfall location. Currently, stormwater from the inboard residential and runway areas is pumped over the levee into San Pablo Bay. Figure 7 shows the location of the discharge point. The discharge will be via a single 30-inch diameter pipe.

Decant Water Discharge Water Volumes

30. For 2005 to 2006, it is expected that 0.75 to 2.5 million cubic yards (MCY) of fine sand and fine-grained dredged material from the Port of Oakland 50-Foot project will be placed at the HWRP. Additionally 250,000 to 350,000 cubic yards of fine-grained dredged sediments from the Bel Marin Keys Community Service District may be delivered to the site in fall 2005 and early 2006. It is anticipated that fine-grained dredged material from navigation projects will be brought to Hamilton in subsequent years; on average about 1 to 2 million cubic yards of sediments that are dredged from San Francisco Bay for navigational purposes each year would be available to Hamilton.

For each 1.0 MCY of dredged material imported into the project, 3 to 20 MCY of process water will be required to slurry and transport the material via pipeline based on a solids ratio of 5% to 20%; sand requires a greater process water volume than fine-grained materials. The process water to create the slurry will be imported from San Pablo Bay at the location of the off-loader. This water will be decanted and released in a nearly continuous process. It is estimated that the rate of discharge will be about 20 cubic feet per second (cfs) (HWRP EIR 1998 and HWRP 2005 Permit Application) or about 20 million gallons per day, but no more than a maximum discharge rate of 50 cfs or 33 million gallons per day.

Decant Water Discharge Management

31. The off-loading of dredged material involves mixing the material with Bay water to form a mixture that could be as high as 95 percent water and 5 percent solids to allow pumping of the slurry mixture onto the site. In practice, the dredged material slurry will likely vary from 5% to 25% solids and 95% to 75% bay water. The dredged material slurry will be pumped through a pipeline in San Pablo Bay to a connecting 30-inch existing steel pipeline across the Hamilton Coastal Salt Marsh and onto the former airfield via a flexible plastic pipeline. The water will be contained in primary settling ponds using containment cells and will then be discharged into secondary settling ponds to clarify the water prior to discharge to San Pablo Bay (refer to Figure 7). One of the planned secondary settling ponds, currently referred to as Nina's Pond, was a borrow pit for the Hamilton Landfill 26 cap. This Order's Self Monitoring and Reporting Program requires

the Discharger to monitor at any secondary settling basin weir, or if none, at the weir of a containment cell and at the receiving water. A portion of the area planned for tidal marsh restoration may be used as one large containment cell that drains to a secondary settling pond close to the point of discharge for the decant water.

The discharge rate is anticipated to be on average about 20 million gallons per day with a maximum rate of 33 millions gallons per day. Temporary portable pumps will also be utilized whenever necessary to pump excess water from the perimeter drainage ditch or for recirculating water to use for soil conditioning of the imported dredged material. The dredged material will need to be kept wet to prevent drying and cracking. The adjustable discharge weirs from the containment cells and the secondary settling ponds will be designed to release only the upper portion of the water column to maximize fine particle settlement. The adjustable weirs will control the water elevation of the cells or secondary ponds prior to discharge.

Non-decant Water Management

32. Stormwater drains from 600 acres of adjacent property: the Landfill 26 and Reservoir Hill areas, housing subdivisions and other former HAAF property. Stormwater from the housing subdivisions is lifted onto the site via two pump stations. Total surface water flows were calculated at about 390 acre-feet per year or 128 million gallons per year (HWRP EIR 1998). Mean annual rainfall at the site is approximately 26 inches. This amount of surface water is small compared to the amount of water expected from the dredged material slurry. The Discharger will manage these stormwater flows during construction of the project, and the project is being designed to handle these flows after the wetlands are created. Post-construction, the water will be conveyed via swales to the tidal wetland. In addition, a pump station to be operated by the City of Novato will be built to drain the runoff from Landfill 26 and adjacent areas.

Local Flood Conditions

33. The flood control and drainage facilities in the airfield parcel previously affected the hydrologic characteristics of surrounding properties, including the New Hamilton Partnership development, the St. Vincent's and Las Gallinas Sanitary District properties, Bel Marin Keys Unit V, Landfill 26, Ignacio Reservoir, and the SLC parcel. Currently the airfield receives drainage only from New Hamilton Partnership development, Landfill 26, and the SLC parcel. Protection of these lands from inundation by San Pablo Bay requires interim site drainage activities and construction of a system of new perimeter levees.

The project will continue to operate the existing drainage pumps and/or supply other drainage pumps until all the perimeter levees are constructed. The project is also designing the seasonal wetland areas to continue to receive all the current drainage waters and pass them into the tidal wetland areas.

Applicable plans, policies and regulations

34. Basin Plan: The Board adopted a revised Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) on January 21, 2004. This updated and consolidated plan represents the Board's master water quality control planning document. The State Water Resources Control Board and the Office of Administrative Law approved the revised Basin Plan on July 22, 2004, and October 4, 2004, respectively, and the U.S. Environmental Protection Agency, Region IX approved it on January 5, 2005. A summary of regulatory provisions is contained in 23 CCR 3912. The Basin Plan defines beneficial uses and water quality objectives for waters of the State, including surface waters and groundwater. The Basin Plan also identifies discharge prohibitions intended to protect beneficial uses.

35. California Toxics Rule: On May 18, 2000, the U.S. EPA published the *Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California* (Federal Register, Volume 65, Number 97, 18 May 2000). These standards are generally referred to as the CTR. The CTR specified water quality criteria (WQC) for numerous pollutants, of which some are applicable to the discharges covered by this Order.

36. Beneficial Uses: The potential beneficial uses of groundwater underlying and adjacent to the site include:

    - Industrial process water supply
    - Industrial service water supply
    - Agricultural water supply
    - Municipal and Domestic Supply
      (Deeper aquifers only; shallow zones are brackish)

    The existing and potential beneficial uses of San Pablo Bay and its tributaries include:

    - Industrial process supply or service supply
    - Water contact and non-contact recreation
    - Wildlife habitat
    - Fish migration and spawning
    - Navigation
    - Estuarine habitat
    - Shellfish harvesting
    - Preservation of rare and endangered species
    - Ocean, commercial and sport fishing

37. State Wetland Policy: This project is consistent with the Basin Plan Wetland Fill Policy that establishes that there is to be no net loss of wetland acreage and no net loss of wetland value when the project and any proposed mitigation are evaluated together, and that mitigation for wetland fill projects is to be located in the same area of the Region.

38. This project is also consistent with the goals of the following components of State Wetlands Policy: California Wetlands Conservation Policy (Executive Order W-59-93, signed August 23, 1993) includes ensuring "no overall loss" and achieving a "...long-term net gain in the quantity, quality, and permanence of wetland acreage and values...." Senate Concurrent Resolution No. 28 states that "it is the intent of the legislature to preserve, protect, restore, and enhance California's wetlands and the multiple resources which depend on them for benefit of the people of the State." Section 13142.5 of the CWC requires that the "[h]ighest priority shall be given to improving or eliminating discharges that adversely affect...wetlands, estuaries, and other biologically sensitive areas."

39. Comprehensive Conservation and Management Plan: The HWRP is consistent with the objectives of the (CCMP, 1993) for the San Francisco Estuary, including, creation of wetland resources and the reuse of dredged material for projects such as wetlands creation/restoration, and upland building material, where environmentally acceptable.

40. Long Term Management Strategy for dredged material disposal (LTMS): The HWRP is consistent with the goals of LTMS. The LTMS programmatic EIS was signed in July 1999 committing the Corps to implement beneficial reuse options in order to decrease in-Bay disposal of dredged material. The LTMS agencies (Corps, Water Board, USEPA, BCDC) signed the LTMS Management Plan in January 2002, which identified the HAAF site as one that was found to be highly feasible for beneficial reuse of dredged material.

41. San Francisco Bay Area Wetlands Ecosystem Goals Project: The HWRP is consistent with the recommendations of the 1999 Goals Report for restoration of a wide, continuous band of tidal marsh along the bay front between Black Point and Gallinas Creek ... and to ensure a natural transition to uplands throughout and provide an upland buffer outside the baylands boundary.

California Environmental Quality Act (CEQA)

42. The California Environmental Quality Act (CEQA) requires all projects approved by State agencies to be in full compliance with CEQA. The SCC, as lead agency, prepared and certified a Final Environmental Impact Report/Environmental Impact Statement (HWRP EIR) for this project in December 1998, a July 2002 Supplemental Environmental Impact Report/Environmental Impact Statement (HWRP SEIR) and a May, 2003 Supplemental Environmental Impact Report/Environmental Impact Statement (BRAC SEIR) required for the final remedial actions associated with the property transfer. The Water Board considered the environmental impacts of the project as shown in the HWRP EIR, BRAC SEIR and HWRP SEIR. The HWRP SEIR identified two significant unavoidable impacts that could not be mitigated for: 1) The potential for increased methylmercury production is identified as a significant unavoidable impact of the project (HWRP SEIR 2002); 2) Construction of the off-loader may result in mortality of individual fish and harassment of individual marine mammals due to pile-driving activity. The Water Board agrees that these significant impacts are unavoidable but has determined that the benefits of the project outweigh these unavoidable adverse environmental effects and are thus considered acceptable. As the responsible agency, the Water Board has the authority and responsibility to require additional mitigation

measures within its powers to impose. The Water Board finds that the Discharger shall consult with NOAA Fisheries to lessen the significant unavoidable impact of pile driving for the off-loader facility. Other than these two impacts, all other significant impacts identified under CEQA have been mitigated to less than significant levels.

Additional Findings

43. The following standard conditions apply to this Order:

    a. Every certification action is subject to modification or revocation upon administrative or judicial review, including review and amendment pursuant to CWC §13330 and 23 CCR §3867.

    b. Certification is not intended and shall not be construed to apply to any activity involving a hydroelectric facility and requiring a Federal Energy Regulatory Commission (FERC) license or an amendment to a FERC license unless the pertinent certification application was filed pursuant to 23 CCR §3855(b) and that application specifically identified that a FERC license or amendment to a FERC license for a hydroelectric facility was being sought.

    c. Certification is conditioned upon total payment of any fee required pursuant to 23 CCR §3833 and owed by the Discharger.

44. An annual fee for Waste Discharge Requirements pursuant to Section 13260 of the California Water Code is required.

Notification and Public Notice

45. The Water Board notified the Discharger and interested agencies and persons of its intent to issue waste discharge requirements and provided them with an opportunity to submit their written views and recommendations.

46. The Board, in a public meeting, heard and considered all comments pertaining to the proposed waste discharge requirements for the project.

It Is Hereby Ordered pursuant to the provisions of Division 7 of the California Water Code and regulations, and guidelines adopted thereunder, that the Discharger, its agents, successors, and assigns shall comply with the following:

A. PROHIBITIONS

1. It is prohibited to discharge decant water at a location or in a manner different from that described in the findings of this Order.

2. Discharges of water, materials, or wastes other than decant and return flow-water, which are not otherwise authorized by this Order, are prohibited.

3. The direct discharge of wastes to surface waters or surface water drainage courses is prohibited, except as authorized in this Order.

4. The activities subject to these requirements shall not cause a condition of pollution or nuisance as defined in Sections 13050 (l) and (m), respectively, of the California Water Code.

B. SPECIFICATIONS

1. Appropriate soil erosion control measures shall be undertaken and maintained to prevent discharge of sediment to surface waters or surface water drainage courses. Appropriate erosion control measures shall be taken to stabilize and prevent erosion from the outsides of perimeter containment berms. Dredged material shall be fully contained to prevent any wind transport, surface runoff or erosion into waters of the state. At no point within the containment areas shall there be erosion of underlying contaminated site soils requiring cover under the RAP/ROD nor shall the elevation of sediment exceed that of the containment berms.

2. The integrity of the dredged material transport pipeline shall be maintained from the intake at the dredged material offloading facility in San Pablo Bay to the point of discharge at the project site. At no point other than the designated discharge point shall water or sediment be allowed to leak from or be intentionally released from the pipeline. The Discharger shall notify the Water Board immediately of any failure occurring in the dredged material transport pipeline.

3. Levee breach shall not occur until approval by the Executive Officer of the technical report required under Task 7 of Board Order No. R2-2003-0076. The Technical report shall be submitted at least 60 days prior to the planned levee breach.

4. Dredged Material Acceptance Criteria: Data characterizing the quality of sediments proposed for placement at the project site shall be submitted for Water Board review and approval prior to placement. This review shall be coordinated through the multi-agency DMMO, of which the Water Board is a member. Sediment characterization shall follow the protocols specified in:

   a. The DMMO guidance document, "Guidelines for Implementing the Inland Testing Manual in the San Francisco Bay Region" (U.S. Army Corps of Engineers Public Notice 01-01, or most current version) with the exception that the water column bioassay simulating in-bay unconfined aquatic disposal shall be replaced with the modified effluent elutriate test, as described in Appendix B of the Inland Testing Manual, for both water column toxicity and chemistry (DMMO suite of metals only); and,

   b. Water Board May 2000 staff report, "Beneficial Reuse of Dredged Materials: Sediment Screening and Testing Guidelines," or most current revised version.

   Modifications to these procedures may be approved on a case-by-case basis. The dredged material acceptance criteria (DMAC) for wetland surface (cover) reuse shown in the following table shall be used to screen prospective dredging projects for placement of material at the HWRP site. If any pollutant chemical

concentration in the pre-dredge sediment samples exceeds the screening values, the Discharger may submit a technical report to the Executive Officer, at least 60 days prior to proposed placement of dredged material, demonstrating the Discharger's ability to comply with all other requirements of this order and demonstrating that the material is unlikely to impact beneficial uses.

HWRP Dredged Material Acceptance Criteria

Constituent	**Wetland Surface (Cover) Material**
Metals:	**mg/kg**
Arsenic	15.3
Cadmium	1.2
Chromium	112
Copper	68.1
Lead	43.2
Mercury	0.43
Nickel	112
Selenium	0.64
Silver	0.58
Zinc	158
Organochlorine Pesticides & PCBs:	**µg/kg**
DDTs, sum	7.0
Chlordanes, sum	2.3
Dieldrin	0.72
PCBs, sum	22.7
Polycyclic Aromatic Hydrocarbons:	**µg/kg**
PAHs, Total	3,390

5. In accordance with Section 13260 of the California Water Code, the Discharger shall file with the Board a report of any material change or proposed change in the character, location, or quantity of this waste discharge. For the purpose of these requirements, this includes any proposed change in the boundaries of the dredged material placement areas or the ownership of the site. Any proposed material change in the operation shall be reported to the Executive Officer at least 7 days in advance of implementation of any such proposal.

6. The responsible representative of the Discharger shall immediately notify the Board by telephone whenever an adverse condition occurs as a result of this discharge. An adverse condition includes, but is not limited to, a violation or threatened violation of the conditions of this Order, significant spill of petroleum products or toxic chemicals, or danger to control facilities that could affect compliance. Pursuant to Section 13267(b) of the California Water Code, a written notification of the adverse condition shall be submitted to the Board within five days of the occurrence. The written notification shall identify the adverse condition, describe the actions necessary to modify the condition, and specify a timetable subject to the modification of the Board, for the remedial actions.

7. The Discharger shall consult with NOAA Fisheries regarding the planned pile driving at the off-loader facility and implement the appropriate mitigation measures to lessen the impacts to fish.

C. EFFLUENT LIMITATIONS

1. Dredged material effluent (decant water) discharged from any point within the beneficial reuse or restoration site shall not exceed the following limits:

Parameter	Limitation	Source
pH	6.5 – 8.5	Basin Plan
Dissolved Sulfide	0.1 mg/L	Basin Plan
Total Suspended Solids (TSS)	Less than 100 mg/L (90% of the time) Less than 50 mg/L (50% of the time)	Based on Regional Monitoring Program measurements of San Pablo Bay background for TSS collected between 1993 and 2001 at the closest sampling station.

D. RECEIVING WATER LIMITATIONS

1. The placement of sediments and/or decant water shall not cause the following conditions to exist in waters of the State at any place:
    a. Floating, suspended or deposited macroscopic particulate matter or foam;
    b. Visible floating, suspended, or deposited oil or other products of petroleum origin;
    c. Bottom deposits or aquatic growths to the extent that such deposits or growths cause nuisance or adversely affect beneficial uses; and
    d. Alteration of temperature, turbidity, or apparent color beyond present natural background levels.

e. No toxic or other deleterious substances shall be present in concentrations or quantities which may cause deleterious effects on aquatic biota, wildlife or waterfowl, or which render any of these unfit for human consumption either at levels created in the receiving waters or as a result of biological concentrations.

2. The placement of dredge material or discharge of decant water shall not cause the following limits to be exceeded in waters of the State at any point:

a.	Dissolved Oxygen:	5.0 mg/l minimum. When natural factors cause lesser concentrations, then this discharge shall not cause further reduction in the concentration of dissolved oxygen.
b.	Dissolved Sulfide:	0.1 mg/l maximum.
c.	pH:	A variation of natural ambient pH by more than 0.5 pH units.
d.	Un-ionized Ammonia:	0.025 mg/L as N, annual median; and 0.16 mg/L as N, maximum.
e.	Total Dissolved Solids:	The project shall not increase total dissolved solids or salinity to adversely affect beneficial uses.

3. Turbidity shall not exceed the background of the Waters of the State, as measured in NTU, as follows:

Receiving Water Background	Incremental Increase
< 50 units	5 units, maximum
> 50 units	10% of background, maximum

4. The discharge shall not cause a violation of any particular water quality standard for receiving waters adopted by the Board or the State Board as required by the Clean Water Act and regulations adopted hereunder. If more stringent applicable water quality standards are promulgated or approved pursuant to Section 303 of the Clean Water Act, or amendments thereto, the Board will revise and modify this Order in accordance with such more stringent standards.

E. PROVISIONS

1. All technical and monitoring reports required pursuant to this Order are requested pursuant to Section 13267 of the California Water Code. Failure to submit reports in accordance with schedules established by this Order or attachments to this Order, or failure to submit a report of sufficient technical quality acceptable to the Executive Officer may subject the Discharger to enforcement action pursuant to Section 13268 of the California Water Code.

2. The Discharger shall comply with all Prohibitions, Specifications, and Provisions of this Order immediately upon adoption of this Order, unless otherwise specified. All required submittals must be acceptable to the Executive Officer.

3. The Discharger must comply with all conditions of these waste discharge requirements. Violations may result in enforcement actions, including Board orders or court orders requiring corrective action or imposing civil monetary liability, or in modification or revocation of these waste discharge requirements by the Board (CWC Sections 13261, 13267, 13263, 13265, 13268, 13300, 13301, 13304, 13340, 13350).

4. **Self-Monitoring Program**: The Discharger shall comply with the Self-Monitoring and Reporting Program (SMP) attached to this Order (Part A and Part B), and as may be amended by the Executive Officer. The Discharger shall submit an annual self-monitoring report **by March 1 of each year**. The SMP may be amended by the Executive Officer in response to a written request by the Discharger, or as necessary to assure collection of information to demonstrate compliance with this Order.

   Due Date: The First Annual Self-Monitoring Report shall be submitted by March 1, 2006.

5. **Site Operation Plan:** The Discharger shall submit an Operation Plan, acceptable to the Executive Officer, detailing ongoing operations for the site. This Operation Plan shall describe site operations and procedures to be followed before, during, and after dredged material placement, including a contingency plan to be implemented in the event that monitoring conducted according to the attached Self-Monitoring Program shows one or more exceedances of the limits for pollutants listed under this Order's Effluent Limitations Section C. The Plan shall specifically state how site operations will be adjusted to comply with the decant water discharge limits. The Operation Plan shall also include an analysis of the following:

   a. Settling basin design and operation, including sediment/water holding capacity of containment cells and settling basins and overall water balance analysis,
   b. Off-loader and associated pipeline operations and maintenance,
   c. Placement of the off-loader electrical power line,
   d. A description of the management of all sources of surface water runoff including, the Southern Seasonal Wetland, adjacent residential areas, Landfill 26, State Lands Commission parcel and the City of Novato property,
   e. An analysis of the potential impacts of the discharge on the existing coastal salt marsh,
   f. Closure of existing storm water control features,
   g. Timing and quality of discharge from Nina's Pond prior to sediment placement,
   h. Abatement plans for mosquitoes and any other potential nuisances,
   i. Bel Marin Keys Community Services District dredged material placement and decant water management, and
   j. Emergency procedures for potential risks, including pipeline breaks and levee failures.

   The Operation Plan shall be reviewed annually, and updated as necessary, and within 90 days of completion of any significant facility or process changes. Annual updates

shall be due one month after the start of construction of the following year, and each year thereafter. The Discharger shall submit proposed changes to the Plan, acceptable to the Executive Officer along with a detailed discussion of the status of site operations. The annual update shall include an estimated time schedule for completion of any revisions determined necessary, a description or copy of any completed revisions, or a statement that no revisions are needed.

Due Date: 60 days Prior to Placement of any Dredged Material at the Site

6. **Erosion and Sediment Control Plan:** The Discharger shall submit annually an update of the Stormwater Pollution Prevention Plan (SWPPP), acceptable to the Executive Officer. The Plan shall include a stormwater discharge monitoring program.

   Due Date: Prior to October 15 of the year of Construction or at least 60 Days Prior to Intent to Construct

7. **Wetlands Monitoring and Adaptive Management Plan (MAMP):** The Discharger shall submit a plan, acceptable to the Executive Officer, that provides a detailed description of procedures for monitoring and assessing, using specific performance criteria, the overall success of the wetland restoration at the site. The performance criteria should address the elements listed in the attached Table 2, including but not limited to, tidal marsh development, tidal channel formation, biological success (plant and animal colonization), use by endangered species, and control of invasive species colonization. A technical advisory team comprising staff from agencies including the Water Board will be created to review the status of the project and advise on the need for changes to the monitoring or adaptive management strategy. Annual reports detailing the progress of the HWRP shall be sent to the Water Board and presented annually to agencies and interested parties in a forum such as the Wetland Monitoring Group under the San Francisco Wetland Restoration Program or some other forum for input and feedback on the project's progress and adaptive management strategies.

   One important element of the Wetlands Monitoring and Adaptive Management Plan is a Methylmercury Adaptive Management Plan. This shall include a discussion of the following:

   a. Background and concerns posed by mercury and methylmercury relative to restoration of the site
   b. Monitoring objectives and strategy
   c. Specifics of Monitoring Plan

   Due Date: June 1, 2006

8. **Public Participation Plan:** The Discharger shall submit a plan, acceptable to the Executive Officer, that describes how the public will be kept informed of activities conducted as part of the HWRP and how the Discharger will respond to inquiries, including complaints from concerned citizens. At a minimum, the Discharger shall hold a public meeting every year at an appropriate location in the City of Novato at a time and place most convenient to the public. Adequate public notice shall be given to the public through a dedicated mailing list, postings and newspaper announcements and copied to the Water Board. The purpose of the meeting shall be to give the public

and agency staff an update on the activities of the project, any changes to the project that have occurred in the previous year and the anticipated work in the coming months.

Due Date: 60 Days from the Date of this Order

9. **Levee Breach Plan:** The Discharger shall submit a plan, acceptable to the Executive Officer, that provides a detailed description of the plan to breach the levee including a discussion of the completion of all activities required under Board Order R2-2003-0076. Board Order R2-2003-0076 requires submission of a technical report, acceptable to the Executive Officer, documenting implementation of the required remedial and environmental actions, 60 days prior to conducting work on the outboard levee breach.

Due Date: 60 days Prior to work on Levee Breach

10. **Decant Water Monitoring Plan:** The Discharger shall submit a Decant Water Monitoring Plan acceptable to the Executive Officer that describes how the Discharger will comply with the requirements set forth in the SMP attached to this Order. The plan shall include a description of how the Discharger will continuously monitor turbidity, DO and pH at the discharge point from the settling basins. The plan shall also describe how the turbidity meters will be calibrated to estimate total suspended solids and describe methods for collecting and analyzing decant water grab samples.

Due Date: At least Three months Prior to Dredged Material Placement at the Site

11. **Quality Assurance Project Plan:** The Discharger shall submit a technical report that is acceptable to the Executive Officer that contains a site-specific Quality Assurance Project Plan (QAPP). The QAPP will outline the collection of soil and water samples, analysis of the samples for chemical constituents of concern, and reporting of the results. The QAPP will specifically address project organization, quality assurance objectives, sampling procedures, sample handling and custody, laboratory analyses and quality control procedures, audits, corrective action, data reduction, management, reporting and validation.

Due Date: At least Three Months Prior to Commencement of Sediment Placement

12. The Discharger shall notify the Executive Officer immediately whenever violations of this Order or the Self Monitoring and Reporting Program are detected. A follow-up written report is due within 15 days of any violation.

13. All reports following these Provisions shall be prepared under the supervision of a registered civil engineer or certified engineering geologist.

14. The discharge of any hazardous waste, as defined in Title 23, Chapter 15 of the California Administrative Code, to the site is prohibited.

15. Only dredged material that has been demonstrated to be non-hazardous and meets the applicable guidelines and criteria specified in this Order may be discharged.

16. Dredged material not meeting the conditions specified in the above Specification B.4 shall not be discharged until and unless a written approval of the discharge has been issued by the Executive Officer.
17. The Discharger shall remove and relocate any wastes that are discharged at this site in violation of these Requirements.
18. The odor from the dredged material placement shall not cause a nuisance.
19. The Discharger shall maintain all devices or designed features installed in accordance with this Order such that they function without interruption for the life of the operation.
20. The Discharger shall implement corrective actions described in the approved Site Operation Plan (see Provision 5) if routine monitoring indicates that there is a potential threat to water quality.
21. The Discharger shall maintain a copy of this Order at the site to be available at all times to site operating personnel.
22. The Discharger shall permit the Board or its authorized representative, upon presentation of credentials:
    - Entry on to the premises on which wastes are located or in which records are kept.
    - Access to copy any records required to be kept under the terms and conditions of this Order.
    - Inspection of any treatment equipment, monitoring equipment or monitoring method.
    - Sampling of any discharge or surface water covered by this Order.
23. This Order does not authorize commission of any act causing injury to the property of another or of the public; does not convey any property rights; does not remove liability under federal, state or local laws, regulations or rules of other programs and agencies nor does this Order authorize the discharge of wastes without appropriate permits from other agencies or organizations.
24. This Order supercedes Provision 5.b of Order 96-113, pertaining to mitigation for wetland impacts at the site due to the placement of a landfill cap on an adjacent property, as described in Finding 9 of this Order. In the event that the wetland design changes materially from what was proposed in the permit application, the Board may consider revision of this Order to address mitigation for wetland impacts.

Review and Modification of Requirements

The Board shall review the waste discharge requirements in this Order periodically, and may modify this Order under, but not limited to, any of the following circumstances:

a. If present or future investigations demonstrate that the discharge(s) governed by this Order might have adverse impacts on water quality and/or beneficial uses of the receiving waters; or

b. New or revised water quality objectives come into effect for the San Francisco Bay estuary and contiguous water bodies (whether statewide, regional, or site-specific). In such cases, discharge limitations in this Order will be modified as necessary to reflect updated water quality objectives; or
c. Addition of adjacent parcels (Navy Ballfields, Bel Marin Keys Unit 5, SLC Parcel) to the HWRP.

I, Bruce H. Wolfe, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of an order adopted by the California Regional Water Quality Control Board, San Francisco Bay Region, on July 20, 2005.

BRUCE H. WOLFE
Executive Officer

Attachments:

Table 1 – Habitat Type Summary
Table 2 – Wetland Monitoring and Adaptive Management Plan Elements
Table 3 – Mitigation Measures

Figure 1. Location Map
Figure 2. Site Map
Figure 3. Plan View of the Planned Wetland
Figure 4. Panhandle Seasonal Wetland
Figure 5. Southern Seasonal Wetland
Figure 6. Wildlife Corridor Cross Section
Figure 7. Sediment Placement and Decant Water Management
Figure 8. Location Map of Off-loader in San Pablo Bay

Self-Monitoring Program (SMP) Part A and Part B

References

Bel Marin Keys Unit V Expansion of the Hamilton Wetland Restoration Project. Uncertified Final General Reevaluation Report and Final Supplemental Environmental Impact Report/Environmental Impact Statement (HWRP SEIR), April 2003. http://www.coastalconservancy.ca.gov/belmarin/index.html

Comprehensive Conservation and Management Plan, San Francisco Estuary Project, 1993.

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TABLES

Table 1. Habitat Type Summary - (Wetland Habitats Shown in Bold)

Landscape Elements	Impacted (acres)	Proposed-Mature Marsh (acres)
Open Water (perennial brackish pond, former borrow pit created for Landfill 26 closure)	**13**	0
Seasonal Wetlands (includes 12.4 acre Landfill 26 wetland mitigation site)	**19.5 (freshwater)**	**156**
Perennial Emergent Marsh – perimeter drainage ditch	**4**	0
Tidal marsh	**88**	**378 (created) plus 87 (existing)**
Grassland vs Wildlife Corridor (Upland transition & buffer)	259	34
Developed land, including levees	284	<30
Tidal Pannes		**13**
Total of wetland acres	**124.5**	**634**

Table 2. Wetland Monitoring and Adaptive Management Plan Elements

Plan Element	Frequency/Duration
Marsh Water/Sediment Quality	To be proposed (Provision 7)
Methylmercury Adaptive Management Plan	To be proposed (Provision 7)
Levee Dimensions	Visual walkover inspection twice annually (pre and post winter conditions). Annual field survey until design expectations met.
Post Construction Fill Elevation	Prior to breach
Sediment Deposition Rates	To be proposed (Provision 7)
Sediment Deposition patterns	To be proposed (Provision 7)
Channel Geometry	To be proposed (Provision 7)
Tide Elevations (determine tidal regime and prism)	To be proposed (Provision 7)
Peninsula Crest Elevation	To be proposed (Provision 7)
Marsh Development- physical parameters (hydrology, topography/bathymetry) Biological parameters (plant and animal life)	Annual for first five years. Then every five years until design expectations met. Locations: tidal wetland interior; tidal wetland perimeter; subtidal channels, existing SP Bay marsh shoreline
Vegetation	Annual for first five years. Then every two years until established.
Bird Use	Periodic surveys
Fish Use	Ongoing surveys
Mammal Use	Periodic surveys
Endangered Species Use	Periodic surveys
Benthic Macroinvertebrates	Additional surveys later if site deficiencies arise
Seasonal Wetland/Upland Vegetation	Field surveys
Invasive Species Monitoring	Non-native plant assessment by qualified botanist
Exterior Tidal Channels	Monitor geometry periodically
Internal Channel Development	Map from aerial photographs; transects

Table 3. Mitigation Measures

Impact	Significance Determination	Mitigation Measure	Significance Determination with Mitigation Incorporation
Water Quality			
Potential for Degradation of Surface Water and Sediment Quality due to Increased Methylmercury Formation Potential	Potentially Significant and Unavoidable	Mitigation Measures WQ-1: Implement Methylmercury Adaptive Management Plan	Potentially Significant
Potential Diesel Pump Spills into San Pablo Bay	Significant	Mitigation Measure WQ-2: Provide for Spill Protection at Offloader and at Booster Pump Facility	Less than Significant
Potential Changes to Circulation in Pacheco Pond	Significant	Mitigation Measure WQ-3: Incorporate Pacheco Pond Water Quality Concerns Regarding Circulation in New Water Management Plan, in Cooperation with MCFCWCD and CDFG.	Less than Significant
Potential for Degradation of Receiving Water Quality due to Dredged Material Placement	Significant	Mitigation Measure WQ-4: Develop and Implement Water Quality Monitoring Program for Dredged Material Placement.	Less than Significant
Potential for Spills from Fueling of Pump(s) at Pump Station	Significant	Mitigation Measure WQ-5: Provide for Spill Protection at Pump Station.	Less than Significant
Loss of drainage capacity from New Hamilton Partnership Development	Significant	Mitigation Measure: 5.1: Provide allowance for drainage similar to design specified for New Hamilton Partnership east outfall	Less than Significant

Impact	Significance Determination	Mitigation Measure	Significance Determination with Mitigation Incorporation
Changes in circulation and morphologic evolution in tidal wetland	Significant	Mitigation Measure 6.3: Ensure adequate tidal exchange and develop and implement a monitoring program to assess project evolution	Less than Significant
Public Health			
Increase of Potential Mosquito Breeding Habitat	Significant	Mitigation Measure PH-1: Coordinate Restoration Design and Expansion Activities with MSMAD	Less than Significant
Biological Resources			
Temporary Disturbance to the Northern Harrier, White-Tailed Kite, Golden Eagle, Cooper's Hawk, Sharp-shinned Hawk, Short-Eared Owl, Burrowing Owl, Saltmarsh Common Yellowthroat, and San Pablo Song Sparrow During Construction	Significant	Mitigation Measure BIO-1: Conduct Surveys to Locate Northern Harrier, White-Tailed Kite, Golden Eagle, Cooper's Hawk, Sharp-shinned Hawk, Short-Eared Owl, Burrowing Owl, Saltmarsh Common Yellowthroat, and San Pablo Song Sparrow Nest Sites Before Construction Is Initiated and Avoid Breeding Sites	Less than Significant
Potential for Construction-Related Mortality of Salt Marsh Harvest Mice	Significant	Mitigation Measure BIO-2: Remove Salt Marsh Harvest Mouse Habitat and Place Barrier Fencing in the Immediate Vicinity of Operating Equipment.	Less than Significant
Potential for Construction-Related Mortality of California Clapper Rails and California Black Rails	Significant	Mitigation Measure BIO-3: Avoid Operation of Equipment within 250 feet of the Outboard Tidal Coastal Marsh During the Breeding Period of the California Clapper Rail and California Black Rail	Less than Significant
Potential for Mortality of San Pablo Song Sparrows	Significant	Mitigation Measure BIO-4: Conduct Surveys to Locate San Pablo Song Sparrow Nest Sites before Construction Is Initiated and Avoid Breeding Sites	Less than Significant

Impact	Significance Determination	Mitigation Measure	Significance Determination with Mitigation Incorporation
Potential for Mortality of Burrowing Owls	Significant	Mitigation Measure BIO-5: Conduct Surveys to Locate Burrowing Owl Nest Sites before Construction Is Initiated and Avoid Breeding Sites	Less than Significant
Potential for Construction-Related Mortality of Outmigrating Salmonid Smolts	Significant	Mitigation Measure BIO-6: Avoid Construction that Could Affect Tidal Aquatic Habitats when Salmonid Smolts Could Be Present	Less than Significant
Potential Disturbance to or Mortality of Special-Status Species Resulting from Monitoring and Adaptive Management Activities	Significant	Mitigation Measure BIO-7: Develop and Implement a Restoration Monitoring and Adaptive Management Program Designed to Minimize Potential Impacts on Special-Status Species.	Less than Significant
Loss of Coastal Salt Marsh	Significant	Mitigation Measure BIO-8: Monitor Site Development and Implement Actions to Increase the Rate of Marsh Development, If Required	Less than Significant
Loss of Brackish Open Water Habitat and Brackish Marsh	Significant	Mitigation Measure BIO-9: Monitor Development of Brackish Open Water, Emergent Marsh, and/or Seasonal Wetlands.	Less than Significant
Loss of Habitat for California Clapper Rail, California Black Rail, Salt Marsh Harvest Mouse, and Saltmarsh Common Yellowthroat	Significant	Mitigation Measure BIO-8: Monitor Site Development and Implement Actions to Increase the Rate of Marsh Development, if Required	Less than Significant

Impact	Significance Determination	Mitigation Measure	Significance Determination with Mitigation Incorporation
Temporary Loss of Nesting Habitat for the San Pablo Song Sparrow	Significant	Mitigation Measure BIO-8: Monitor Site Development and Implement Actions to Increase the Rate of Marsh Development, if Required Mitigation Measure BIO-9: Monitor Development of Brackish Open Water, Emergent Marsh, and/or Seasonal Wetlands.	Less than Significant
Potential for spread of invasive nonnative plants within and outside of restoration area during construction activities	Significant	Mitigation Measure 10a: Prevent Spread of Perennial Pepperweed and Other Invasive Weeds to Uninfested Areas Mitigation Measure 10b: Monitor Restoration Sites and Control for Infestation by Invasive nonnative plants	Less than Significant
Disruption of Sensitive Wildlife due to Bay Trail Construction, All Alternatives	Significant	Mitigation Measure BIO-1: Conduct Surveys to Locate Northern Harrier, White-Tailed Kite, Golden Eagle, Cooper's Hawk, Sharp-shinned Hawk, Short-Eared Owl, Burrowing Owl, Saltmarsh Common Yellowthroat, and San Pablo Song Sparrow Nest Sites Before Construction Is Initiated and Avoid Breeding Sites	Less than Significant
Disruption of Sensitive Wildlife due to Public Access Interactions along the Bay Trail	Significant	Mitigation Measure BIO-11: Incorporate Wildlife-Sensitive Approaches in Bay Trail Design and Develop Trail Access Management Plan	Less than Significant

Impact	Significance Determination	Mitigation Measure	Significance Determination with Mitigation Incorporation
Disruption of Sensitive Wildlife due to Public Access Interactions along the Bay Trail, Southward and Northward Extension	Significant	Mitigation Measure BIO-12: Implement Specific Design and Management Mitigation for Bay Trail Southward Extension and Northward Extension from City of Novato Levee	Less than Significant
Potential Harm to Marine Mammals, and Special-Status Fish Species, and Common Fish Species due to Pile-Driving Activities for Off-Loader Facility and Booster-Pump Platforms	Significant and Unavoidable	Mitigation Measure BIO-13: Coordinate with Appropriate Federal and State Agencies to Reduce Impact on Marine Mammals and Special-Status Fish Species during Pile-Driving Activities	Significant
Potential Disruption to Nesting Special-Status and Common Birds due to Removal of Several Eucalyptus Groves and Several Oak Trees	Significant	Mitigation Measure BIO-14: Remove Identified Eucalyptus Groves and Oak Trees outside Special-Status and Other Bird Breeding Seasons	Less than Significant
Potential Disruption to Special-Status Bat Species due to Removal of Structures	Significant	Mitigation Measure BIO-15: Conduct Site Surveys for Presence of Special-Status Bat Species and Remove Structures in accordance with State and Federal Laws.	Less than Significant
Potential Effects of Construction of and Access to the Interpretive Center and Access Area on the "Bulge" Parcel West of the HWRP	Significant	Mitigation Measure BIO-16: Recommended Mitigation Measures for Construction of and Access to and from the Interpretive Center and Access Area on the "bulge" parcel west of HWRP.	Less than Significant
Temporary Disturbance of Fish in San Pablo Bay During Construction	Significant	Mitigation Measure BIO-17: Use Fish Screens to Prevent Possible Entrainment of Fish	Less than Significant
Hazardous Substances and Waste			
Potential Exposure of Humans, Plants, or Wildlife to Hazardous Chemicals Contained in Dredged Material Used as Fill Material	Potentially Significant	Mitigation Measures WQ-1: Implement Methylmercury Adaptive Management Plan	Potentially Significant

Impact	Significance Determination	Mitigation Measure	Significance Determination with Mitigation Incorporation
Potential Exposure of Humans, Plants, or Wildlife to Hazardous Chemicals Due to Sedimentation from Novato Creek and/or San Pablo Bay	Potentially Significant	Mitigation Measures WQ-1: Implement Methylmercury Adaptive Management Plan	Potentially Significant
Transportation			
Construction-Related Emissions of PM10 from Terrestrial Construction Equipment	Significant	Mitigation Measure A-1: Control PM10 Emissions in Accordance with BAAQMD Standards	Less than Significant
Construction-Related Emissions of Ozone Precursors from Terrestrial Equipment and Use of Diesel Pumps to Offload Dredge Material	Significant	Mitigation Measure A-2: Control and/or Offset NOx Emissions Associated with Unloading of Dredged Material	Less than Significant
Noise			
Temporary Increases in Noise Levels to More Than 60 dBA during Onshore Construction	Significant	Mitigation Measure N-1: Employ Noise-Reducing Construction Practices	Less than Significant

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

SELF-MONITORING AND REPORTING PROGRAM FOR

HAMILTON WETLAND RESTORATION PROJECT

NOVATO, MARIN COUNTY

ORDER NO. R2-2005-0034

CONSISTS OF

PART A

AND

PART B

PART A

A. GENERAL

1. Reporting responsibilities of waste dischargers are specified in Sections 13225(a), 13267(b), 13383, and 13387(b) of the California Water Code and this Board's Resolution No. 73-16. This Self-Monitoring Program is issued in accordance with Provision E.4 of Board Order No. R2-2005-0034.
2. The principal purposes of a discharge monitoring program are: (1) to document compliance with waste discharge requirements and prohibitions established by the Board, (2) to facilitate self-policing by the waste dischargers in the prevention and abatement of pollution arising from waste discharge, (3) to develop or assist in the development of standards of performance and toxicity standards, (4) to assist the dischargers in complying with the requirements of the California Code of Regulations.

B. SAMPLING AND ANALYTICAL METHODS

1. Sample collection, storage, and analyses shall be performed according to the most recent version of EPA Standard Methods for the Analysis of Water and Wastewater
2. Water and sediment analysis shall be performed by a laboratory approved for these analyses by the State of California. The director of the laboratory whose name appears on the certification shall supervise all analytical work in his/her laboratory and shall sign all reports of such work submitted to the Board.
3. All monitoring instruments and equipment shall be properly calibrated and maintained to ensure accuracy of measurements.

C. DEFINITION OF TERMS

1. A **grab sample** is a discrete sample collected at any time.
2. **Decant Water**, also known as overlying water, or return water, is the water entrained with the sediment particles during dredging or upland placement of dredged material. After suspended sediment concentrations have been reduced through discrete settling (primary settling in the sediment placement cells and secondary settling in Nina's Pond and other basins), clarified decant water will discharge to an existing storm water pumping station from which it will be pumped to San Pablo Bay.
3. **Receiving waters** refers to any waterbody that actually or potentially receives surface or groundwater, which passes over, through, or under dredged sediment during placement, dewatering, and settling/consolidation activities. The outboard drainage ditch which runs along the outboard levee is the receiving water body for the decant water discharge. The outboard drainage ditch is a tributary to San Pablo Bay, which will receive the decant water flow.
4. A **dredged material placement episode** consists of continuous dredged material slurry placement that stops for no more than 15 consecutive days. If placement stops for more than 15 consecutive days and then starts up again, the date of start-up will be considered the beginning of a new dredged material placement episode for monitoring purposes.
5. A **decant water discharge episode** consists of continuous decant water discharge that stops for no more than 15 consecutive days. If discharge stops for more than 15 consecutive days

and then starts up again, the date of start-up will be considered the beginning of a new decant water discharge episode for monitoring purposes.

6. **Receiving Waters Standard Observations** refer to:
   a. Evidence of floating and suspended materials generated by project activities, as recorded by visual observations.
   b. Discoloration and turbidity: description of color, source, and size of affected area.
   c. Evidence of odors, presence or absence, characterization, source, and distance of travel from source.
7. **Site Standard Observations** refer to visual inspection of:
   a. The overall condition and integrity of the sediment placement cell and settling basin perimeter containment berms.
   b. The location of placed material, amount of freeboard available, and whether any discharge of dredged sediments outside of the containment berms has occurred.
   c. The overall condition and integrity of the dredged material effluent (decant water) discharge weir/s.
   d. The overall condition and integrity of the dredged material transport pipeline from the intake at the connection point at the off-loader in San Pablo Bay to the point of discharge into the sediment placement cells.
   e. The overall condition and integrity of the off-loader and whether any discharge of dredged sediments from the off-loader into San Pablo Bay has occurred.

D. SAMPLING, ANALYSIS AND OBSERVATIONS

1. The total suspended solids (TSS) in the top of the water column in each secondary settling basin prior to discharge over the weir shall be continuously estimated with turbidity meters (optical backscatter sensors) that have been calibrated with grab samples.

The Discharger is required to perform observations and monitoring according to the schedule in Part B.

E. RECORDS TO BE MAINTAINED

Written reports shall be maintained by the Discharger or its laboratory, and shall be retained for a minimum of five years. This period of retention shall be extended during the course of any unresolved litigation regarding this discharge or when requested by the Board. Such records shall show the following for each sample:

1. Identity of sample and sample station number.
2. Date and time of sampling and the name of the person performing the sampling.
3. Date and time that analyses are started and completed, and name of the personnel performing the analyses.
4. Complete procedure used, including method of preserving the sample, and the identity and volumes of reagents used.
5. Calculation of results.

6. Results of analyses, and detection limits for each analysis.

F. REPORTS TO BE FILED WITH THE BOARD

1. Written monitoring reports shall be filed each quarter, by the 30th day of the month following the reporting period, during which placement of material onto the site occurs.

Reporting Period	Report Due Date
January to March	April 30
April to June	July 30
July to September	October 30
October to December	January 30

The reports shall contain the following:

a. Letter of Transmittal

A letter transmitting the essential points in each report should accompany each report. Such a letter shall include a discussion of any Waste Discharge Requirement violations found during the last report period, and actions taken or planned for correcting the violations. If the Discharger has previously submitted a detailed time schedule for correcting requirement violations, a reference to the correspondence transmitting such schedule will be satisfactory. If no violations have occurred in the last report period this shall be stated in the letter of transmittal. Monitoring reports and the letter transmitting the monitoring reports shall be signed by the duly authorized representative of the HWRP responsible for the overall operation of the facility from which the discharge originates. The letter shall contain a statement by the official, under penalty of perjury, that to the best of the signer's knowledge the report is true, complete, and correct.

b. The quantity and locations of dredged material placed at the site and a description of maintenance activities occurring during the reporting period.

c. A map or aerial photograph showing observation and monitoring stations.

d. Laboratory statements of results of analyses specified in Part B; the director of the laboratory whose name appears on the laboratory certification shall supervise all analytical work in his/her laboratory and shall sign all reports of such work submitted to the Board.

i. The methods of analyses and detection limits must be appropriate for the expected concentrations. Specific methods of analyses must be identified. If methods other than EPA approved methods or Standard Methods are used, the exact methodology must be submitted for review and approved by the Executive Officer.

ii. In addition to the results of the analyses, laboratory quality assurance/quality control (QA/QC) information must be included in the monitoring report. The laboratory QA/QC information should include the method, equipment and analytical detection limits; the recovery rates; an explanation for any recovery rate that is less than the recovery acceptance limits specified in the USEPA method procedures or the laboratory's acceptance limits, if they are more stringent than those in the USEPA

method procedures; the results of equipment and method blanks; the results of spiked and surrogate samples; the frequency of quality control analysis; and the name and qualifications of the person(s) performing the analyses.

e. A summary and certification of completion of all Standard Observations for the facility.

2. By March 1 of each year, the Discharger shall submit an annual report to the Board covering the previous calendar year's activities. This report shall contain the following:

   a. Summaries of the quantities and locations of dredged material placement and the source of the dredged material.

   b. An estimate of the total volume of decant water generated from dewatering the dredged material.

   c. A summary of site maintenance activities.

   d. Tabular and graphical summaries of the monitoring data obtained during the previous year.

   e. A description of the compliance record and corrective actions taken or planned which may be needed to bring the Discharger into full compliance with Order No. R2-2005-0034.

3. **Contingency and Corrective Action Reporting**

   a. A report to the Executive Officer and Board case manager shall be made by telephone of any accidental discharge of whatever origin immediately after it is discovered. A written report shall be filed with the Board within fifteen days thereafter. This report shall contain the following information:

      - A map showing the location(s) of discharge(s);
      - Approximate flow rate;
      - Nature of effects, i.e., all pertinent observations and analyses; and
      - Corrective measures underway or proposed.

   b. If the Decant Water Limitation for Total Suspended Solids (TSS) in Order No. R2-2005-0034 is exceeded (i.e., more than 10% of the measurements in a 24 hour period of discharge are greater than 100 mg/L or more than 50% greater than 50 mg/L), the Discharger shall submit a Corrective Action Report within 15 days of the end of the month in which the exceedance occurred. The report shall contain at a minimum:

      - A summary of the continuous monitoring data for each day of the month that decant water discharge occurred. At a minimum, the daily data summary should include the minimum, maximum, mean, median, standard deviation, and percentage of measurements greater than 100 mg/L and percentage of measurements greater than 50 mg/L on a daily basis.
      - A description of the actions that the discharger has taken to adjust site operations to stay within the TSS Decant Water Limitation. These actions may include temporarily delaying material placement to increase retention time in placement cells and settling basins, installing structures to control the flow rate of dredged

material slurry through the site, enlarging the overall size or changing the shape of the cells/basins to increase retention time, or other measures.

- An evaluation of the effectiveness of the corrective actions taken.

PART B: MONITORING AND OBSERVATION SCHEDULE

A. DESCRIPTION OF OBSERVATION AND MONITORING STATIONS

1. **Receiving water standard observations** shall be made within a 100-foot radius of the pump station outfall into the outboard drainage ditch.
2. **Site standard observations** shall be made along the entire length of the dredged material placement cell berms, the secondary settling pond berms, and along the visible portion of the dredged material transport pipeline and within a 100-foot radius of the Off-Loader Facility.
3. Continuous TSS measurements and grab samples of water for **decant water monitoring** shall be taken on the inboard side of settling basin discharge weir spillways.

B. SCHEDULE OF OBSERVATIONS AND MONITORING

1. The schedule of observations and monitoring is provided in Table 1, below:

Table 1. Observations and Monitoring Schedule for the Hamilton Wetland Restoration Project

Constituent/Type of Analysis (units)	**Location**	**Observation/Monitoring Frequency**	**Reporting Frequency (Due Date)**
Site standard observations (visual)	Along placement cell and settling basin containment berms, and along slurry transport pipeline	Daily during dredged material placement episodes	Quarterly (30th of the month following the reporting period)
	Off-Loader Facility within a 100-foot radius	Daily during dredged material placement episodes	Quarterly (30th of the month following the reporting period)
Receiving water standard observations (visual)	Outboard drainage ditch within a 100-foot radius of the pump station.	Daily during decant water discharge episodes	Quarterly (Same as above)
<u>Decant Water Monitoring</u>[1]			
Flow rate (mgd)	Effluent	Continuous during each 24 hour period that decant water discharge occurs	Quarterly (same as above)

Constituent/Type of Analysis (units)	Location	Observation/Monitoring Frequency	Reporting Frequency (Due Date)
TSS estimated from turbidity measurements	Inboard side of secondary settling basin discharge weir	Continuous during each 24 hour period that decant water discharge occurs	Quarterly (Same as above) If TSS limit has been exceeded report monthly, until limit is met (see F.3.b. of Part A).
Dissolved Oxygen (DO)	Inboard side of secondary settling basin discharge weir	Continuous (May through October) during each 24 hour period that decant water discharge occurs.	Quarterly (Same as above)
pH	Inboard side of secondary settling basin discharge weir	Continuous (May through October) during each 24 hour period that decant water discharge occurs.	Quarterly (Same as above)
Dissolved sulfide	Grab sample from inboard side of secondary settling basin discharge weir	Daily for the first 15 days of a Decant Water Discharge Episode, thereafter a monthly average	Quarterly (Same as above)
Metals (µg/L) Arsenic Cadmium Chromium VI Copper Lead Mercury (total) Nickel Selenium (total) Silver Zinc	Grab sample of San Pablo Bay influent water at the off-loader	Daily for the first 15 days of a Decant Water Discharge Episode, thereafter a monthly average	
Wetland Monitoring (will be expanded once Wetlands Monitoring Plan is submitted)	Aerial photography and field survey locations to be determined.	Annual for first five years after outboard levee breach, then every other year until established	Annual Summary Report (March 1 of the following year)
Levee Dimensions	Visual Observation and field survey locations to be determined	Visual walkover inspection twice annually (pre and post winter conditions). Annual field survey.	Annual Summary Report (March 1 of the following year)

Constituent/Type of Analysis (units)	Location	Observation/Monitoring Frequency	Reporting Frequency (Due Date)
Fill and Marsh Development Elevations	Field survey, locations to be determined.	Prior to levee breach (after sediment placement completed), annually for first five years and then every five years until design expectations met.	Annual Summary Report (March 1 of the following year)

[1]For decant water effluent limits, refer to Section C. Effluent Limitations of Order No. R2-2005-0034

2. The Discharger may submit a written request to reduce the frequency of monitoring for constituents listed in Table 1 based on monitoring data collected and analyzed according to the conditions of this SMP, which demonstrate that the temporal variability of these constituents is low enough to justify less frequent monitoring. The request should include a proposed revised monitoring schedule for the subject constituents. The request and schedule must be approved in writing by the Executive Officer prior to implementation.
3. All reports shall be submitted to the Board's case manager at:

California Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA 94612

I, Bruce H. Wolfe, Executive Officer, hereby certify that the foregoing Self-Monitoring Program:

1. Has been developed in accordance with the procedure set forth in this Board's Resolution No. 73-16 in order to obtain data and document compliance with waste discharge requirements established in Board Order No. R2-2005-0034.
2. Was adopted by the Board on July 20, 2005; and
3. May be reviewed at any time subsequent to the effective date upon written notice from the Executive Officer or request from the Discharger, and revisions will be ordered by the Executive Officer or the Board.

Bruce H. Wolfe
Executive Officer

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802- 4213

AUG 9 2005

In Response Refer To:
151422SWR2001SR9138:DPW

Lieutenant Colonel Philip T. Feir
District Engineer
U.S. Department of the Army
San Francisco District, Corps of Engineers
333 Market Street, 8th Floor
San Francisco, California 94105-2197

Dear Colonel Feir:

Thank you for your February 22, 2005, request to NOAA's National Marine Fisheries Service (NMFS) to initiate consultation pursuant to section 7 of the Endangered Species Act (ESA) and the Essential Fish Habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). These consultations pertain to restoration activities proposed for the Hamilton Army Airfield, which is located adjacent to San Pablo Bay, near the City of Novato, Marin County, California. The U.S. Army Corps of Engineers (Corps), California State Coastal Conservancy, and San Francisco Bay Conservation and Development Commission are proposing restoration of the Hamilton Army Airfield as authorized in the Water Resources Development Act of 1999. A revised Biological Assessment for this project was enclosed with your letter. On July 28, 2005, NMFS received an EFH assessment for this project. Additional information clarifying issues presented in the EFH assessment was received via electronic mail from the Corps by NMFS on August 4, 2005, and August 8, 2005.

The project involves placement of up to 7.1 million cubic yards of dredged material at the airfield over an 8-year period to create and restore seasonal and tidal wetlands. Dredged material will be obtained from dredging projects conducted within San Francisco Bay. To facilitate the placement of dredged material, a hydraulic offloading facility will be constructed in about 24 feet of water about 1.5 miles offshore of the site and within San Pablo Bay. A total of sixty-nine 24-inch diameter concrete or steel piles will be used to anchor the offloading structure in place. Dredge scows will tie up to the facility and 17 to 23 million gallons per day (mgd) of water from San Pablo Bay will be used to slurry the dredged material. The slurried material will then be transported five miles to the restoration site through a 30-inch diameter pipe. One or two booster pumps will be needed to deliver the material. The booster pumps will be floating structures, each anchored by up to 12 concrete or steel piles. The offloading structure comprises about 186,000 square feet of floating surface area. After approximately six to eight years of dredged material

placement, the external levee will be breached, and a tidal channel will be dredged across the outboard marsh to connect tidal waters of San Pablo Bay to the restoration area. This will occur whether or not the proposed target elevations are met.

On July 8, 2005, NMFS received a letter from the Corps that contained the following measures to be incorporated into the project in order to avoid or minimize potential impacts to listed salmonids:

1) The Corps will adopt the NMFS recommended criteria for screening the offloader intake. The screen will be constructed of 3/32 inch mesh and the approach velocity will not exceed 0.33 feet per second.

2) In-water construction activities (i.e., dredging of the tidal connection channel and pile driving) will be conducted from June 1 through November 30.

3) Peak underwater sound pressure levels as a result of pile driving will not exceed 180 decibels re 1 micropascal from December 1 through May 31.

Your letter requests NMFS' concurrence with your determination that this project is not likely to adversely affect listed salmonids.

Endangered Species Act

Available information indicates that the following listed species (Evolutionarily Significant Units) may occur at the project site:

Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*)
endangered (January 4, 1994, 59 FR 440)
critical habitat (June 16, 1993, 58 FR 33212)
Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha*)
threatened (September 16, 1999, 64 FR 50394)
proposed critical habitat (December 10, 2004, 69 FR 71880)
Central Valley steelhead (*Oncorhynchus mykiss*)
threatened (March 19, 1998, 63 FR 13347)
proposed critical habitat (December 10, 2004, 69 FR 71880)
Central California Coast steelhead (*Oncorhynchus mykiss*)
threatened (August 18, 1997, 62 FR 43937)
proposed critical habitat (December 10, 2004, 69 FR 71880)

The salmonids listed above use San Pablo Bay primarily as a migration corridor en route to the Pacific Ocean to rear as juveniles or to upstream areas to spawn as adults. Migration of these species occurs primarily in winter and spring months. The Corps has proposed measures to limit in-water construction activities to a period of time when listed salmonids are unlikely to be present. In addition, the Corps has proposed to install a fish screen on the offloader water intake

to prevent the entrainment of juvenile salmonids. The Corps has also proposed to implement measures during pile driving to ensure that peak underwater sound pressure levels remain below 180 decibels if pile driving occurs at a time when juvenile salmonids may be present. Therefore, based on the best available scientific information, NMFS concurs with the Corps' determination that listed anadromous salmonids are not likely to be adversely affected by this project.

This concludes consultation in accordance with 50 CFR §402.14(b)(1) for activities proposed as part of the restoration of Hamilton Army Airfield, Novato, California. However, further consultation may be required if: (1) new information becomes available indicating that listed species or critical habitat may be adversely affected by the project in a manner not previously considered, (2) current project plans change in a manner that affects listed species or critical habitat, or (3) a new species is listed or critical habitat designated that may be affected by the action.

Magnuson-Stevens Fishery Conservation and Management Act

The project is located within an area identified as EFH for various life stages of fish species managed with the following Fishery Management Plans (FMP) under the MSFCMA:

Pacific Groundfish FMP - English sole, starry flounder, leopard shark, spiny dogfish
Coastal Pelagics FMP - northern anchovy, Pacific sardine
Pacific Coast Salmon FMP - Chinook salmon

NMFS has evaluated the proposed project for adverse effects to EFH pursuant to Section 305(b)(2) of the MSFCMA. Potential adverse effects to EFH from this type of restoration project include harm or mortality to fish from sound pressure waves during pile driving; loss of benthic habitat from the footprint of pilings and pipeline; entrainment/impingement of fish and invertebrate eggs and larvae into the dredge material delivery pipeline; degraded water quality from discharge of slurry water following dredge material placement; and temporary turbidity from levee breach and dredging of the outboard marsh. In addition to adverse effects, this project is anticipated to result in significant beneficial effects to EFH by creating 378 acres of tidal marsh, including intertidal mudflats and subtidal sloughs adjacent to San Pablo Bay. Tidal marsh systems are highly productive habitats that produce abundant prey sources and excellent rearing and feeding areas for Federally managed species.

The Corps has incorporated a number of measures into the proposed project to avoid and minimize adverse effects to EFH. As stated in the EFH Assessment, the Corps will minimize effects of pile driving by utilizing a vibratory hammer for pile installation whenever possible. Adverse effects from degraded water quality will be minimized by monitoring of discharge water as required by the California Regional Water Quality Control Board (Order No. R2-2005-0034). The Corps will minimize the loss of benthic habitat from piles and pipelines by using the minimum number of piles (not to exceed 93) and pipeline as possible. The total footprint will be no more than approximately 2.2 acres. While this area will be unusable as feeding and rearing areas during project construction, it represents a very small percentage of available feeding and

rearing habitat within San Pablo Bay. The function of this area will be returned following project construction.

Adverse effects to EFH that will not be avoided during project construction include temporary turbidity from dredging and impingement and entrainment of eggs and larvae through the delivery pipeline. Dredging will only occur within the outboard tidal marsh to link the restoration site to San Pablo Bay. Existing elevations within the proposed area to be dredged are +3 to +7.5 feet North American Vertical Datum (NAVD) and will be lowered to -6 feet NAVD. While temporary turbidity will occur that may harm fish or cause them to move away from the area where the new channel discharges, the dredging will ultimately increase subtidal feeding areas within San Pablo Bay by 3.6 acres within the dredged channel and by an even larger area within the restoration site. Furthermore, placing dredged material at either the restoration site or at an upland disposal site will avoid impacts to EFH associated with in-bay disposal of the dredged material.

The Corps estimates that pumping water from San Pablo Bay (approximately 17-23 mgd) to the restoration site will occur for approximately 710 days within the 7-year construction period. The Corps considered alternative methods to avoid using bay waters, including non-slurry transport, alternate water sources, and recycling water. These options were prohibitively expensive, resulted in other significant environmental effects, or were not reliable enough to complete the project. The Corps will minimize effects to juvenile and adult fishes by screening the intake to NMFS criteria, but impingement and entrainment of eggs and larvae will still occur. Entrained organisms are assumed to experience 100 percent mortality. The effects of this intake cannot be quantified without a full analysis of population dynamics and densities within San Pablo Bay of the species and life stages entrained. In general, mortality resulting from water intake will be limited in space and time to the area and period of construction, and the long-term benefits from habitat restoration should more than compensate for the short-term impacts of project construction.

Given the avoidance and minimization measures included in the proposed project, NMFS concludes adverse effects from construction of the Hamilton Airfield Restoration Project will be less than substantial and adequately compensated by beneficial long-term effects of the project. To further minimize adverse effects to EFH from construction activities, NMFS provides the following EFH Conservation Recommendations:

EFH Conservation Recommendations

- In order to avoid harm or mortality to Federally managed species resulting from sound pressure waves, NMFS recommends that the Corps attenuate peak underwater sound pressure levels to below 180 decibels re 1 micropascal, to the extent possible, whenever an impact hammer is utilized. This recommendation extends attenuation for impact hammer use to year-round and not only during the period of salmonid migration. Examples of attenuation measures could include the use of an air bubble curtain or cushioning block.

- To minimize harm or mortality to Federally managed species from sudden, severe increases in turbidity, NMFS recommends that levee breaching and dredging of the outboard marsh be conducted from the marsh side of the project area towards the bay side of the project, and that the last plug of material that isolates the project from bay waters be removed during a period of low tide.

Please be advised that regulations (50 CFR Sections 600.920) to implement the EFH provisions of the MSFCMA require your office to provide a written response to this letter within 30 days of its receipt and prior to the final action. A preliminary response is acceptable if a final response cannot be completed within 30 days. Your final response must include a description of how the EFH Conservation Recommendations will be implemented and any other measures that will be required to avoid, mitigate, or offset the adverse impacts of the activity. If your response is inconsistent with our EFH Conservation Recommendations, you must provide an explanation for not implementing those recommendations at least 10 days prior to final approval of the action.

If the proposed project changes in a manner that would result in new adverse impacts to EFH, or if new information indicates there may be adverse impacts from these construction activities not previously considered, the Corps should reinitiate EFH consultation with NMFS.

If you have questions concerning these comments, please contact David Woodbury at (707) 575-6088.

Sincerely,

Rodney R. McInnis
Regional Administrator

cc: Philip S. Hill, NMFS, Long Beach, California
Ryan Olah, USFWS, Sacramento, California
Bob Batha, BCDC, San Francisco, California
Tom Napoli, CDFG, Los Alamitos, California

APPENDIX G

Methyl Mercury Monitoring Report

(In preparation by others, to be attached)

APPENDIX H

Summary Control Plan for Invasive Plants

APPENDIX H. Summary Control Plan for Invasive Plants

As part of a Common Practices Management program, aggressive weed control measures will be taken to limit the spread of invasive, non-native plant species within the HWRP site, to allow proper establishment of native species. Specifically, non-native cordgrass, ice plant, perennial pepperweed, and common reed will be the focus for weed removal. Other weedy species of concern include stinkwort, broom, and starthistle. The control plan will completely eradicate all non-native cordgrass species and ice plant, and reasonably control (average less than 5% cover) other undesirable non-native species during the 15-year period of simple monitoring (see Sections 6.2.1, 6.3.1, 8.3). The Site Manager will treat major infestations (those covering more than 100 m^2) immediately and then work on smaller, more diffuse pockets. All infestations occurring within the HWRP site will be controlled and removed without substantially hindering or harming the establishment of native vegetation.

Non-native Cordgrass (*Spartina alterniflora* and hybrids)

Stands of cordgrass should be closely examined throughout the 15-year monitoring period to identify non-native ("smooth") cordgrass. If this species is suspected on site, then the stands should be tested genetically to reliably and officially establish its presence. Smooth cordgrass is an aggressive invasive species that would significantly alter the habitat suitability for Salt Marsh Harvest Mouse and California Clapper Rail, and will be completely removed from the site.

In order to completely eradicate this species the USACE will coordinate monitoring and control with the San Francisco Estuary Invasive *Spartina* Project Control Program. This Program coordinates, plans, and implements the on-the-ground *Spartina* treatment activities. The Control Program is moving forward with an aggressive treatment program, aimed at quickly eradicating invasive cordgrass, particularly smooth cordgrass and its hybrids, from San Francisco Bay.

The control plan for removal of invasive cordgrass from the HWRP site will be based on the site-specific conditions of its growth, adjacent land uses, and feasible treatment methods, coordinated within the Control Program established by the Invasive *Spartina* Project. Treatment methods used by the Invasive *Spartina* Project include a range of manual, mechanical, and chemical methods. Some of these methods are aimed at killing target cordgrass populations, while some are 'support techniques,' which facilitate implementation of a removal method or provide temporary control pending a more permanent solution. No single treatment technique is expected to be completely effective on its own; most frequently the methods are combined according to site-specific needs to achieve the desired control objective with minimized adverse impacts.

Four main mechanical treatment methods are being adopted by the Invasive *Spartina* Project; hand pulling and manual excavation; covering/blanketing; mowing, burning, and pruning; and mechanical excavation and dredging. The main chemical method is to apply herbicide either on the ground or by boat, or from an airborne helicopter.

Hand-pulling and manual excavation

Manual removal includes pulling cordgrass plants out of marsh sediments or using hand-tools such as spades or mattocks to cut away as much cordgrass as possible within reach. Manual removal methods are effective primarily at removing above ground plant parts, but are less effective at removing below ground rhizomes that rapidly regenerate shoots. Unless digging removes the entire marsh soil profile containing viable rhizomes and buds, its effect is equivalent to pruning, since roots left in contact with moist soil often retain viability and regenerate in place, or disperse to establish new populations. Manual removal is most effective on isolated seedlings, or very young discrete clumps. Digging and excavation are not practical on larger areas and can cause relatively greater damage to the sensitive marsh environment as compared to aquatic herbicide.

Mechanical excavation and dredging

Mechanical removal in marshes uses equipment specially designed for working in semi-terrestrial, semi-aquatic wetland environments, such as amphibious dredges fitted with excavators or clamshells, 'cutterhead' dredges, or terrestrial excavators working from mat structures on the marsh surface. Some locations allow use of conventional shallow-draft, barge-mounted dredging equipment working within reaches of the marsh from the margins of navigable channels, particularly at high tide. Where cordgrass colonies lie adjacent to levees or roadways, track-mounted excavators can work without entry into the aquatic or wetland environments. Mechanical excavation working to the full depth of the rhizome system (up to one foot) in tidal marshes has the potential to be significantly more effective than manual excavation.

Covering/blanketing

This method typically involves crushing the *Spartina* so that it is even with the substrate, covering the entire plant with opaque geotextile fabric, and firmly staking the cover completely around a patch of cordgrass. This excludes light essential to photosynthesis, and 'bakes' the covered grass in a tent of high temperature and humidity. This technique can be used for small, discrete clones where the geotextile fabric can be fastened to the marsh surface securely with stakes for a sufficient period of time to kill the plants. High tides, high winds, and tide-transported debris common in tidal marshes often make this technique difficult or impossible. Care must be taken to cover beyond the edge of the clone to a distance sufficient to cover the expected vegetative expansion from the rhizomes for at least one growing season. Staking geotextile tents on soft mudflats is very difficult, and is not feasible in many situations.

Mowing, burning, and pruning

Cordgrass is well adapted to disturbances that 'crop' or otherwise remove above ground biomass. A single event that removes living or dead above ground cordgrass biomass generally just stimulates cordgrass growth, and as soon as a cordgrass stand re-sprouts, it begins to 'recharge' its roots and rhizomes with new food reserves. If vegetation is removed with frequency, roots and rhizomes are prevented from regenerating reserves of energy and nutrition and cordgrass begins to die back as its organs of regeneration and storage become exhausted. If the cordgrass is mown close to the mud surface, it also severs the connections that transport oxygen from the leaves to roots growing in extremely anoxic

(oxygen-deprived) waterlogged sediment, an additional source of stress on the plant that may eventually lead to mortality.

Repeated close mowing may be used to increase physiological stress to a point that cordgrass cannot regenerate, but this method is only feasible to use on small discrete stands of *Spartina*. Controlled burning may be used in some situations to remove vegetation prior to other treatments, or to prevent pollen and seed dispersal in founder colonies invading new sites. Burning may prove very useful prior to herbicide treatment to clear dense areas of standing dead cordgrass that remains from the previous year's treatment. Selective pruning may be used to remove flower heads and seed heads of discrete colonies to prevent flow of pollen from contaminating seed production of Pacific cordgrass, and to prevent seed production within founding colonies. Pruning would have little or no effect on the clone's growth rate or overall health and must be followed up with other methods to control spread.

Aquatic herbicide application

Aquatic herbicides have proven to be highly effective in eradicating populations of non-native cordgrass. Imazapyr and glyphosate are the only herbicides currently approved by the U.S. Environmental Protection Agency (USEPA) and the California Department of Pesticide Regulation (CDPR) for use in estuarine environments. While glyphosate has been available for estuarine vegetation management in California for some time, imazapyr was registered for estuarine use in the State of California on August 30, 2005. Both imazapyr and glyphosate herbicides are systemic broad-spectrum herbicides that are normally applied to and absorbed by foliage, and are circulated (translocated) throughout the plant and down into the below ground roots and rhizomes. Because *Spartina* clones propagate rapidly via rhizomes, the translocation of the herbicide into the rhizomes and their ensuing cell death effectively prevents further spreading of the clone once the above ground portion of the plant has died. Both herbicides block specific enzymes in the synthesis of certain amino acids in plants. The ensuing disruption of protein synthesis leads to interference in cell growth resulting in chlorosis and tissue necrosis of new leaves.

The Invasive *Spartina* Project Control Program uses a number of herbicide delivery systems including backpack sprayer, conventional spray truck, amphibious tracked vehicle, hovercraft, shallow-bottom boat, airboat, and aerial application via helicopter, where appropriate. Because the application of herbicide is highly effective with very low environmental impact compared to non-chemical control methods, it is the preferred control option on about 95% of the *Spartina* treatment sites in the Invasive *Spartina* Project.

Ice plant (Carpobrotus edulis)

Ice plant is native to South Africa but came to the U.S. in the 1800s. Since that time, it has dominated many wetland areas in California and out-competes native plants for nutrients in the soils. It also alters soil chemistry to the detriment of native plants. Two main control methods could be adopted for eradication of ice plant; hand clearing and application of herbicide. Because of the high water content of shoot tissues, burning of live or dead plants is not a useful control method.

In areas where small native seedlings are growing within an ice plant mat, the ice plant will be removed by hand to prevent damaging the seedlings through the use of herbicide. The technique will focus on removing the entire clonal mat and root system, to prevent re-sprouting. Manual removal will also consist

of pulling trailing runners that are encroaching on native vegetation or in areas that are inappropriate for chemical application. Earth-moving machinery may also be used to remove buried stems.

Ice plant areas where no native seedlings are growing will be treated with a 2% solution of glyphosate herbicide with a 0.5% non-ionic surfactant. Application will be conducted in the fall using a backpack sprayer during periods when wind velocities are less than 5 miles per hour. Native plants will be protected by using plastic shields to reduce spray drift. To further protect native plants a three-foot 'no spray' buffer and blue-dye indicator will be used. Appropriate manual techniques will be used to remove remaining buffer biomass without harming native relict vegetation.

Perennial pepperweed (*Lepidium latifolium*)

Perennial pepperweed is an aggressive weed and if it becomes a major part of the vegetation composition of the HWRP site, plant diversity will be lowered and habitat structure within the marsh will be dramatically altered. Annual control of those individuals within the site will prevent rapid spread of this weedy species.

Perennial pepperweed plants have large underground root systems and reproduce both by fragmentation of the root system and seed germination. A large amount of the plant's energy is stored within the root system. The most effective control method is a combination of both mechanical and chemical methods. A 2% solution of glyphosate with the addition of 0.5% non-ionic surfactant is effective in the control of perennial pepperweed when the application is preceded by mowing. The most effective timing for application of herbicides is during the flower bud stage of growth (usually late May to mid June), when the plants begin to allocate large amounts of photosynthate to the root structures. Mowing or cutting of the plants will be completed during the flower bud stage followed by an application of herbicide to the re-sprouting growth. Timing for application will be field-checked as flowering is weather dependant and will vary from year to year. An NPDES permit from the RWQCB is required for the application of herbicides within an aquatic body for aquatic weed control.

If the clusters of perennial pepperweed plants within the HWRP site are small, then another option for control is hand removal. Small infestations can be removed by repeated removal of the entire plant, including the below ground root system. However, even small root pieces can re-sprout. If any portion of the root system is left intact, the process will need to be repeated.

Common reed (*Arundo donax*)

Common reed is a long-lived perennial grass that grows in dense stands to a height of up to 15 feet, with rhizomes that may extend three feet deep underground. While common reed is capable of reproducing by seed, it primarily reproduces asexually by means of rhizomes. A combination of physical and chemical methods results in the best control of common reed. Between mid August and mid October, the reed should be cut down after it has flowered, followed immediately with a cut stump application of 50% glyphosate. The cut vegetative material will be removed as this litter will preclude native species from germinating in the area. The herbicide should not be broadcast sprayed, as that will prevent the growth of desired vegetation. The herbicide should be applied directly to the recently cut stump, either painted on or hand sprayed. This type of application will allow the desired vegetation to grow up, shade out, and out-

compete the common reed. The timing of any herbicide application should take into account the possible effect on special-status species.

Stinkwort (Dittrichia graveolens)

Stinkwort is a fall-flowering, sticky aromatic annual that appears to be rapidly expanding its range in California. Stinkwort has the ability to spread rapidly potentially assisting its establishment as a dominant species. It is recommended that dittrichia plants be immediately removed by hand as they are found.

Broom (Cytisus monspessulanus, Spartium scoparium, Genista juncea)

French broom was introduced as a landscape ornamental, along with Scotch , and Spanish broom. French broom is an aggressive invader, forming dense stands that exclude native plants and wildlife. These leguminous plants produce copious amounts of seed, and may resprout from the root crown if cut or grazed.

Starthistle (Centaurea solstitalis)

Yellow starthistle is one of the most serious grassland weeds in the northwestern U.S., impacting native plant diversity, altering water cycles, and poisoning animals.

Other Species to be Controlled

Pampas grass (*Cortaderia* sp.), acacia (*Acacia* sp.), fennel (*Foeniculum vulgare*), all non-native blackberries (*Rubus* sp.) and pennyroyal (*Mentha pulegium*) are also high priority targets for eradication. Additional species may be added to the control list by the Site Manager or the Adaptive Management Working Group.